LUBRICATING OIL SYSTEM.

The lubricating oil system is of the dry sump type which has a sump tank for holding the oil supply. Oil is circulated through the system by an engine-driven pump. Refer to the lubricating oil piping schematic drawing in the "Drawings" section of this manual for the specific details of the system, relative location of major components, direction of flow, and notes relative to installation of the system.

FLOW PRINCIPLE.

Pump suction draws the lubricating oil from the sump tank and discharges it to the lubricating oil cooler. Flow from the cooler is through a lubricating oil filter and pressure strainer to the engine main headers. A branch line from the strainer takes oil to the turbochargers. Return is by gravity flow from the engine base to the sump tank. Separate lines direct return flow from the turbochargers from the sump tank. A relief valve, set at 70 psi, provides protection to the system, and pressure regulating valves regulate the system pressure.

KEEP WARM CIRCUIT.

A "keep warm" circuit is provided to maintain the lubricating oil charge, and thereby the engine, in a warmed and lubricated condition when in the standby status. Heaters at the sump tank warm the oil which is then pumped by the keep-warm pump to the keep-warm filter and strainer and then to the main engine lubricating oil header. To prevent flooding of the turbochargers, there is no supply to the turbochargers in this circuit. The lubricating oil heater thermostat should be set at 150° F.

PLACING LUBRICATING OIL SYSTEM IN SERVICE.

Before the engine is first started, the assembled lubricating oil piping system must be thoroughly flushed with oil. Disconnect the pipe at the pressure strainer inlet and arrange a temporary bypass from this pipe to the sump tank. The bypass will permit oil circulation through the pipes without filling the internal lubricating oil system of the engine. Several thickness of cloth sack should be secured to the outlet of the bypass to catch debris as it is flushed out. The sump tank and engine base must be thoroughly cleaned before being filled. The auxiliary lubricating oil pump, or any other continuous duty pump of sufficient capacity, can be used to pump oil during flushing operations. Flushing should continue for at least eight hours if care was exercised during fabrication of the system. As much as 24 hours of flushing may be required for a dirty system. When oil is circulating through the system, the pipes should be thoroughly pounded several times with a heavy hammer to loosen dirt and debris. Hot flushing oil will clean better than cold oil. Piping around the oil cooler requires special attention to insure that the pipes and oil cooler are properly flushed. Precautions must be taken to insure the complete removal of testing fluids, water or other liquids before attempting to flush the cooler.

Note

Engines may be received with the strainer mounted on the engine and connected to the engine lubricating oil header. If it is certain that the connections between the strainer and the engine oil header have not been disconnected since the engine left the factory, the following paragraph may be omitted.

Disconnected jumper tubes between the engine lubricating oil header and the main bearings, and between main headers and auxiliary headers. Secure a fine screen such as a nylon stocking over each main header fitting to catch debris that may be washed through as the system is flushed. Cover main bearing fittings and open ends of auxiliary header feeders to prevent the entry of dirt. Engine oil should be pumped through the open system for at least four hours to be sure that any foreign material remaining in the headers is removed. Reassemble internal tubes and brackets as required.

PART K – LUBRICATING OIL SYSTEM

FILTERS AND STRAINERS.

The full flow filter continuously filters all of the lubricating oil from the pump before it passes to the oil strainer. The length of time that the lubricating oil and the filter elements may remain in service can best be determined by carefully watching the result of oil analysis and the pressure drop across the oil filter. Change period will vary with the operating conditions to which each individual engine is subjected. During the first two or three days of engine operation after initial installation, or after a major overhaul, the strainer at the pump suction and the strainer at the oil header inlet should be checked and cleaned as necessary to remove any debris and other foreign matter that may be present. If at any time the oil pressure gauge shows a low reading, the following should be done to the degree necessary to correct the situation.

a. Check the oil level in the sump tank.

b. Inspect strainer, filter and lubricating oil cooler. A leak in the cooler may be detected by a sudden increase in oil consumption, and by the presence of oil in the cooling water system. Leakage may occur in the packing between the tubes and the tube sheet, or may be due to tube erosion, depending on the construction of the cooler.

c. Inspect all external and internal piping for tightness and freedom from obstructions.

d. Dismantle and inspect pump.

LUBRICATING OIL PUMP.

The engine-driven lubricating oil pump is a positive displacement, rotary type. As the pump rotates, the unmeshing of the teeth of the two gears produces a vacuum which draws oil between the tooth spaces. Oil is confined in the space between the gear teeth and the housing, and is carried to the discharge side of the pump. The meshing of the gears forces the oil into the discharge line by displacing the oil from the tooth spaces as the opposite gear enters the space. The pump is mounted on the engine gearcase by means of an adapter, and is driven by the idler gear through a gear carrier assembly. A spline on the pump shaft engages internal splines on the gear carrier shaft coupling. Refer to figure 6-K-1 for mounting details.

REMOVING PUMP.

To remove the pump from the engine, do the following.

a. Remove the inlet and discharge piping as well as any other interfering piping or accessories.

b. Position a sling on the pump and attach to a chainfall and take up the slack.

c. Remove the capscrews that secure the pump to the adapter and pull the pump directly away from the engine until it is clear.

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PART K – LUBRICATING OIL SYSTEM (Continued)

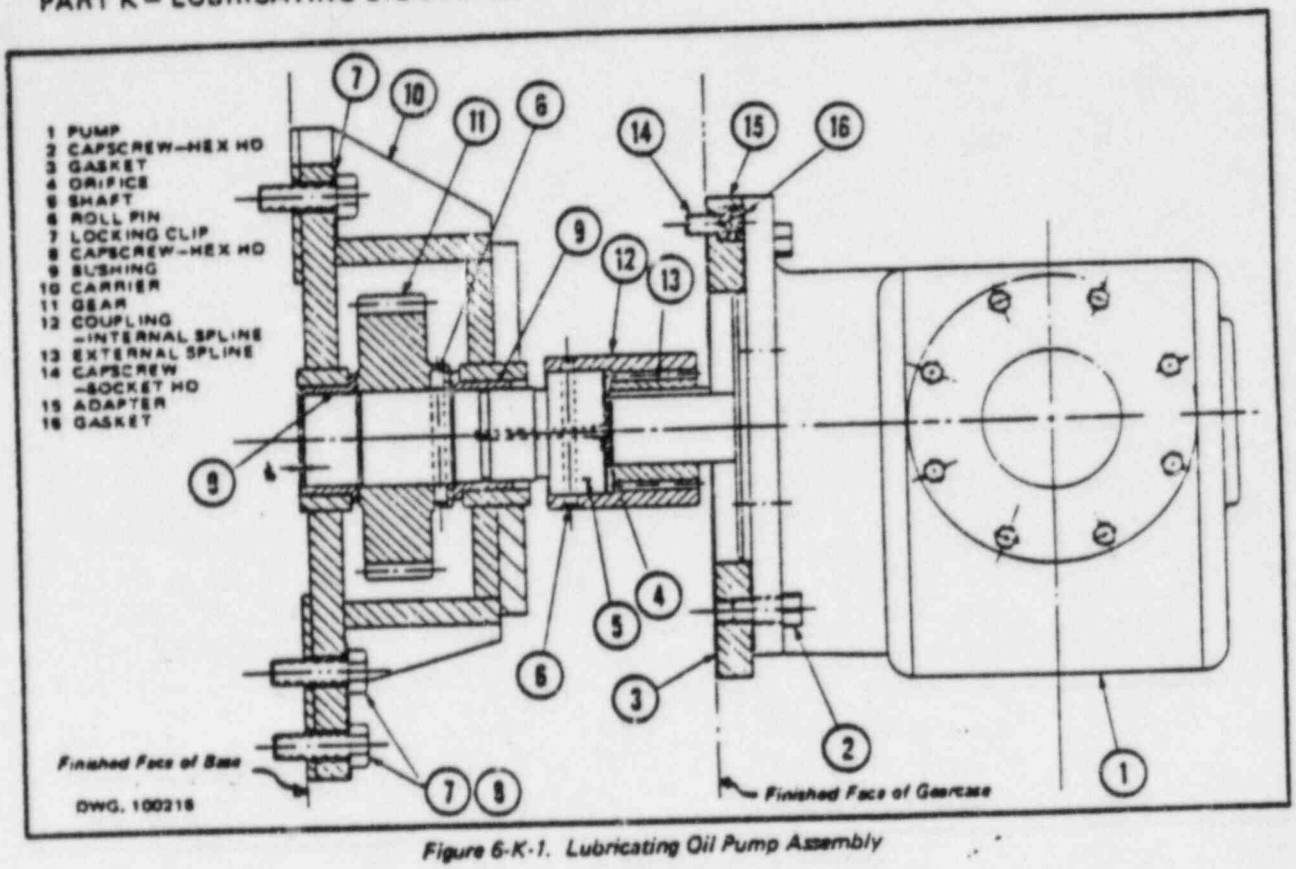

Figure 6-K-1. Lubricating Oil Pump Assembly

PUMP DISASSEMBLY (See Figure 6-K-1).

If it is necessary to disassemble the pump, exercise care to keep the parts clean so that no dirt, grit or other foreign matter will be present when the pump is assembled. Disassemble as follows.

a. Remove spline from pump shaft, taking care not to exert any internal forces on the pump parts.

b. Remove hex head screws from the faceplate end of the pump and remove the faceplate which contains two bearings.

c. Remove idler gear and shaft, then the drive gear and shaft.

d. Remove hex head screws from backplate end of pump housing and remove backplate which contains two bearings.

e. Carefully examine the surfaces of the gears. Slight burrs or feather edges may be removed with a hand stone.

f. Examine bearings and clean oil grooves and passages.

g. Remove burrs and foreign matter on gasketed surfaces of end plate and case.

h. Check bearing wear, using the table of clearances provided on next page.

PART K – LUBRICATING OIL SYSTEM (Continued)

TABLE OF CLEARANCES
Roper Pump Company Figure 2877 Type 1

SHAFT OUTSIDE DIAMETER TO BEARING INSIDE DIAMETER*	
Bearing Inside Diameter	2.0050" – 2.0055"
Shaft Outside Diameter	2.0000" – 1.9995"
Diametric Clearance	0.0050" – 0.0055"
Maximum permissible operating clearance	0.0100"
NOTE: Wear can occur in bearing ID or shaft OD. Total of both not to exceed 0.010".	
GEAR OUTSIDE DIAMETER TO CASE BORE*	
Case Bore	5.657" – 5.669"
Gear Outside Diameter	5.658" – 5.657"
Initial Clearance	0.009" – 0.012"
PUMP LATERAL CLEARANCE**	
Case Width	8.751" – 8.750"
Gear Width	8.750" – 8.749"
Total Compressed Gasket Thickness	0.014" – 0.016"
Total Initial Lateral Clearance	0.018" – 0.014"

*Not considering roundness, concentricity and positioning tolerance.
**Not considering squarness, perpendicularity and positioning tolerance.

PUMP REASSEMBLY.

Assembly is the reverse of disassembly. The spline must be mated to the shaft without exerting any internal forces on the pump parts. The tapered end of the idler gear should be meshed to the opposite end of the drive gear. Taper ends are designated by the letter "T" appearing in the root area of the gear teeth.

INSTALLATION OF PUMP.

Before mounting pump on engine, make sure pump rotates freely. Mount pump to adapter, engaging dowel and the pump shaft spline with that of the gear carrier shaft. Use a gasket between the pump and the adapter. Assemble nuts on studs, and capscrews. Tighten. Lubricate pump through ports with any good grade of light weight oil to insure pump will not be dry at the time of initial starting. When installing piping, do not force as the strain imposed will cause undue wear on the pump. No external lubrication is required as the pump is self lubricated by the oil it pumps during operation.

PUMP GEAR CARRIER ASSEMBLY.

The pump gear carrier assembly consists of a shaft, supported by two bronze bushings, pressed in the carrier assembly with their flanges to the inside. The pump end of the shaft has an internally splined adapter, attached to the shaft with a roll pin, which accepts the spline on the pump shaft. The drive gear is mounted on the shaft between the two bushings and engages the idler gear. The carrier assembly is secured to the engine block by capscrews and locking clips.

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PART K – LUBRICATING OIL SYSTEM (Continued)

DISASSEMBLY AND ASSEMBLY OF GEAR CARRIER ASSEMBLY.

To remove the pump gear carrier assembly, the pump must be removed as outlined above, then the gearcase removed.

a. Remove lubricating oil lines from carrier assembly.

b. Bend back locking clips and remove capscrews. Remove carrier assembly.

c. To remove gear, shaft and bushings from carrier assembly, remove gear-to-shaft roll pin then press shaft out of gear. With shaft and gear removed, press bushings out of drive bracket.

d. Assembly is the reverse of disassembly. Use new locking clips.

PART K – LUBRICATING OIL SYSTEM (Continued)

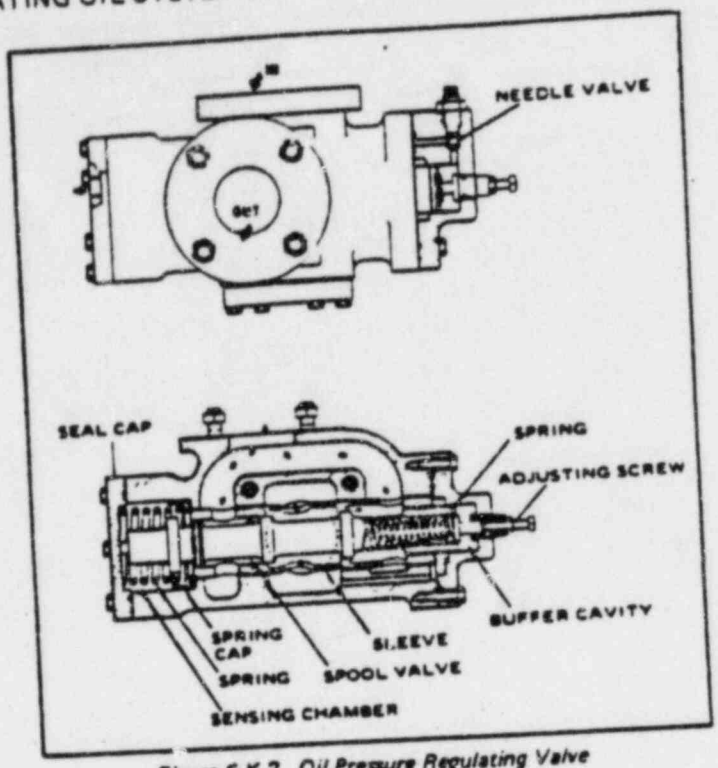

Figure 6-K-2. Oil Pressure Regulating Valve

PRESSURE REGULATING VALVE.

Lubricating oil header pressure in the engine is regulated by a pressure regulating valve, mounted on the pump discharge piping so that the pump discharge is directed to this valve before reaching any other system components. Set at 50 psig, it senses header pressure and regulates the bypass volume to maintain the set header pressure. Besides regulating header pressure, the valve protects the system from excessive pressure during starts with cold oil, or when flow in the system is restricted between the pressure regulating valve and the header pressure sensing point. The functioning of the valve is as follows.

a. The "IN" port of the valve is connected to the pump discharge line and the "OUT" port is connected to a bypass line leading back to the engine base. A sensing tube, connecting the valve seal cap to a point on the main engine oil header, applies header pressure to the valve pressure sensing chamber.

b. The pressure in the sensing chamber acts against the end of a spool valve, compressing a spring at the adjusting screw end of the assembly. If the sensed pressure rises above the set point, the lands of the spool valve will clear the lands on a sleeve. Oil then flows from the inlet section to the outlet section of the regulating valve and back to the engine base to bypass a part of the pump discharge to reduce the pressure in the header.

c. A drilled passage connects the inlet section of the valve to the annular space around the spool valve at the adjusting screw end. This allows pump discharge pressure to act against the end of the sleeve and oppose the spring force at the other end. When an excessive pressure differential exists between the pump discharge and the header pressures, such as when starting with cold oil, or because of an obstruction in the system between the regulating valve and the header pressure sensing point, the sleeve is forced towards the sensing chamber end, compressing the spring. This will uncover the lands of the spool valve and the excess oil will bypass through the spool valve and the excess oil will bypass through the outlet side of the valve back to the engine base.

PART K – LUBRICATING OIL SYSTEM (Continued)

d. The oil in the annular space around the spool valve, at the adjusting screw end, will leak past the sealing grooves of the spool valve and into a cavity in the cap. This cavity functions as a buffer chamber. To stop valve oscillation, an adjustable needle valve controls oil spillage from the buffer cavity to the outlet-section of the valve.

e. The oil header pressure is set by increasing or decreasing the spring force acting against the header pressure in the valve sensing chamber. Turning the adjusting screw in will increase header pressure, and backing it out will decrease pressure.

f. Normal lubricating oil pressure is 50 psi, measured between the engine lubricating oil strainer and the engine oil header which is also the pickup point for all gauges and other instrumentation that show or indicate engine lubricating oil pressure. Lubricating oil pressure shutdown devices may take their sensing point at the opposite end of the engine in which case the shutdown set pressure will take into account the normal change in pressure between the supply end of the engine and the shutdown sensor under all conditions of engine speed and lubricating oil temperature.

ADDING LUBRICATING OIL.

The lubricating oil sump tank is provided with a fill connection and a dipstick, located on the top of the intake section of the tank. A level indicator may be provided at the control panel for monitoring purposes, however, the level in the sump tank should be verified by means of a visual reading of the dipstick before oil is added to the system, and the expected rise in the level in the sump tank must be verified by means of the dipstick. Oil may be added to the system with the engine running or with the engine stopped. The dipstick has two sets of marks, one for the static condition and one for the running condition. The markings are "Full Static" and "Low Static" on one side of the dipstick, and "Full Run" and "Low Run" on the other. Before oil is added, it should be determined that the correct oil is available. Appendix VI of this manual contains the recommended specifications for the lubricating oil to be used.

CAUTION

Oil must never be added from any location other than the fill connection on the sump tank. Do not overfill. Attempting to fill from any other location could result in oil reaching other than design locations.

PART K – LUBRICATING OIL SYSTEM (Continued)

SELECTION OF A LUBRICATING OIL.

The selection of a lubricating oil to be used in the engine is a complex matter, and is very important to the engine's successful operation. The recommendations of both the oil supplier and the engine manufacturer should be carefully considered. Transamerica Delaval's recommendations for a suitable lubricating oil are stated in Section 8, Appendix VI. Other factors to be considered include the price, service life, load factor and fuel sulphur content as well as the filtration and oil purification system used.

CHANGING LUBRICATING OIL.

Once an oil has been selected the engine user, in consultation with the oil supplier, should map out a plan for periodic sampling and laboratory analysis of the oil. A careful review of these results by the owner, the oil supplier and the testing laboratory can then become the basis for deciding whether or not the oil needs to be changed. Transamerica Delaval recommends that oil be changed on the basis of condition of the used oil rather than on a time schedule.

ANALYSIS OF OIL.

Various chemical and physical tests have been developed to classify and identify new oil, and to determine what changes have occured in these oils while in service. The American Society for Testing Materials (ASTM) has standardized these tests, and certain of these tests have been approved as an American National Standard by the American National Standards Institute, Inc. (ANSI). Transamerica Delaval, as stated in Section 5, recommends that representative oil samples be submitted to a qualified laboratory for analysis on a monthly basis, or oftener if operating conditions indicate. The following tests should be conducted.

a. OIL VISCOSITY – Tested in accordance with ASTM D88, D445, ANSI Z11.2 and ANSI Z11.107. The viscosity test will indicate whether the proper grade of oil is being used, and will indicate oxidation (by increased viscosity) or fuel dilution (decreased viscosity). The oil supplier can provide advice regarding the significance of the specific values obtained.

b. WATER/GLYCOL CONTAMINATION – A measure of water and/or glycol contamination of the oil can give warning of potential problems. Water or glycol contamination can come from liner seals, turbocharger casings or faulty lubricating oil heat exchangers.

c. NEUTRALIZATION VALUE – Test in accordance with ASTM D664, D974, ANSI Z11.59 and ANSI Z11.131. Engine oils are intentionally formulated slightly alkaline so that they are capable of neutralizing the acidic compounds that form from products of combustion and of oil oxidation. Generally this reserve alkalinity is depleted and the weak organic acids that attack bearing surfaces can be destructive. Periodic evaluation of Total Base Number (TBN) and Total Acid Number (TAN) are an important measure of oil degradation. As time goes on, TBN is depleted and TAN begins to rise.

d. PENTANE AND BEZINE INSOLUBLES – ASTM D893. This test is a measure of oil insoluble materials, oil resinous matter from oil or additive degradation, external contamination, fuel carbon and highly carbonized materials from degradation of fuel, oil, additives, engine wear and corrosive materials.

e. SPECTROGRAPHIC ANALYSIS – This test is used to measure quantitively the mineral elements in the oil, including wear or corrosion metals such as aluminum, chromium, iron, copper, silver, lead and tin. Also, dirt contaminants from the coolant such as boron, potassium and sodium.

Note

The Transamerica Delaval Customer Service Department in Oakland, California will welcome any correspondence regarding oil selection and/or testing. Although Transamerica Delaval cannot recommend a specific lubricant, nor accept any responsibility for the performance of the lubricant selected by the owner, it will be pleased to discuss its experience with a given oil product, or review your oil analysis and offer comments.

PART K – LUBRICATING OIL SYSTEM (Continued)

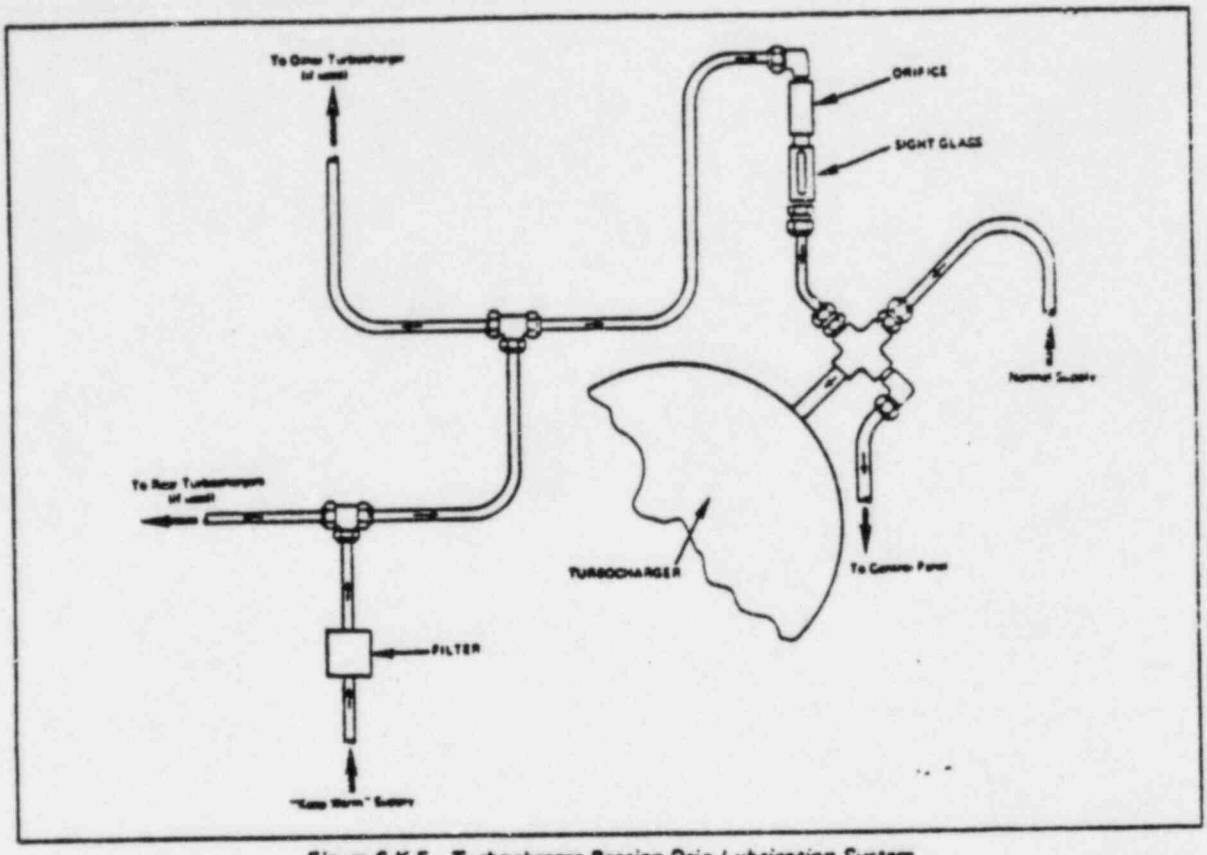

Figure 6-K-5. Turbocharger Bearing Drip Lubrication System

TURBOCHARGER BEARING LUBRICATION.

The turbocharger bearings are lubricated by the engine lubricating oil system during normal engine operation. On the other hand, when the engine is in standby status oil is not circulated to the turbocharger. The design features of the Elliott BCO 90G turbocharger are such that the prolonged circulation of oil to the bearings while the turbocharger is at rest will result in oil intruding past the bearings into the turbine section. To prevent failure of the bearings during a start, however it is essential that the bearings be properly lubricated during prolonged periods in standby. A drip lubrication system is provided to perform this function (see figure 6-K-3). Lubricating oil from the "keep warm" supply is passed through a 60 micron filter then through a 0.014 inch diameter orifice to a sight glass. The sight glass, one for each turbocharger, provides a means for positive determination of oil flow to the bearings. This flow is sufficient to provide for proper lubrication of the bearings without flooding the turbocharger. Little maintenance should be required other than the possible replacement of filter elements.