CAROLINA POWER & LIGHT COMPANY

RALEIGH, NORTH CAROLINA 27602

July 6, 1971

Dr. Peter A. Morris
Division of Reactor Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

DOCKET NO. 50-261
FACILITY OPERATING LICENSE NO. DPR-23

Dear Dr. Morris:

This letter is in reply to your letter of March 29, 1971, regarding operation of the emergency diesel generators at our H. B. Robinson Unit No. 2. The following information is submitted in response to the eight questions contained in the above referenced letter:

The trip functions which will prevent startup or initiate shutdown of the diesel generators, along with the setpoints and normal operating parameters, are listed below:

Trip Function	Setpoint	"A" Diesel Normal	"B" Diesel Normal
High Jacket Coolant Temperature, °F	205	158	160
Low Lube Oil Pressure, psig	16 (decreasing)	27	28
Local Control Electrical Trip	Manual	-	-
Starting Failure, seconds	10	-	-
High Crankcase Pressure, inches H_2O	-0.5	-4.0	-2.0
Low Jacket Coolant Pressure, psig	9	38	34
Generator Overcurrent, amps	24,000 (instantaneous)	3,759	3,759
Mechanical Overspeed, rpm	1,010	900	900
Local Manual Trip	Manual	-	-

The low lube oil pressure trip is provided since a complete failure of the flow of lubricant would result in metal-to-metal contact between the bearings and crank and rod journals, as well as the pistons and rings with the cylinder walls. Since the oil also serves as a cooling fluid for the engine (pistons in particular), failure of the oil supply adds to the heat produced by the lack of the lubricating film between bearings and journals.

/S/ JGK/Staff 9/12/71
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If the engine were operating under rated load and a complete loss of flow of lube oil occurred, it is expected that the engine would stop in as little as fifteen seconds or less. If, however, the loss of pressure was very slow, the engine might run for several hours or even days after the pressure dropped to the low lube oil pressure trip setpoint.

The high jacket coolant temperature trip is provided since high jacket coolant temperatures can result in piston seizure due to failure of the oil film between the piston and cylinder liner and in cavitation of the jacket cooling pump with complete loss of flow of coolant in the cooling system. This results in formation of steam since the cooling system is not capable of removing the heat rejected by thermal syphon action alone. We would estimate that, with the diesel running at rated load, damage to the engine could occur within three minutes after reaching the high jacket coolant temperature shut-down switch setpoint if the trip was not provided. It should be noted that a jacket coolant high temperature alarm switch is provided that actuates below the functioning of the shut-down switch.

The low jacket coolant pressure trip is provided primarily to back up the high jacket coolant temperature switch. On other diesels, it has been found that with a rapid loss of coolant, the high jacket coolant temperature switch did not function to protect the engine in that the flow of steam resulting from the evaporation of the remaining water in the diesel jackets did not operate the high jacket coolant temperature switch which subsequently resulted in loss of pistons and liners.

The high crankcase pressure trip is provided to shut the engine down in case of severe blow-by and/or crankcase explosions. In this event, the exact time that the diesel would operate after the development of a pressure in the crankcase which would activate the high crankcase pressure switch would vary over a wide time range. In one case, almost immediate stoppage of the diesel could result if a piston failed. On the other hand, the diesel could operate for many hours or even days after the detection of a positive pressure in the diesel crankcase if the blow-by from several cylinders increased at a slow rate over a period of time or if the crankcase ejector operated improperly.

The local control electrical trip and the local manual trips provide a manual tripping capability for the operator's observance of a condition of diesel operation requiring a diesel stop.

The starting failure trip is a mechanism to prevent the diesel from completely consuming all its starting air supply if the diesel fails to start and is in reality a signal to terminate the starting attempt until the starting difficulty can be corrected.

The generator overcurrent trip is provided to stop the diesel if a condition exists in the generator circuit requiring the generator to trip. In this event, the operation of the diesel would not be useful and might cause additional damage to the generator. If this trip were removed and a serious bus fault were to occur, extensive generator damage could be expected within seconds. If only the generator field were tripped and the diesel were to continue to operate, extensive mechanical damage to the generator could occur due to rubbing of the generator internals.

The diesel mechanical overspeed trip is a conventional weight operated device set at 1010 rpm and is provided to stop the diesel if the governing mechanism were to malfunction causing an uncontrolled increase in speed. Such a failure could result in the destruction of the diesel in seconds.

The following list contains all alarm and trip function indications associated with operation of the emergency diesel generators including annunciator window name and the sources which will give the indication on either the Control Room Board or at the diesel locations:

ALARM AND TRIP FUNCTION INDICATIONS

Annunciator Window Name & Sources	Location: Control Room Board	Location: Local Diesel Alarm Lights
1. Diesel Trouble	X	
Starting Failure Pressure		X
High Crankcase Pressure		X
Low Lube Oil Pressure		X
Local Control		X
Low Raw Water Pressure		X
Engine Overspeed Warning		X
Low Coolant Pressure		X
Expansion Tank Low Level		
2. Diesel Lube Oil High Temperature	X	
Lube Oil High Temperature		X
3. Diesel Coolant Temperature H/L	X	
Coolant Temperature Low		X
Coolant Temperature High		X
4. Diesel Start Air Pressure Low	X	
Starting Air Pressure Low		X
5. Diesel Control Power Last	X	
6. Diesel Day Tank Level Low	X	
Day Tank Level Low		X
7. Emergency Generator Ground	X	
Lube Oil Temperature Low*		X
Day Tank Level High*		X

* Local Diesel Alarms Only.

Annunciator Window Name & Sources	Location: Control Room Board	Location: Local Diesel Alarm Lights
8. Emergency Generator A/B Auto Trip	X	
9. Diesel A/B Air Compressor Oil	X	
10. Diesel Fuel Oil Pump A/B Oil	X	
11. Oil Storage Tank Level Low	X	

A separate set of Control Room Board annunciator windows (Items 1-7 above) are provided for each diesel generator with windows 8-11 common to both diesel generators. Local diesel alarm lights are located at their respective local diesel control panels.

No protective devices are capable of being bypassed during manual, test, or emergency operation of the diesel generators.

We have attached the following material in response to your request for detailed descriptions of the diesel cooling system, diesel lubricating oil system, and compressed air start system:

1. Description titled "Lubricating System"
2. Description titled "Cooling System"
3. Description titled "Air Start System"
4. Lube Oil System Schematic
5. Jacket Cooling System Schematic
6. Starting Air Schematic

The above listed material should provide you with the requested description of these three systems.

We hope that the information provided above, with attachments, will permit your Staff to complete their review of this matter.

Yours very truly,

E. E. Utley
Manager
Generation & System Operations

LSW/RLM/lcf
Attachments

cc: Mr. J. A. Jones

P. LUBRICATING SYSTEM

Piping System

The lubricating oil piping system is shown in Illus. P1. The arrangement shown is a typical installation.

The built-in lubricating oil pump draws oil from the oil pan or subbase through a coarse mesh intake screen and forces it through the cooler and strainer and into the engine. The pump is protected by a built-in relief valve. A small part of the oil from the pump is by-passed through the filter and back into the engine oil pan or subbase. The lubricating oil temperature is regulated by means of a temperature regulator which by-passes more or less oil around the cooler. In the cooler, the oil passes around the tubes which are mounted in a bundle.

An auxiliary lubricating oil pump is used to provide lubrication in case the built-in pump fails. The auxiliary lubricating oil pump may also be used as a prelubricating oil pump.

Some installations will be furnished with a prelubricating oil pump instead of the auxiliary lubricating oil pump.

Refer to Section B for operating data regarding lubricating oil pressure and temperature.

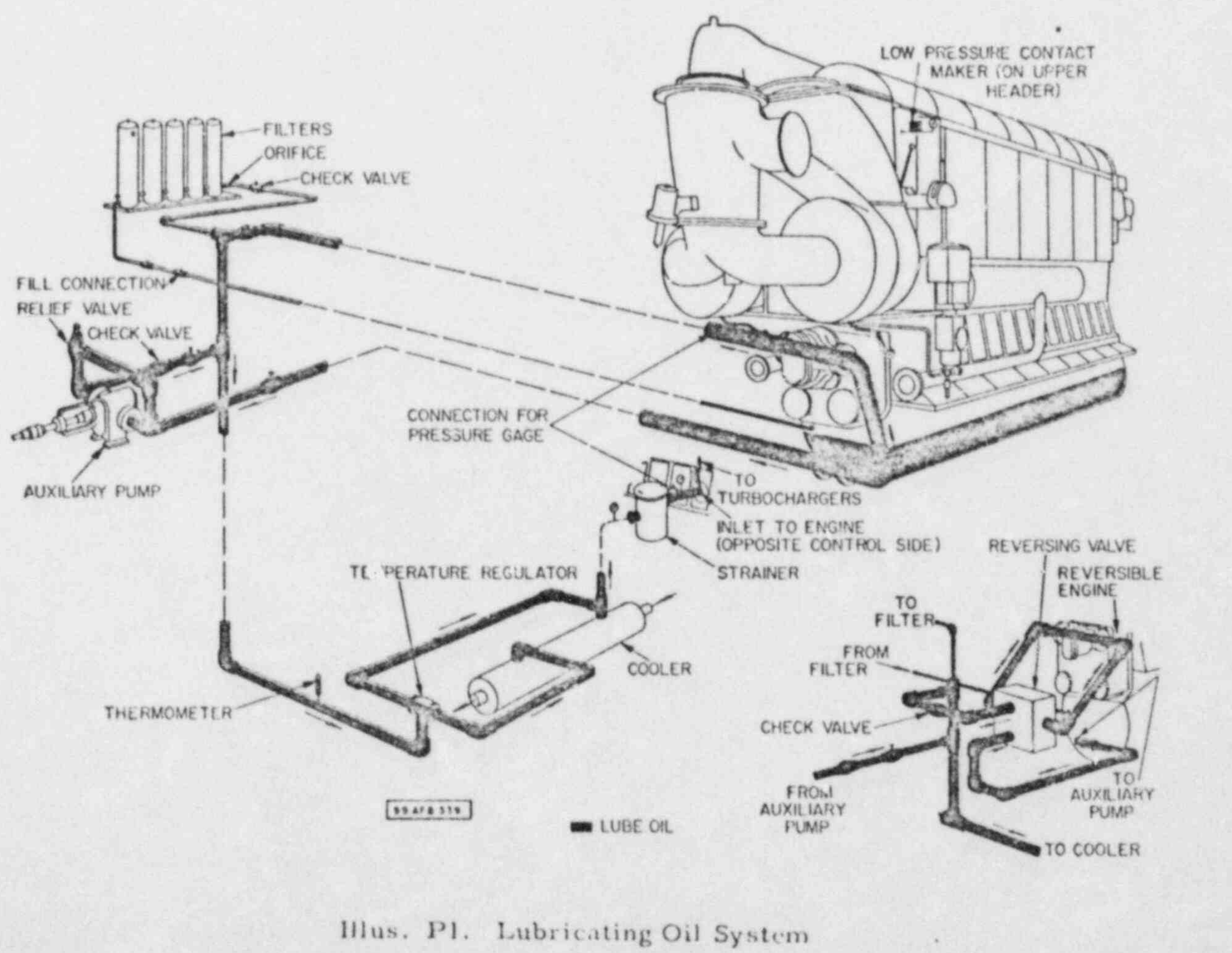
Engine Pressure System

The engine is equipped with a pressure lubrication and piston cooling system which supplies a continuous flow of oil to all surfaces requiring lubrication and to the pistons for cooling.

Lubricating oil enters the lower lubricating oil header from the inlet near the control end, the oil flows through the lower header toward the blower end. There a vertical piping carries the oil to the upper header.

Through supply pipes from both lower and upper headers, oil is forced to each main bearing, and thence, through tubes swedged into the crankshaft, to each crankpin bearing. From each crankpin bearing, oil passes through the drilled passage in the connecting rod to the piston pin bearings, and to the pistons.

The surfaces between the thrust bearing



Illus. P1. Lubricating Oil System

shells and the crankshaft flanges are lubricated through openings in the thrust bearing shells.

An opening through the upper crankshaft lubricates the timing chain, the sprockets over which this chain passes, and the bearings of the timing sprockets and the tightener sprocket.

The cooling oil from each lower piston is discharged through a hole in the insert. Oil from each upper piston is discharged through a hole in the insert into the compartment around the upper ends of the cylinders. This oil then drains either toward the blower or the control end and down to the oil pan or subbase.

The two camshafts receive lubrication from the upper oil header. The camshafts are hollow and small openings at each bearing allow oil to reach the bearing surfaces. An opening in the end of each camshaft supplies oil to the camshaft sprockets and to the overspeed governor.

The drive bushings of the pump flexible drive (on the control end of the lower crankshaft) receive lubrication through an opening in the lower crankshaft from the control end main bearing.

Oil from the upper engine compartment enters the tappet housing and lubricates the tappet assembly. The excess oil is drained through a return header.

The blower drive gears are lubricated by a stream of oil from a nozzle which branches from the pipe connecting the upper and lower headers. Oil tubes supply oil to the inner and outer blower bearings.

The blower clutch drive and clutch control (intermittant blowers) is supplied lubricating oil from the engine upper header.

The turbocharger is supplied oil from the inlet header. The oil gravity drains to the engine crankcase.

The oil spray from the timing chain provides adequate lubrication for the control mechanism.

The flexible pump drive receives lubrication through a hole in the crankshaft and through grooves in the damper spider or spacer. The governor drive is amply lubricated.

The torsional dampers (when used) receive lubrication through drilled holes in the spider which are connected to a passage in the crankshaft.

The vertical drive gears and pinions are lubricated by sprays of oil from nozzles on tubes from the upper and lower oil headers. Other tubes supply oil to the vertical drive pinion shaft roller and thrust bearings.

Lubricating Oil

A neutral attitude is maintained by the company toward the selection or recommendation of particular brands of lubricating oil for use in Fairbanks Morse diesel engines. The major oil companies have had sufficient experience with the selection of proper lubricants for Fairbanks-Morse diesels of various types under various operating conditions to be in a position to recommend the proper grade and quality of lubricating oil for the specific installation. Many reputable oil companies are willing to assume complete responsibility for the successful and economical lubrication of a particular diesel engine installation, but before making any such arrangement, a careful effort should be made to establish the standing of the oil company.

Lubricating Oil Gage Marking

The bayonet gages for stationary engines are marked at the factory at 19-7/8" below the underside of knob or 3-3/16" below lowest point of lowest connecting rod for "FULL" level mark with "LOW" oil level mark 6" below "FULL" oil level mark.

The gages for marine engines are to be marked at installation of engine at 4" below lowest point of lowest connecting rod at outer dead center for "HIGH" or "FULL" level mark with "ADD" oil level mark 4" below "HIGH" oil level mark.

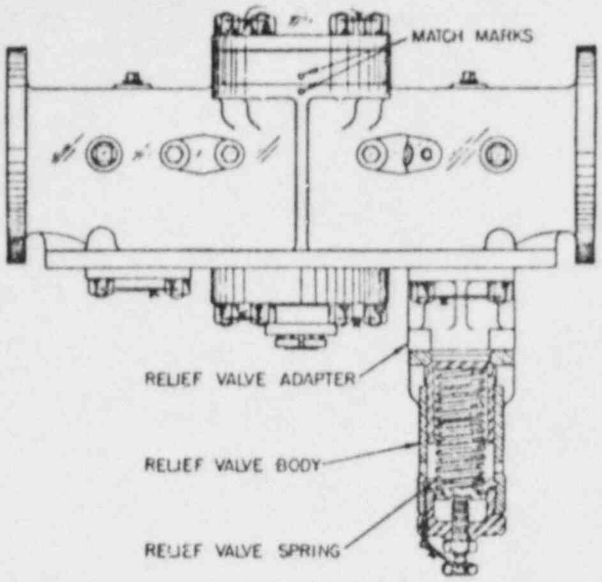
Lubricating Oil Pump
Description

The lubricating oil pumps are shown on Illus. P2 and P3. The impellers are of the herringbone gear type. The pump is mounted on the pump mounting plate at the control end of the engine, and is driven through gears and a flexible drive by the lower crankshaft.

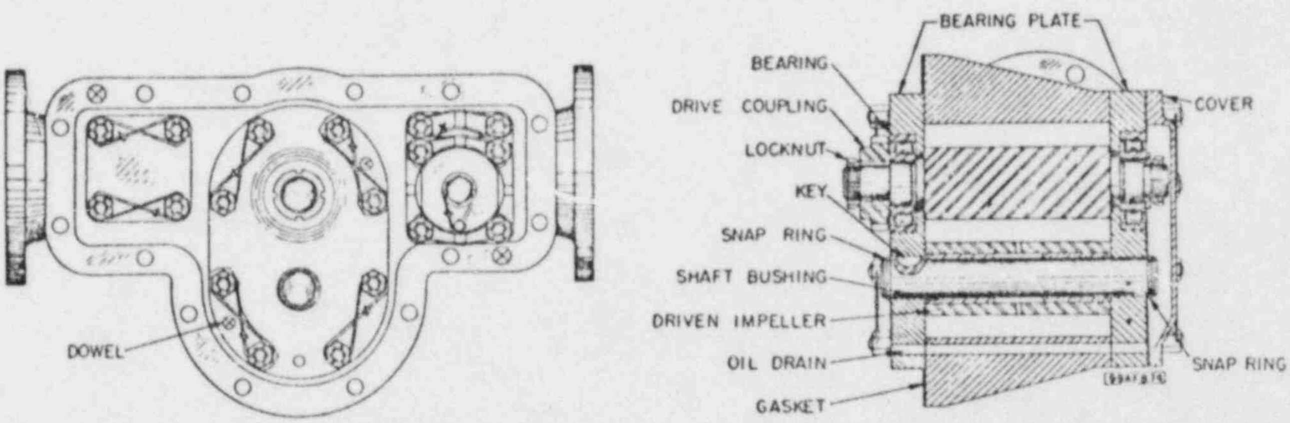
The pumps for the 6 and 9 cylinder engines have ball bearings on the driver impeller and a sleeve bearing in the driven impeller. The 12 cylinder pumps have roller bearing at the ends of both impellers. The driver impeller bearings and the driven impeller bushing are lubricated by oil passing through an opening in the bearing plate and by holes through the driven impeller to the bearing (6 and 9 cylinder engines). The bearings on the impellers of the 12 cylinder pump are lubricated by a line from the lower oil header.

Maintenance

The impellers may be examined by removing the discharge pipe and barring the engine. The outer bearings may be examined by removing the cover.



	BACKLASH	CLEARANCE
IMPELLERS	.005	
DRIVEN IMPELLER SHAFT TO BUSHING		.005 TO .0065
DRIVEN IMPELLER BUSHING TO IMPELLER		.001 TO .0025
IMPELLER TO HOUSING		.008 TO .011



Illus. P2. Lubricating Oil Pump - 6- 9 Cyl. Engines

The lubricating oil pump should be removed and disassembled for inspection of parts.

Disconnect the piping and remove the pump from the engine.

The following procedure should be used depending on the pump in service.

Applicable to 6 and 9
Cylinder Engines

The lubricating oil pressure pump should be removed and disassembled for inspection of parts.

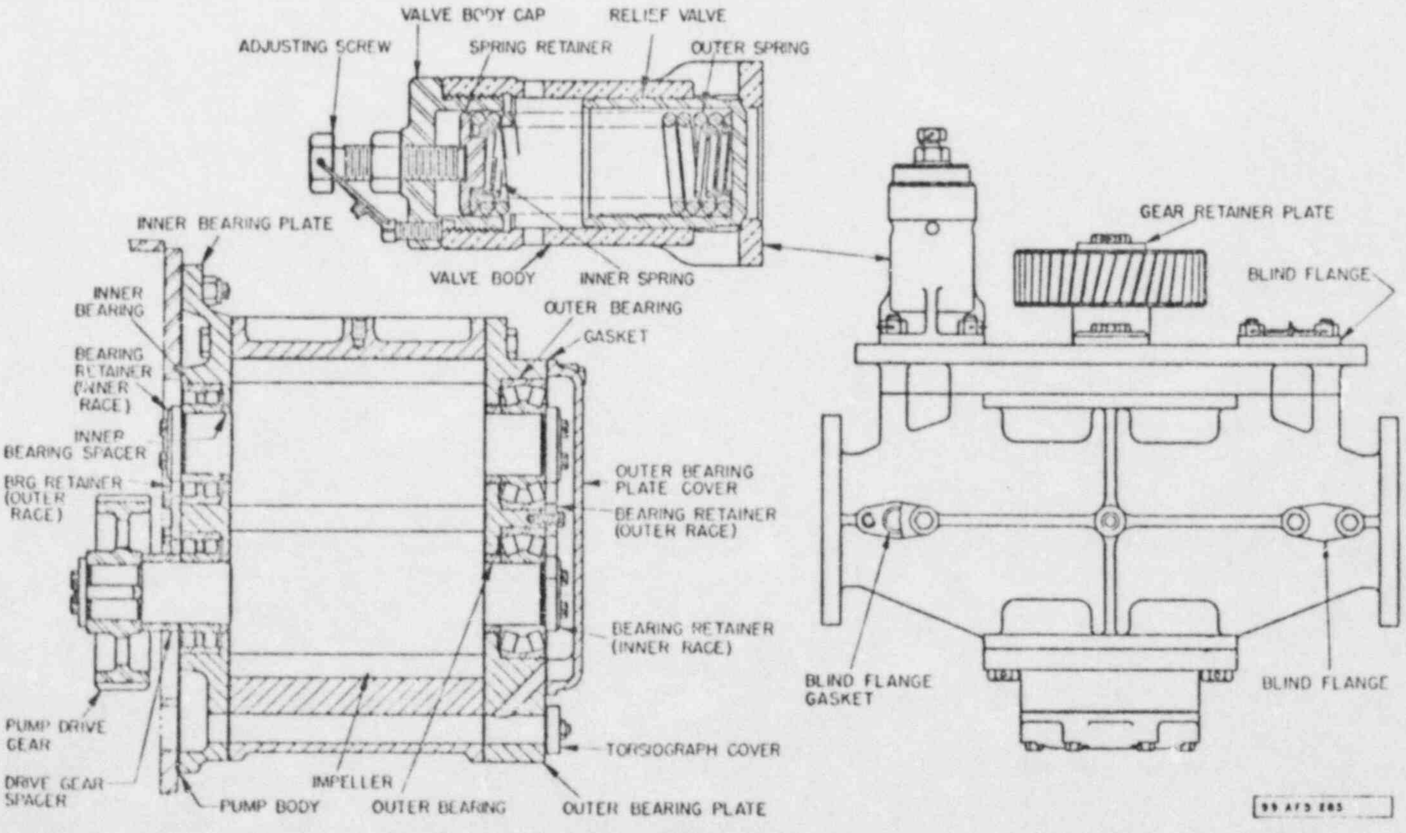
1. Disconnect the suction and discharge pipes from the pump.
2. Remove the dowels and nuts from the pump to mounting plate.
3. Remove the pump from the mounting plate.
4. Remove the cover, locknut and washer from the ends of the driver impeller.
5. Remove the snap ring from the ends of the driven impeller.
6. Use the puller tool to remove the drive coupling.
7. Remove the inner bearing plate to body capscrews and dowels.
8. Block the pump body and drive the impeller shaft from the outer end plate. (Protect the shaft before driving.)
9. Reverse the procedure to tap the impeller from the inner bearing plate.
10. Remove the end plates and separate the driver impeller from the shaft.
11. The bearings can be tapped out of the end plates.
12. Inspect the impellers, shafts and shaft bushings.
13. Replace the bearings in the end plates.
14. Install the pump body to the inner bearing plate.
15. Install the dowels and secure the capscrews.

16. Install the impellers and replace the outer bearing plates.
17. Install the dowels and secure the capscrews.
18. Replace the drive coupling, lockwashers and locknuts to the ends of the driver impeller.
19. In reassembling the parts, refer to Illus. P2, for the clearances between parts. Clearances given are maximum and minimum. When assembling the pump, minimum clearances are desired and must be held as close as practically possible by fitting in such a manner that parts still come within limits.
20. In replacing the pump on the mounting plate, the dowels should relocate the pump so that the drive gear has the correct backlash.
21. Before pulling nuts up tight, check alignment and free movement of the drive.
22. Tighten the nuts to torque limit specified in Sec. B.
23. Install piping connections and oil lines.

Applicable to 12 Cyl. Engines

The pump should be removed and disassembled for inspection of parts. Refer to Illus. P3.

1. Disconnect suction and discharge pipes from the pump.
2. Remove the dowels and stud nuts.
3. Remove the pump from the mounting plate.
4. Remove capscrews and outer bearing plate cover.
5. Remove the capscrews and retainer plate at the drive end of the impeller shaft.
6. Pull the drive gear using the puller tool.
7. Pull the dowels and remove the capscrews from the outer bearing plate.
8. Remove the bearing retainers (inner and outer bearing races).
9. Tap the outer bearing plate from the pump body. The bearings remain in the end plate as they are removed from the impeller shafts.
10. Remove the bearing retainer from the drive end of the pump.
11. Tap the impeller shafts from the bearings.
12. Pull the dowels and remove the capscrews from the inner bearing plate.
13. Tap the bearings from the inner bearing plate.
14. Check the parts for wear and damage especially the bearings and impellers.



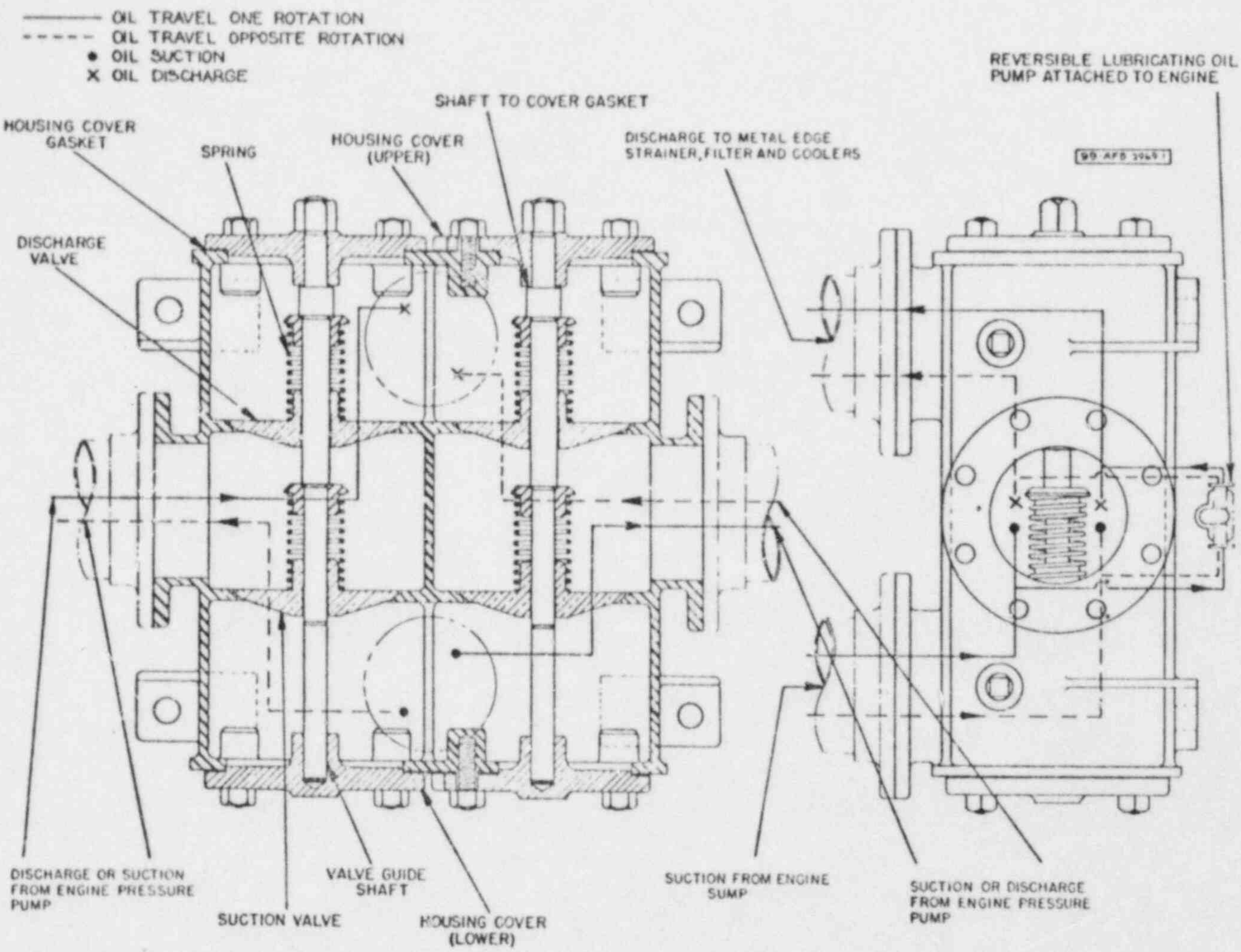
Illus. P3. Lubricating Oil Pump - 12 Cyl. Engines

15. Install bearings into inner bearing plate and inner bearing plate to pump body. Locate in position and install dowels and capscrews.
16. Install impeller shafts with spacers into inner bearing plate. Secure with bearing retainers.
17. Install outer bearing plate to pump body, align with dowels and secure capscrews.
18. Install outer bearing spacer and bearing on each impeller shaft and tap into end plate and onto shaft. Secure with bearing retainers.
19. Install the drive gear and retainer plate. Secure with capscrews.
20. In reassembling the parts, refer to Sec. B for the clearances between parts. Clearances given are maximum and minimum. When assembling the pump, minimum clearances are desired and must be held as close as practical.
21. In replacing the pump on the mounting plate, the dowels should relocate the pump so that the drive gear has the correct backlash.
22. Before pulling nuts up tight, check alignment and free movement of the drive.
23. Tighten the nuts to 60-80 ft. lbs. torque.
24. Install piping connections.

Lube Oil Reversing Valve - Marine Engines

The lubricating oil reversing valve, Illus. P4, is installed in the piping on marine installations to maintain the direction of flow of the lubricating oil when the engine rotation changes.

The reversing valve will require very little servicing except the replacement of gaskets and springs. The valves and springs should be inspected when the pressure of the lubricating oil at the engine header is less than 17 psi pressure.



Illus. P4. Lubricating Oil Reversing Valve

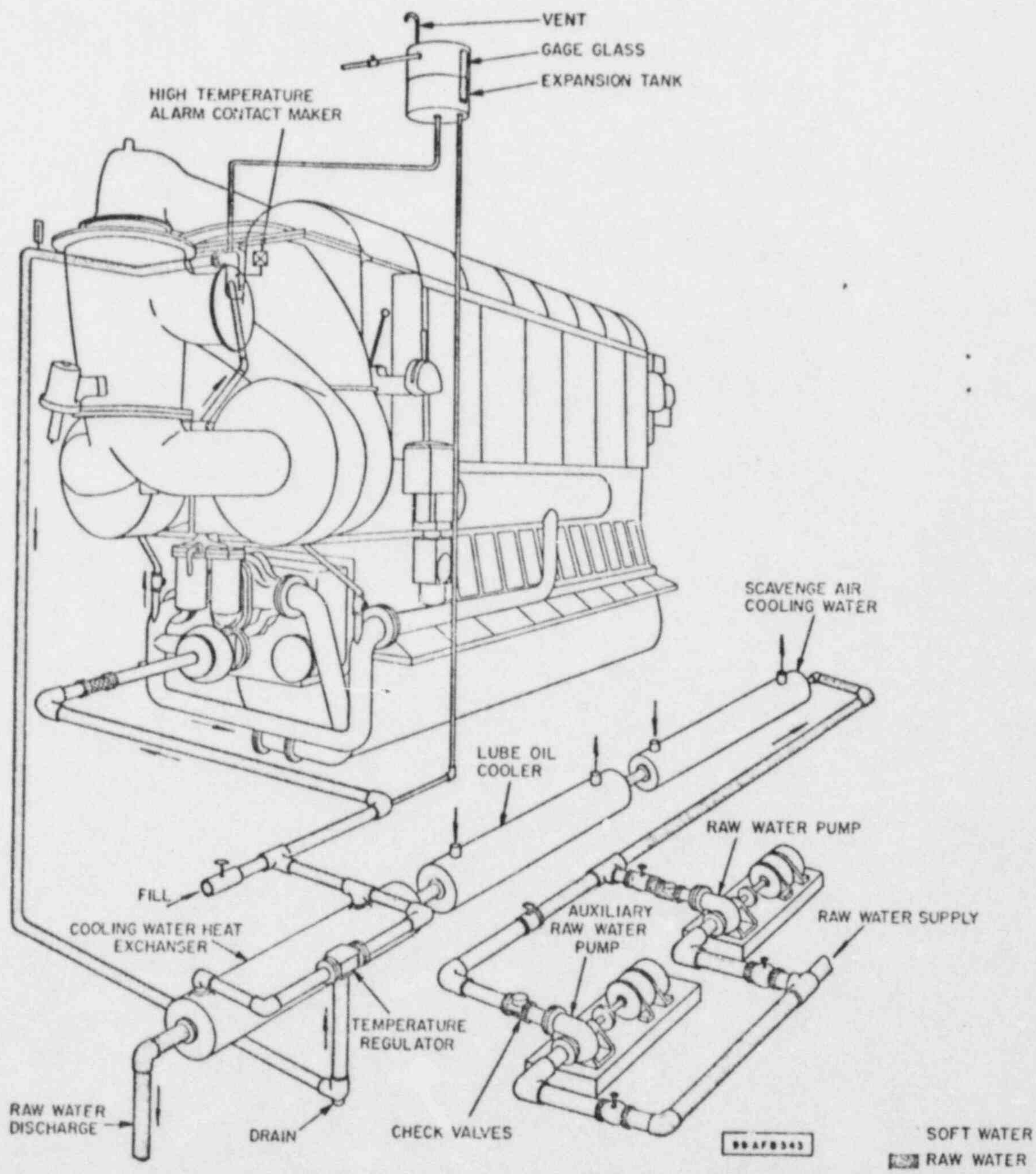
Q. COOLING SYSTEM

Description of External System

The engine is cooled by circulating soft water through the engine passages. This water circulates in a closed system. That is, the same water is used repeatedly, being piped out of the engine, cooled and then returned to the engine.

The equipment furnished varies with different installations. The system shown on Illus. Q1 and described in this section is a typical closed cooling stationary installation and will vary somewhat according to the particular application.

The soft water leaves the engine and is piped to the heat exchanger. The water circulates through the heat exchanger where heat is absorbed by cool raw water. A by-pass, controlled by a temperature regulator, is provided around the heat exchanger so that the temperature of the soft water may be regulated. After being cooled in the heat exchanger, the soft water flows back to the engine pump suction



Illus. Q1. Fresh Water Piping Diagram

and is again forced through the cooling passages of the engine.

A vent pipe leads from the water header outlet to an expansion tank. Another pipe leads from the pump suction line to the expansion tank. This arrangement enables the closed system to accommodate variations in water volume which result from the expansion and contraction of heating and cooling.

The raw water pump draws water from the raw water source of supply, and discharges it through the lubricating oil cooler, heat exchanger and air cooler heat exchanger and out of the system. The full flow of raw water is carried through the coolers.

The scavenge air cooling system consists of the circulating pump, air cooler heat exchanger and air receiver temperature control valve, Illus. Q2. Soft water, separate from the engine system is circulated to cool the scavenge air before entering the engine.

Treatment of Engine Cooling Water

It is mandatory that all cooling water be completely treated, not only for the prevention of scale deposits, but also for the elimination of all corrosive characteristics of the water. It is also imperative that the treatment be continually maintained at recommended levels.

It is the recommendation of Fairbanks Morse that a reputable company specializing in the treatment of diesel engine cooling water be contacted for recommendations as to type, amount and methods of cooling water treatment. Actual treatment may consists of only adding chemicals to the cooling water, or supplemental external treatment may be required. The nature of the cooling water supply will determine the exact treatment required to fulfill Fairbanks Morse requirements.

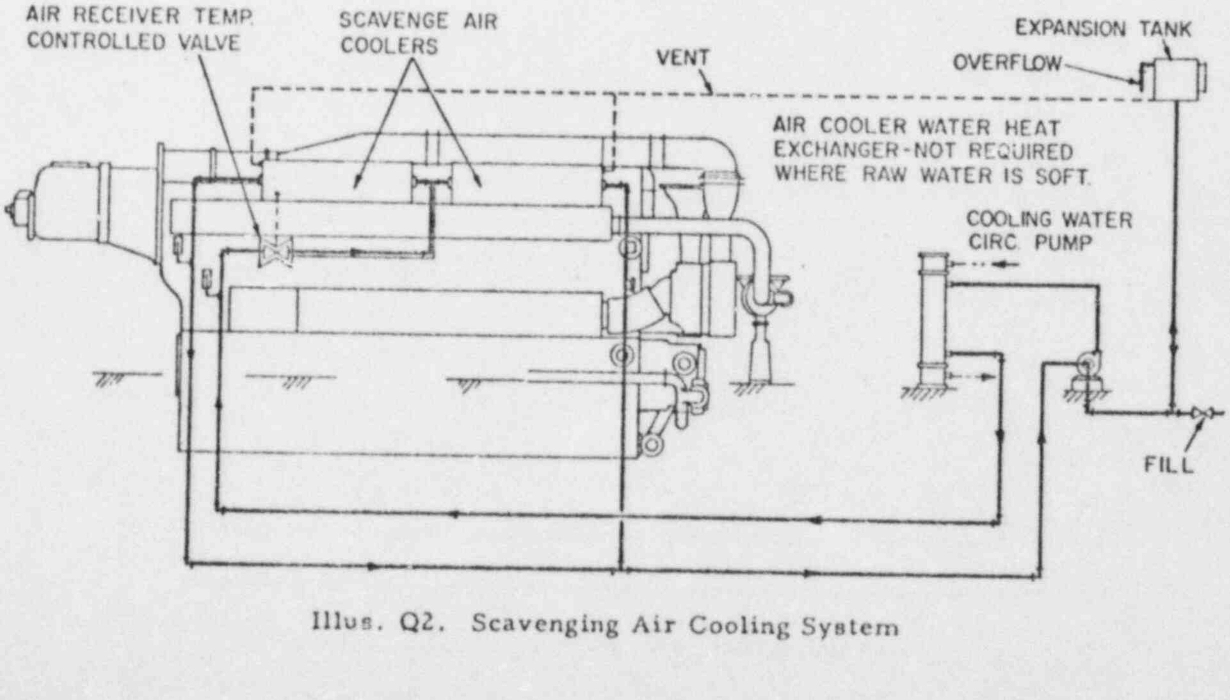
Failure to properly treat the engine cooling water or failure to properly maintain treatment can result in either scale formation or corrosion in the cooling water system. Scale impedes the transfer of heat and can result in engine overheating. Corrosion, if allowed to continue, will eventually result in sufficient loss of metal to cause a failure of the cooling water system.

Particular care should be taken when adding make-up water to be sure that an appropriate amount of treatment is also added, or that the make-up water has been previously treated sufficiently. In addition, periodic checks (as recommended by the water treatment vendor) must be made to determine the sufficiency of the treatment. Any deficiency should be corrected immediately. Samples should be taken only after it is certain that all chemicals are dissolved and thoroughly mixed. This may require several hours of engine operation where chemicals are added directly to the cooling system.

There are a number of acceptable commercially available water treatment compounds using either alkaline chromates or organic compounds as bases. Both types are acceptable to the engine builder.

Usual cooling water treatment compounds will result in the treated water being slightly alkaline (approximate pH 8.0 to 9.5). Thus cooling water already alkaline, such as Lime-Soda ash softened water, should not be used as such water would have too high a resulting pH.

Some treatment compounds, chromates particularly, cannot be used with anti-freeze solutions having primary alcohols or glycols as



Illus. Q2. Scavenging Air Cooling System

bases. It is usually permissable to use secondary alcohols (iso-propyl, etc.), however, in all cases, have the water treatment vendor advise on compatibility with all anti-freeze solutions.

NOTE: Do not depend upon the anti-corrosion protection. Such protection is usually insufficient.

Should cleaning of the water system be required for the removal of oil, sludge or scale, obtain a recommendation from a reputable chemical company for a suitable cleaner. Strong alkalies, such as caustic soda, should not be used. Such cleaners will vigorously attack the non-ferrous parts of the cooling system.

If any difficulty is encountered in applying the foregoing, contact your Fairbanks Morse sales office.

Cooling Water Passages through the Engine

Cooling water supplied by the engine pressure pump is piped to each side of the engine and enters the exhaust belts midway of the engine. By-pass fittings connect the lower water passages of the exhaust belts. The water flows up through the exhaust belts, out of the top into the outlet by-pass fittings bolted to the upper outside of the exhaust belts. From the outlet by-pass fitting, connection is made by the inlet elbows to the cylinder liner jacket. The water flows up through the cylinder liner jacket. Refer to Illus. D1.

Ribs on the cylinder liner direct the water upwards to cool the liner thoroughly. Water passages also lead to the water jackets around the injection nozzle adapters, cylinder relief valve adapters and air start check valve adapters.

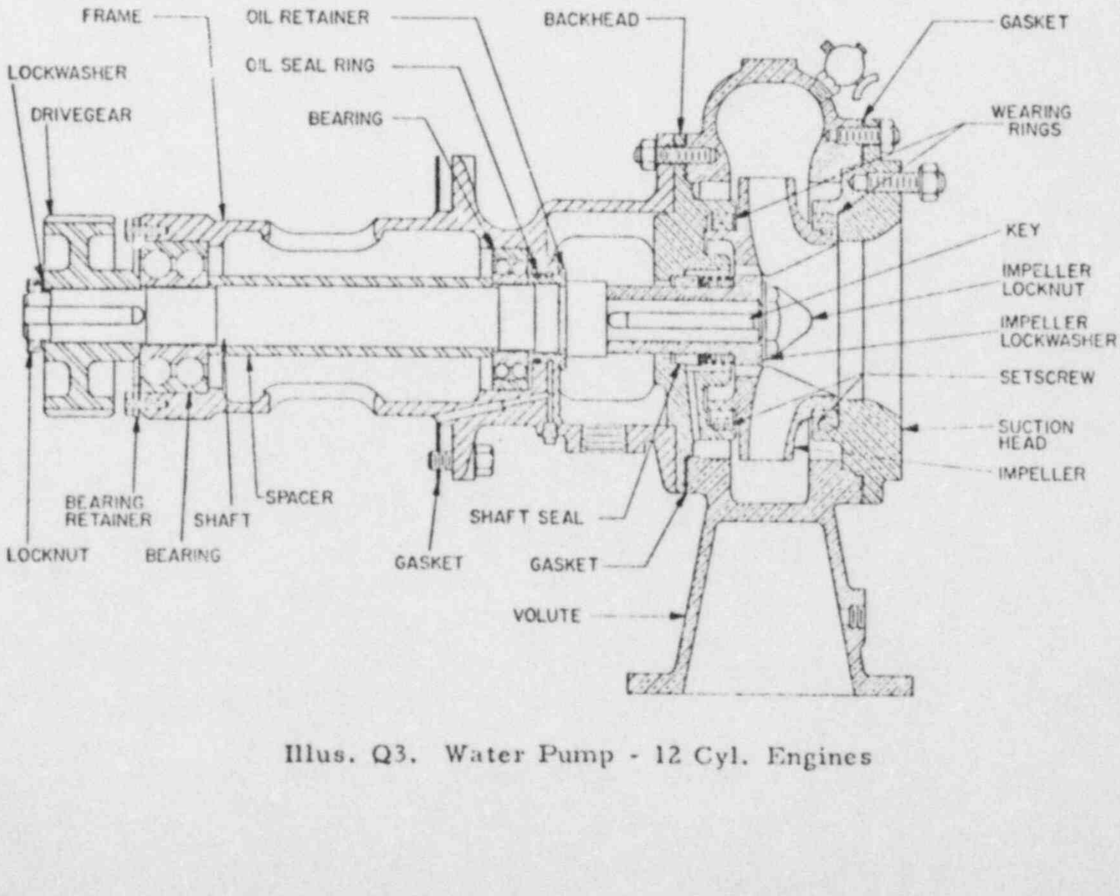
Upon reaching the top of the liner jacket, the water flows out of the cylinder water space through an outlet pipe which leads to the water header. This header, rectangular in cross-section, extends along the opposite control side of the cylinder block just below the air receiver. Its outlet flange is at the governor end of the engine.

The turbochargers are supplied cooling water from the inlet pipes. Water is discharged into the engine water header. Shutoff cocks are provided in the inlet and outlet lines and must be closed when the engine is water tested.

Suggestions to the Operator

Watch the water level in the expansion tank If the level rises abnormally, the cause may be a leak in the jacket water cooler. If the water level drops, a leak in the closed system is indicated.

No restrictions should be allowed in the closed cooling system.



Illus. Q3. Water Pump - 12 Cyl. Engines

The engine system should be subjected to 50 psi hydrostatic pressure after any parts have been replaced and reconnections made. The water test applies to the engine only and not to the external piping and coolers. Be sure shutoff cocks to and from the turbocharger are closed. Use pump or hydrant pressure and block off the inlet and outlet. Observe all connections for possible leakage.

WATER PUMPS

Description

The built-in circulating water pump is of the centrifugal type as shown in Illus. Q3, Q4.

The pump is gear driven from the lower crankshaft through the flexible drive.

A rotary mechanical seal prevents water in the volute from leaking out along the pump shaft. In operation, the seal assembly rotates with the pump shaft. The seal is formed by contact between the surface of the seal face with the stationary seat pressed in the pump frame bore. The spring tension holds the seal face tightly against the stationary seal seat.

Lubricating oil reaches the pump bearings from the control end compartment through openings in the pump frame. Leakage of oil to the outside of the engine is prevented by the oil seal.

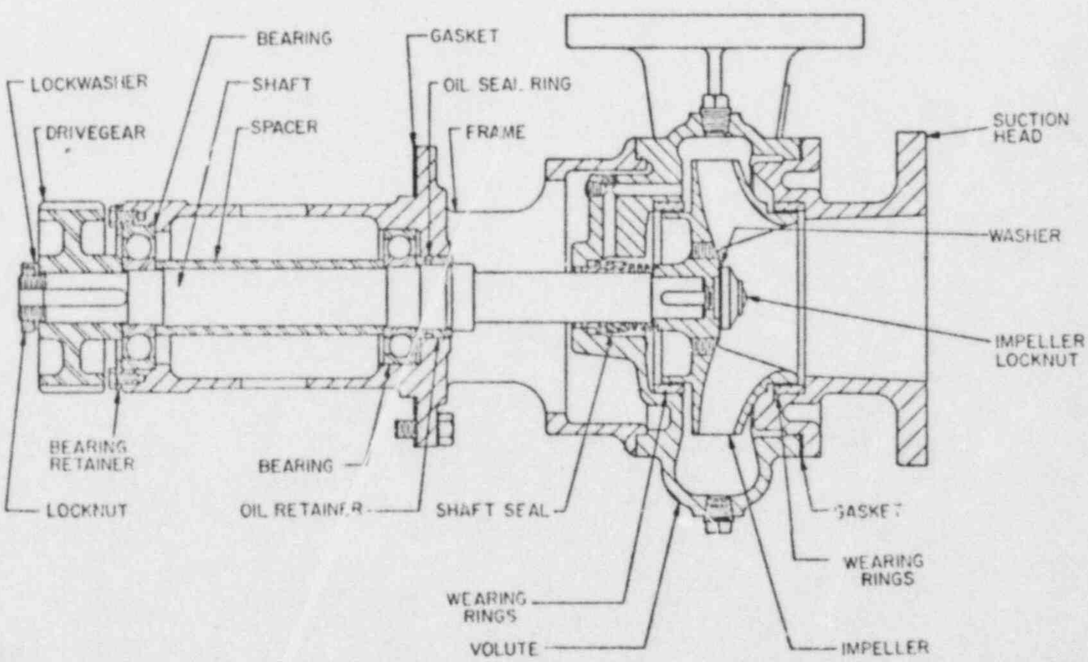
Maintenance - Shaft Seal

It is not considered advisable to recondition seal parts in the field or to replace component parts separately. If the seal requires servicing, a complete new seal should be installed.

1. To remove the seal, disassemble the pump. Refer to Steps 1 through 6 under Pump Disassembly.
2. The seal assembly is removed from the impeller and backhead.
3. Before installing a new seal, clean the impeller and backhead thoroughly.
4. Coat the outer surface of the seat gasket with water slightly soapy and press seat in place into backhead.
5. Dip the seal assembly into water, slightly soapy and slide onto the impeller.
6. Install the impeller and reassemble the pump.

Pump Disassembly

1. Disconnect the piping connections to and from the pump.
2. Remove the stud nuts (pump to mountin plate) and remove the pump.
3. Mark the suction head and the volute so that the head can be replaced in its or-



Illus. Q4. Water Pump - 6 and 9 Cyl. Engines

iginal position.

4. Remove the suction head. Tap lightly with lead hammer to loosen.
5. Remove the nut and washer from the shaft.
6. Tapped holes are provided in the impeller for a puller. Pull the impeller from the shaft.
7. Remove the seal from the impeller and seal seat from the backhead.
8. Bend the lockwasher and remove locknut.
9. Hold the drive gear and tap on the shaft to loosen the gear.
10. Remove the bearing retainer capscrews and bearing retainer.
11. Tap on the drive end of the shaft to remove the shaft.
12. Remove the bearing from the frame and bearing from the shaft.
13. Inspect all parts for wear. Replace worn parts.
14. Wearing rings are provided on the mating surfaces of the suction head and the impeller.
    a. The wearing rings are held in place by setscrews.
    b. Original clearance is .060" to .067" on the diameter.
    c. Replace rings when wear increases to about twice the original clearance.

Reassembly and Installation

1. Install bearing into frame and secure with the thrust bearing retainer and capscrews.
2. Install shaft with bearing into frame and through bearing.
3. Install the drive gear and secure with locknut and lockwasher.
4. Install the oil retainer with seal ring over the shaft and secure with capscrews.
5. Install the shaft seal and impeller. Refer to Steps under Shaft Seal.
6. Secure the impeller with locknut and lockwasher.
7. Install the suction head and secure with nuts.
8. Install the pump to the mounting plate.
9. Tighten and secure the stud nuts.
10. Check the backlash of the drive gears.

R. AIR START SYSTEM

General

The air starting system consists of the starting air piping and the engine starting mechanism.

Air for the starting system is required at between 150 and 250 psi (250 psi preferred) at the engine and is stored in suitable air tanks.

Engine starting is accomplished by the action of compressed air on the pistons in their proper firing order.

The engine starting mechanism includes the air start control valve, air start distributor, the air header, the pilot air tubing and the air start check valves at the individual cylinders, Illus. R1. The air start control valve and the distributor are amply lubricated by the splash of engine oil. The air start check valves receive lubricating oil with the air from the distributor.

> NOTE: The distributor on the 6 - 9 cylinder engines is driven from the control end of the upper crankshaft. On 12 cylinder engines, the distributor is mounted opposite the governor drive on the pump mounting plate and is driven from the lower crankshaft.

Starting Mechanism

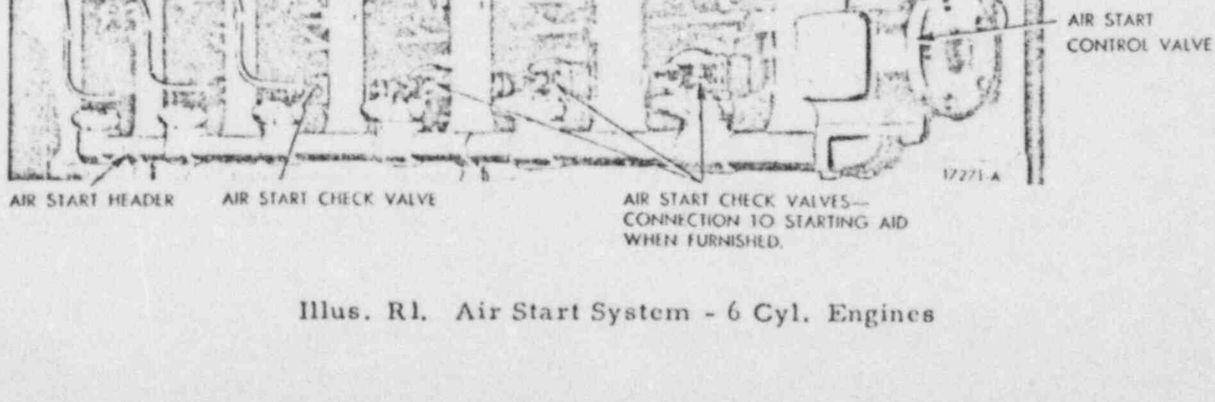
The air start control valve is mounted near the control or governor end of the engine on the side opposite the controls. When the control shaft lever is moved to "START" position, a lever linkage opens the air start control valve. This is explained and illustrated in Sec. J.

With the air start control valve open, compressed air passes into the header, Illus. R1, which leads to the individual cylinder air start check valves. Air also passes into the pilot air supply pipe connected to the air start distributor.

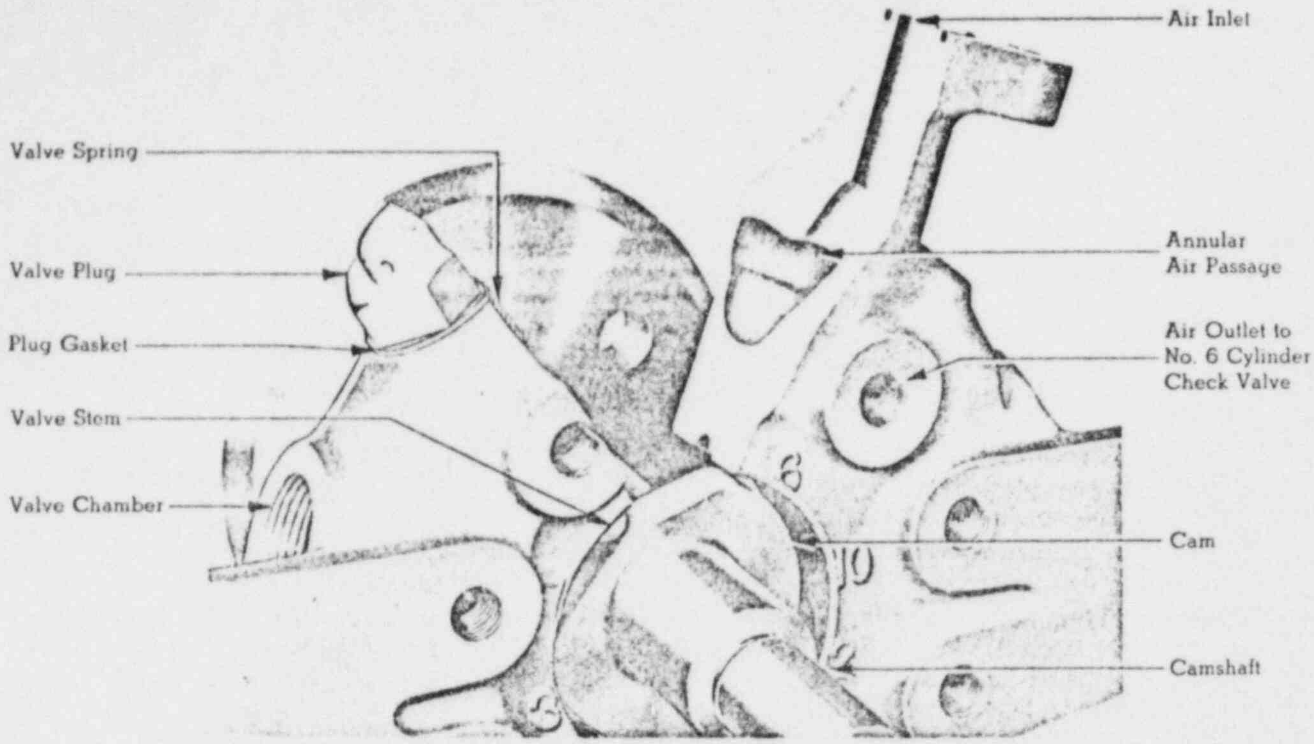
The air start distributor includes one pilot air valve for each air start check valve. The valves are arranged radially and in cylinder firing order around the air start distributor camshaft, Illus. R2. A spring holds each valve normally out of contact with the cam, as shown in Illus. R3. Air enters the distributor from the air start control valve, air pressure overcomes the spring tension and forces each valve plunger down into contact with the cam.

Regardless of where the camshaft stopped, one valve will be on the low point of the cam and will therefore be open, as shown in Illus. R4. Two other valves, one on each side of the open valve, will be partially open. Each of the pilot air valves, when open, admits air through a connecting tube, Illus. R1, to an air start check valve. The air, under pressure, opens the air start check valve. The actual starting air then rushes into the cylinder from the air header. The starting air forces the pistons apart and thus causes the crankshafts to rotate.

The air start distributor camshaft rotates with the upper crankshaft on 6 - 9 cylinder engines and with the lower crankshaft on 12 cylinder engines. The cam opens and closes the valves in sequence to the engine firing order. Soon the engine begins to fire. The control shaft lever should then be moved to "RUN" position. This actuates linkage on the control shaft which



Illus. R1. Air Start System - 6 Cyl. Engines



Illus. R2. Air Start Distributor

closes the air start control valve shutting off air pressure to the distributor.

Air in the starting mechanism escapes through vents in the pilot valves and in the control valve. As the air pressure drops, the distributor valve springs raise the valves to their normal position, out of contact with the cam, as shown in Illus. R3.

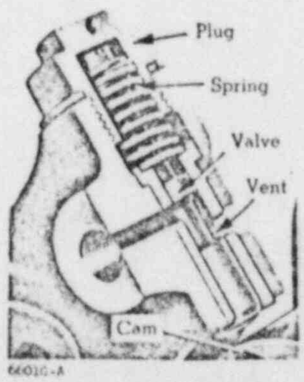
Air Distributor Timing
(other than 12 cylinder engines)

The air distributor is timed to open the air start check valve in the No. 1 cylinder (at the control end of the engine) when the "crank lead" mark on the crankshaft coupling comes to the pointer and the valve closes 90° later. Observing the marking, these readings indicate that the valve opens when the upper crankshaft is on inner dead center and closes approximately 90° past inner dead center.

The distributor is properly timed when the engine leaves the factory by having the air start camshaft properly located on the dowel in the crankshaft. Timing consists of mating the camshaft with the crankshaft so that the dowel is in the proper hole.

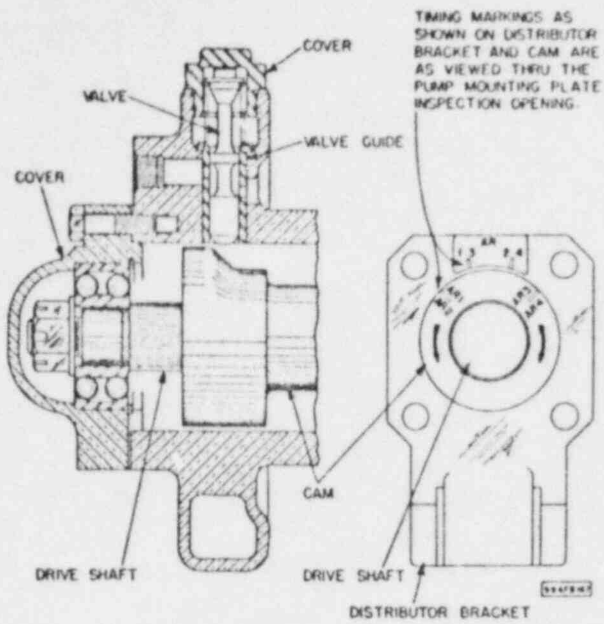
Air Distributor Timing
(12 cylinder engines)

The air distributor is timed to open the air



Illus. R3. Pilot Air Valve in Normal Position

Illus. R4. Pilot Air Valve During Starting



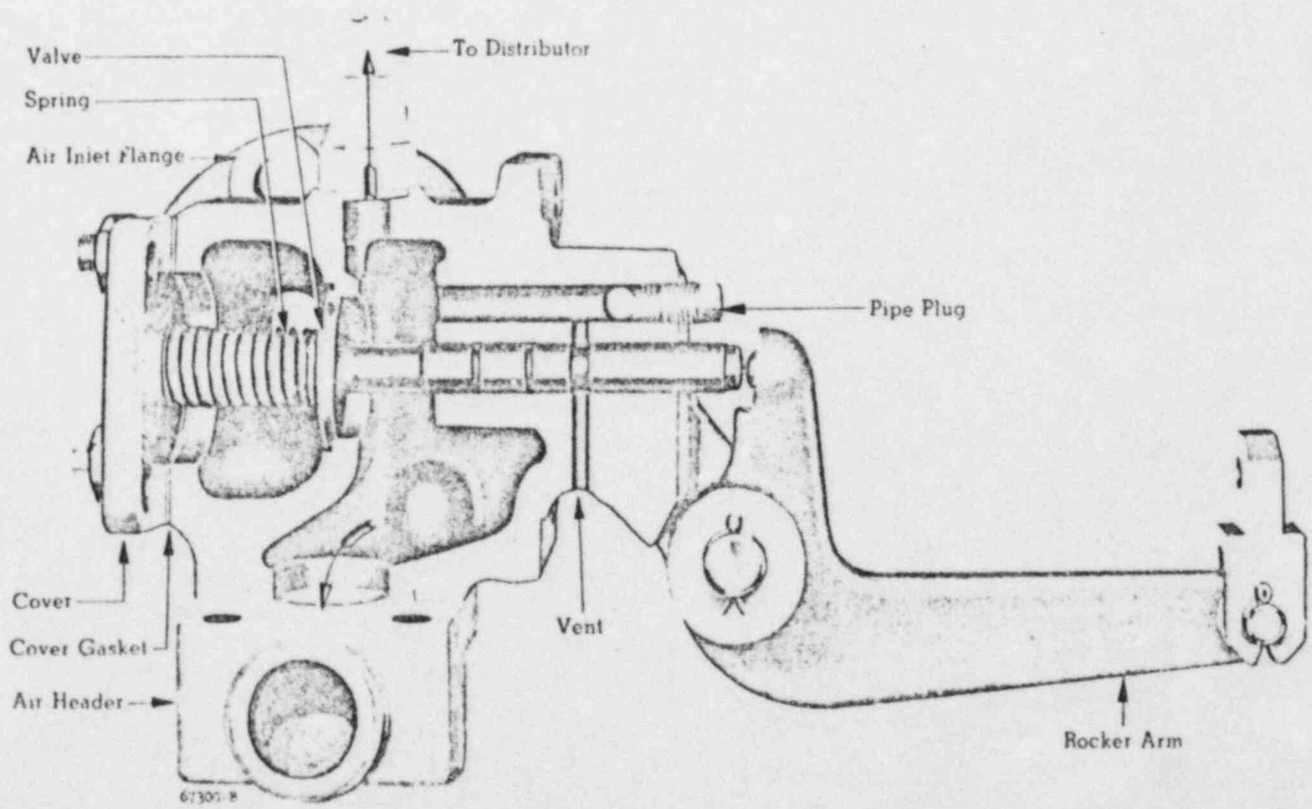
Illus. R5. Air Start Distributor Timing
12 Cyl. Engines

start check valve in the No. 1 cylinder when the "O" mark on the crankshaft coupling comes to the pointer and the valve closes when the mark "90" reaches the pointer. Observing the markings, these readings indicate that the valve opens when the lower crankshaft is on inner dead center and closes 90° later.

The distributor is properly timed when the engine leaves the factory by having the air start camshaft properly located in respect to the lower crankshaft. Timing consists of mating the scribe line on the cam to the proper scribe line on the bracket with the lower crankshaft set for No. 1 inner dead center ("O" coupling pointer reading), Illus. R5. Remove the pump mounting plate cover to view the markings. If necessary to re-time the distributor, remove the cam setscrew and move the cam to the right on the drive shaft. Line up the marks and move the cam back into position. Slight shifting may be required to engage the splines of the cam to the drive shaft. Replace the setscrew.

Air Distributor Valves and Springs

The distributor valves should not require attention other than a periodic inspection. To service them, take off the control end cover, (6- 9 cylinder engines). Remove the plugs, springs and valves. Clean and inspect the valves for wear. The valves and the guides are lapped together and should always be replaced together. Clean and inspect the springs for any small



Illus. R6. Air Start Control Valve

cracks and replace if any are found. Lubricate the lapped surface of the valves and reassemble in original position. Work the valve in and out to make sure it works freely before replacing springs and plugs.

Air Start Control Valve

The air start control valve, Illus. R6, requires practically no servicing other than the disassembly for cleaning and inspection of the valve seat and spring.

Air Start Check Valve
Description

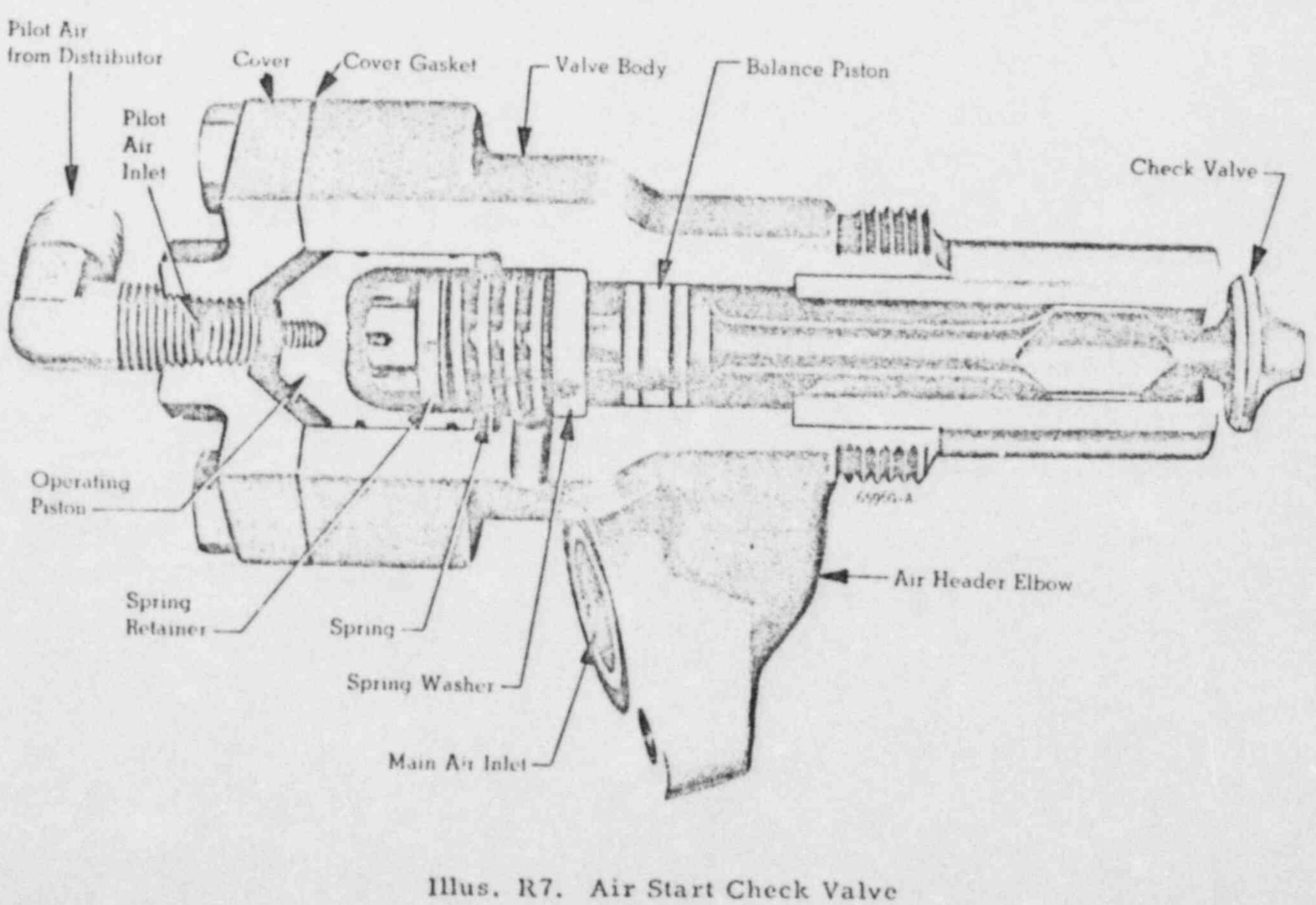
The air start check valves, Illus. R7, admit starting air into the cylinder. The valve is cooled by water from the cylinder liner jacket. This is accomplished by water circulating through the space between the adapter water jacket and the check valve to liner adapter.

When air from the distributor valves reaches the operating piston of the air start check valve. it acts against the pressure of the check valve spring and opens the valve a small amount against the compression pressure. Then the main supply of starting air from the header enters the cylinder through the holes in the adapter.

When the air distributor valve closes, air pressure on the operating piston is stopped. Compression of the spring is relieved allowing both the operating and balance piston to move towards closed position. Air from the engine header presses against the balance piston with greater force than it does against the check valve. Therefore, there is not enough pressure to keep the valve open. Thus air pressure for starting the engine is applied to the pistons only during the proper phase of the cycle. Any air escaping past the two pistons is vented through holes in the valve body.

Maintenance

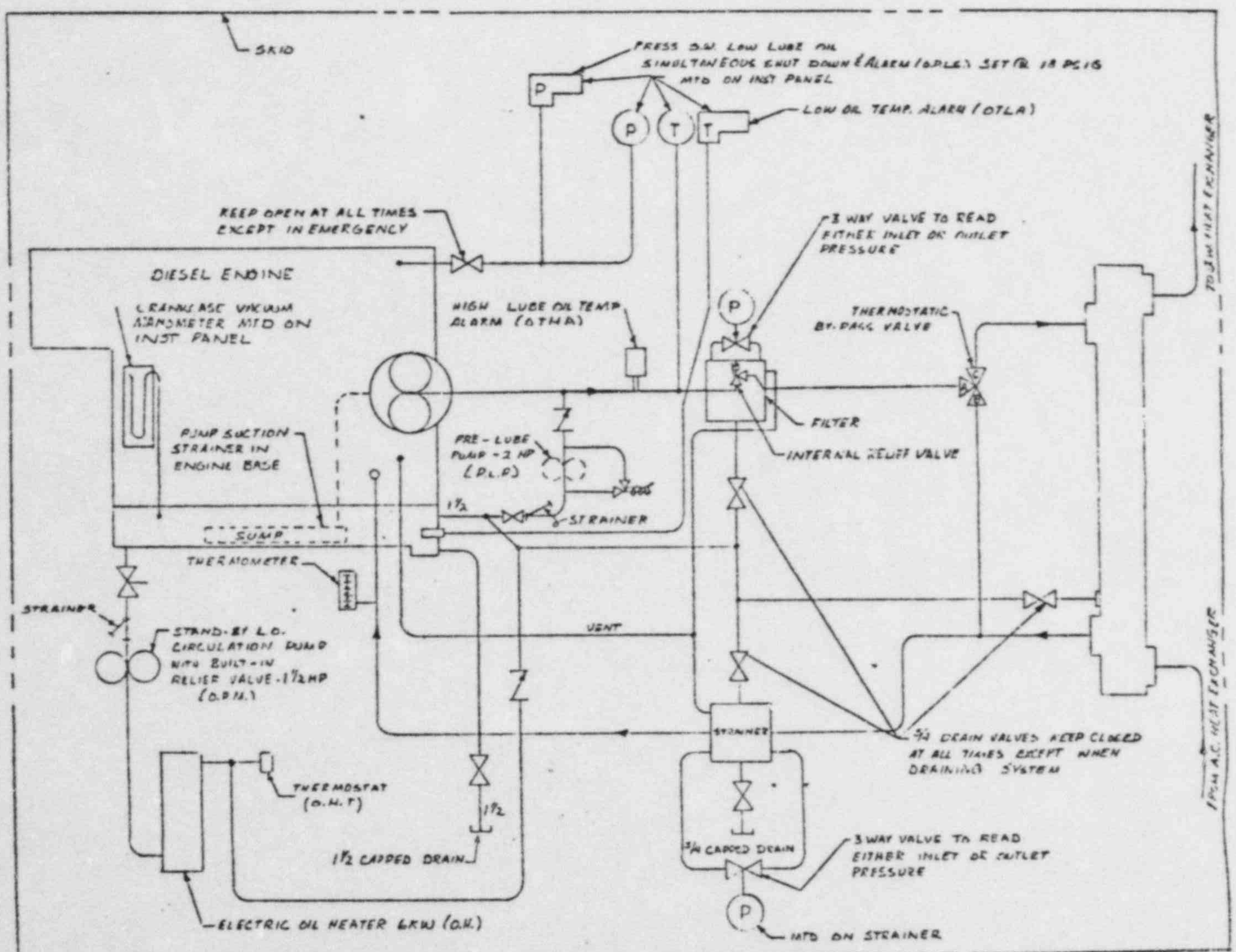
1. The air start check valves may be disassembled for cleaning and inspection.
2. To remove a check valve, disconnect the pilot valve tube and remove the supply pipe from the header to the valve. Be careful not to lose the gaskets.
3. Remove the two nuts securing the check valve to its adapter collar.
4. Withdraw the valve assembly from its adapter in the cylinder liner.
5. Remove the cover capscrews and cover.
6. Remove the operating piston.



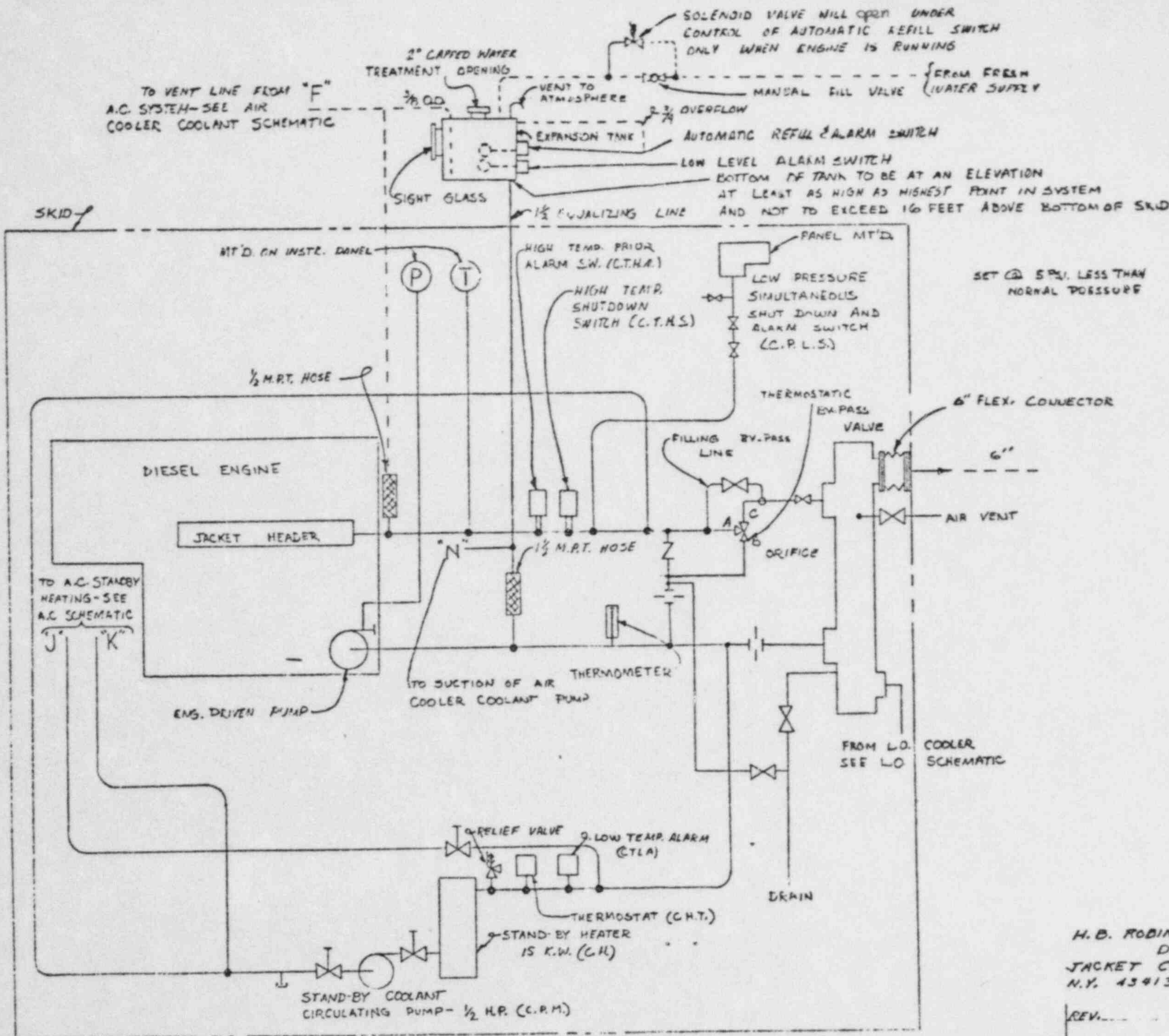
Illus. R7. Air Start Check Valve

7. Remove the retainer nut, retainer, spring, washer and balance piston.
8. Remove the valve and clean all parts thoroughly.
9. Inspect the spring for small cracks and replace if necessary. Reseat the valve seat, if necessary.
10. Following this operation, the valve should be lapped to the seat in the valve body.
11. Oil the parts removed.
12. Install the valve, balance piston, washer, spring, retainer and nut.
13. Replace the operating piston and cover.
14. Inspect the interior of each adapter for carbon deposits and clean if necessary. Do not allow carbon to get into the cylinders.
15. Clean the check valve body, especially where it seats in the adapter.
16. Replace in the adapter.
17. Replace the collar stud nuts and tighten to 35 to 40 ft. lbs. torque.
18. Connect the pilot air tubing. Reinstall the air supply pipe. Do not omit the gaskets.

The removal of the air start check valve adapter is outlined, Sec. D.

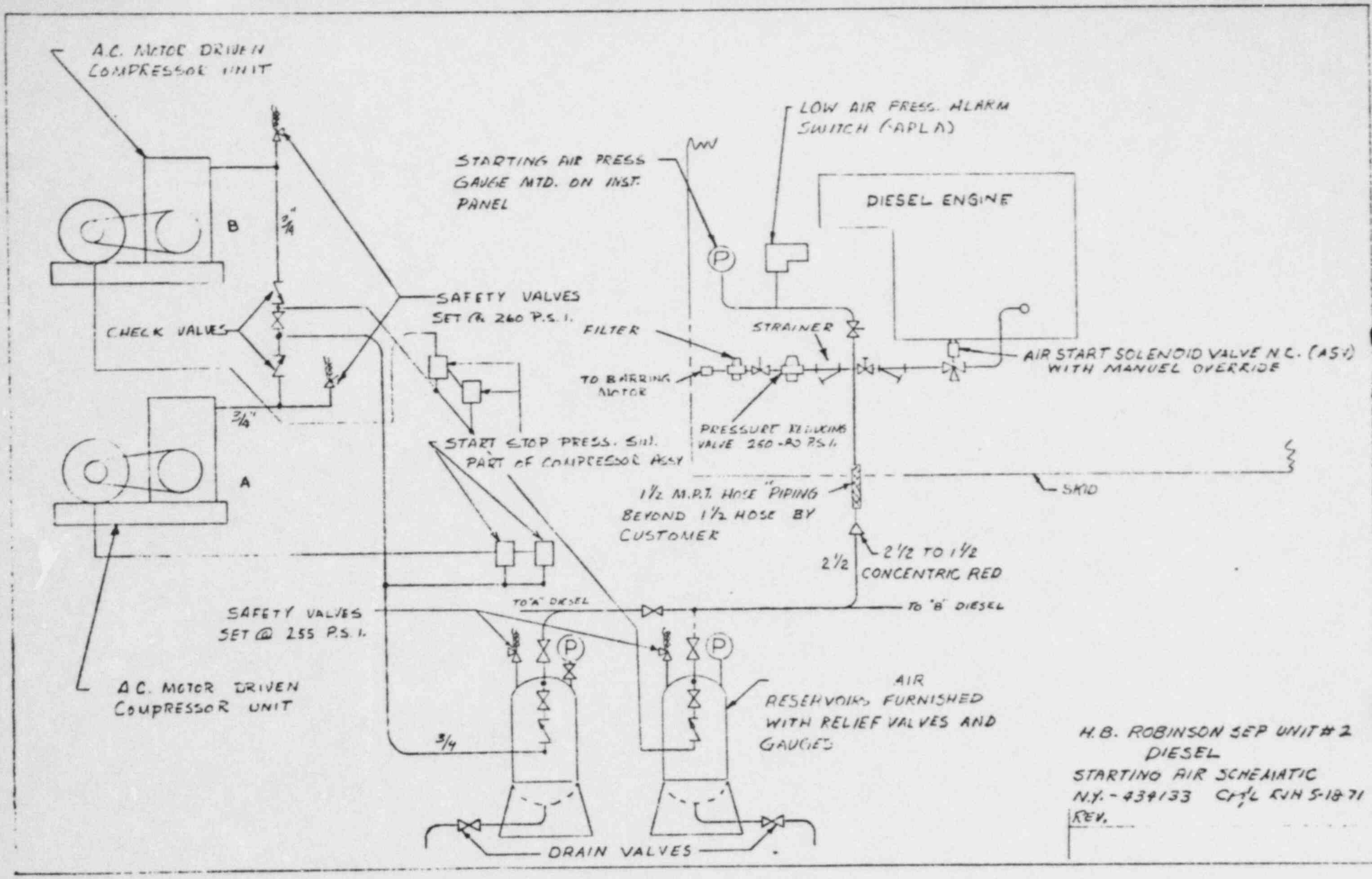


H.B. ROBINSON S.E.P. UNIT # 2
DIESEL
LUBE OIL SYSTEM SCHEMATIC
N.Y.-434133 CP&L RJH 5-18-71
REV. ________



H. B. ROBINSON SEP UNIT #2
DIESEL
JACKET COOLANT SYSTEM SCHEMATIC
N.Y. 434133 CP&L RJH 5-18-71

REV.___


A.C. MOTOR DRIVEN COMPRESSOR UNIT
B
3/4"
LOW AIR PRESS. ALARM SWITCH (APLA)
STARTING AIR PRESS GAUGE MTD. ON INST. PANEL
DIESEL ENGINE
P
SAFETY VALVES SET @ 260 P.S.I.
CHECK VALVES
FILTER
STRAINER
AIR START SOLENOID VALVE N.C. (ASV) WITH MANUEL OVERRIDE
TO BARRING MOTOR
3/4"
PRESSURE REDUCING VALVE 260-80 P.S.I.
START STOP PRESS. SW. PART OF COMPRESSOR ASSY
A
1 1/2 M.P.T. HOSE "PIPING BEYOND 1 1/2 HOSE BY CUSTOMER
SKID
2 1/2 TO 1 1/2 CONCENTRIC RED
2 1/2
TO "A" DIESEL
TO "B" DIESEL
SAFETY VALVES SET @ 255 P.S.I.
A.C. MOTOR DRIVEN COMPRESSOR UNIT
AIR RESERVOIRS FURNISHED WITH RELIEF VALVES AND GAUGES
3/4
DRAIN VALVES
H.B. ROBINSON SEP UNIT #2
DIESEL
STARTING AIR SCHEMATIC
N.Y. - 434133
REV.