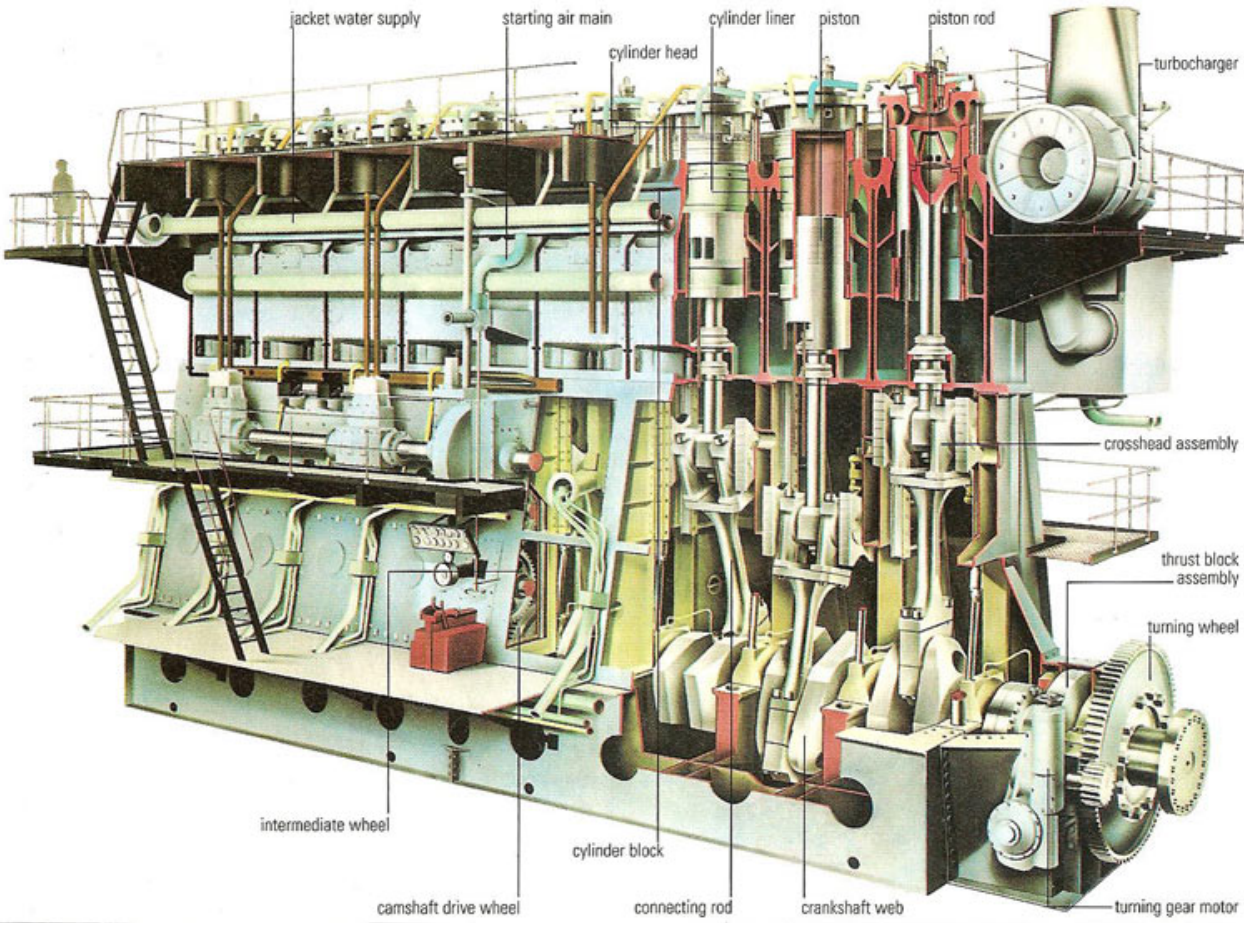
Massachusetts Maritime Academy

EN-4131L Internal Combustion Engines II
Laboratory Manual

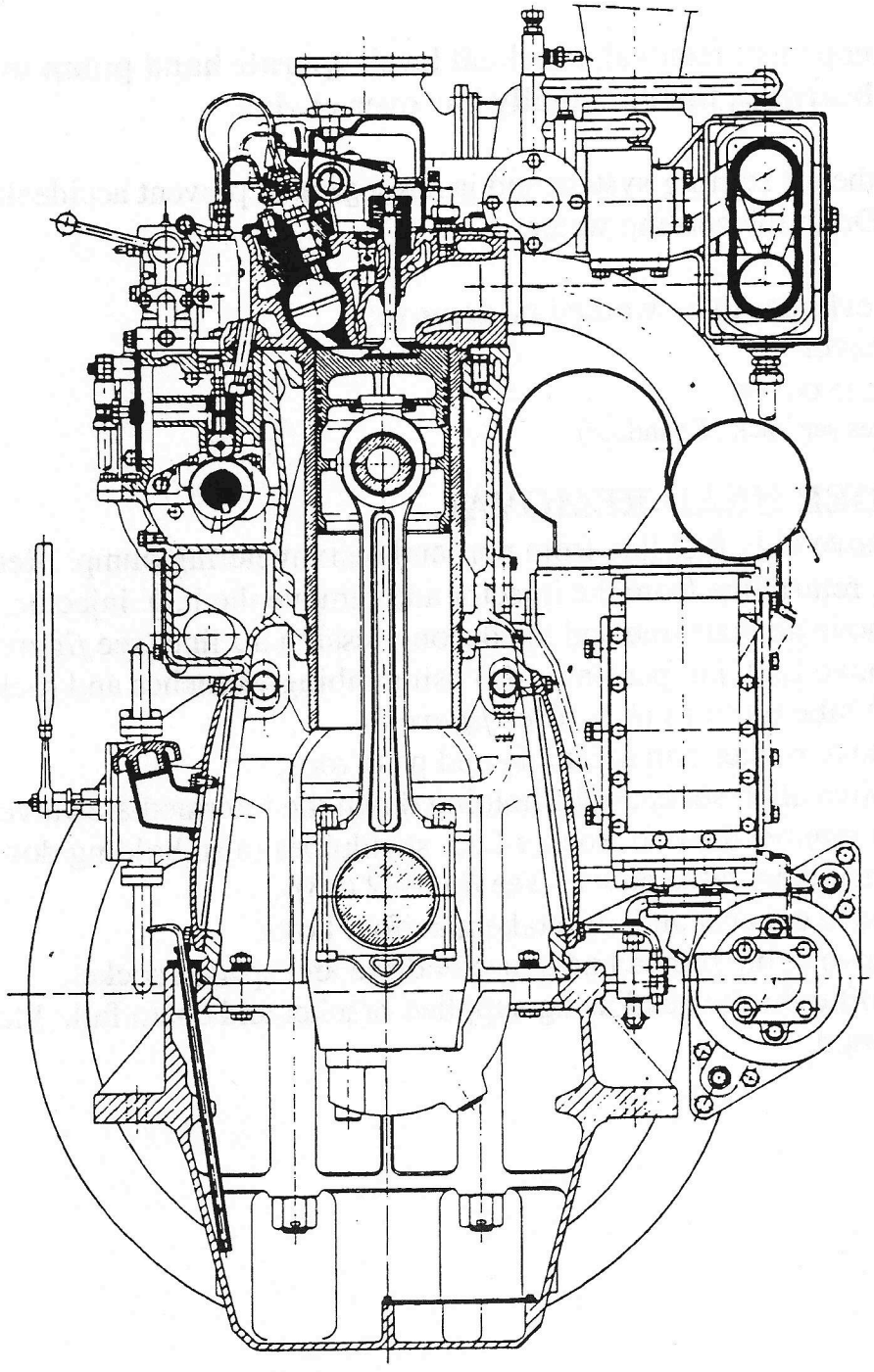


Internal Combustion Engines II

EN – 4131L

Lab #1

MASSACHUSETTS MARITIME ACADEMY
INTERNAL COMBUSTION ENGINES II, EN4131
STORK WERKSPOOR MAIN PROPULSION DIESEL
HEAD - PISTON REMOVAL - LINER



The purpose of this lab is to familiarize the student with a typical medium speed, four stroke-cycle engines found aboard tugboats and larger vessels as both main propulsion and generators. The lab will include cylinder head, piston, and cylinder liner removal and replacement.

Prior to component removal, check oil level, **operate hand pump to force oil to the bearings, then manually bar over engine**.

1. Secure the air starting system and jacking gear to prevent accidental rotation. Drain the cooling water.

2. For the cylinder to be worked on **remove**;
A. Valve cover
B. Crankcase covers
(For tool sizes see back of handout)

CYLINDER HEAD REMOVAL

1. Remove H.P. fuel line from port and helix metering pump. Remove F.O. return line from the injector and remove the F.O. injector.
2. Remove air start line and the decompression air line (see *figure 1*).
3. Remove L.O. jumper lines (#1) using tubing wrenches and rocker shaft lube oil lines (#2). (See *figure 2*).
4. Remove rocker arm assembly and push rods.
5. Remove allen socket bolts holding down the intermediate valve cover. Also remove the two Rocker L.O. standpipes (also holding down the intermediate valve cover – see *figure 2* (#3)).
6. Remove exhaust and air intake manifold bolts.
7. Remove cylinder head nuts, use ¾ drive and special socket.
8. Lift off cylinder head using supplied bracket and chain fall. Place on plywood.

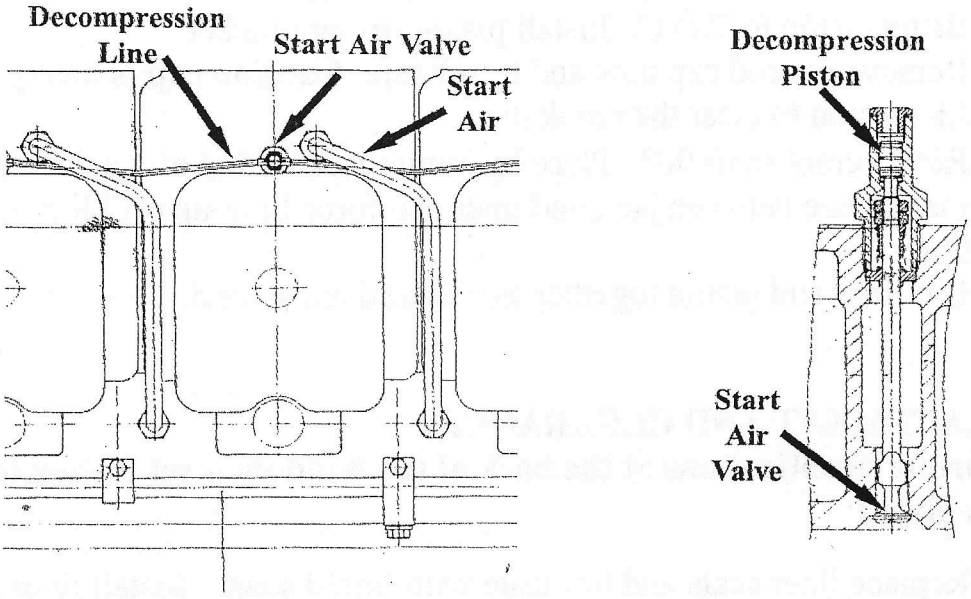


FIGURE 1

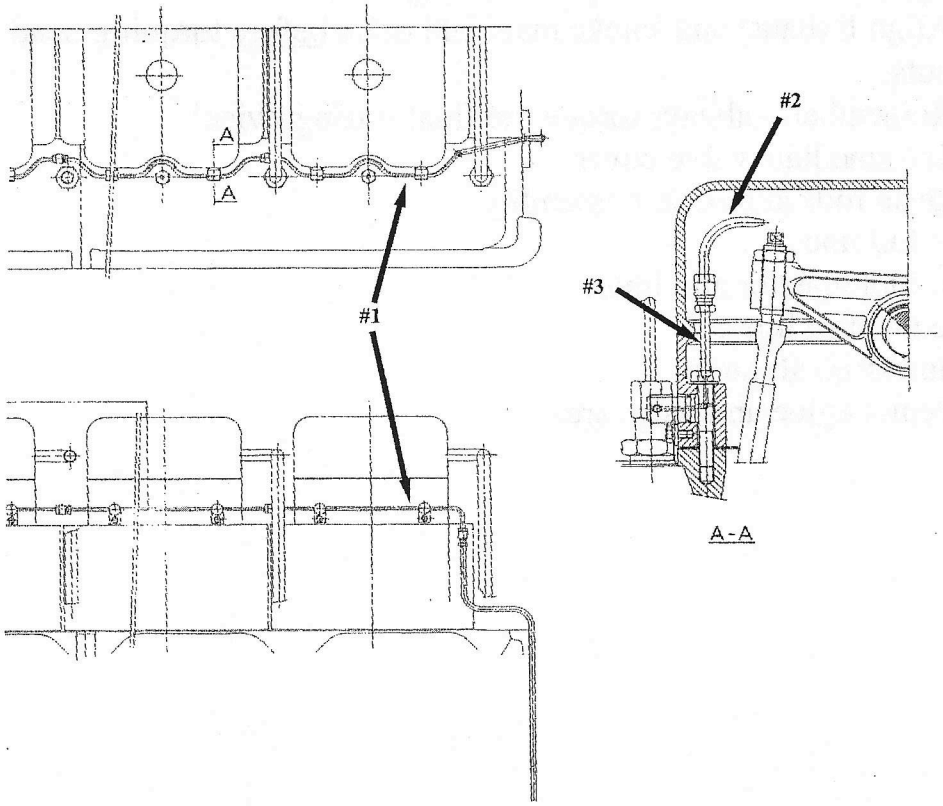


FIGURE 2

PISTON AND CYLINDER LINER REMOVAL

1. Bring piston to T.D.C. Install piston lifting bracket
2. Remove conrod cap nuts and lower cap. **Caution cap is heavy.**
3. Lift piston to clear the crank pin.
4. Rotate crankshaft 90°. Place hydraulic jack on top of crank web, set metal plate between jack and liner and force liner up off block counter bore.
5. Lift liner and piston together as pictured in *figure 3*.

REPLACEMENT AND CLEARANCES

(see torque specifications at the back of the handout – set torque to ½ x values given)

1. Replace liner seals and lubricate with liquid soap. Install liner and piston.
    a. Use channel iron/ pipe tool along with 2 head nuts to drive liner into position
2. Install cylinder head. Follow pattern in *figure 4*
    a. Align Exhaust and Intake manifold bolts before torquing head nuts.
    b. Remember – always torque the final setting twice!
3. Install intermediate valve cover
4. Install push rods and rocker assembly.
5. Replace LO lines.
6. Replace fuel injector and lines.
7. Replace air start lines.
8. Clean and store all tools
9. Wipe clean engine and work area

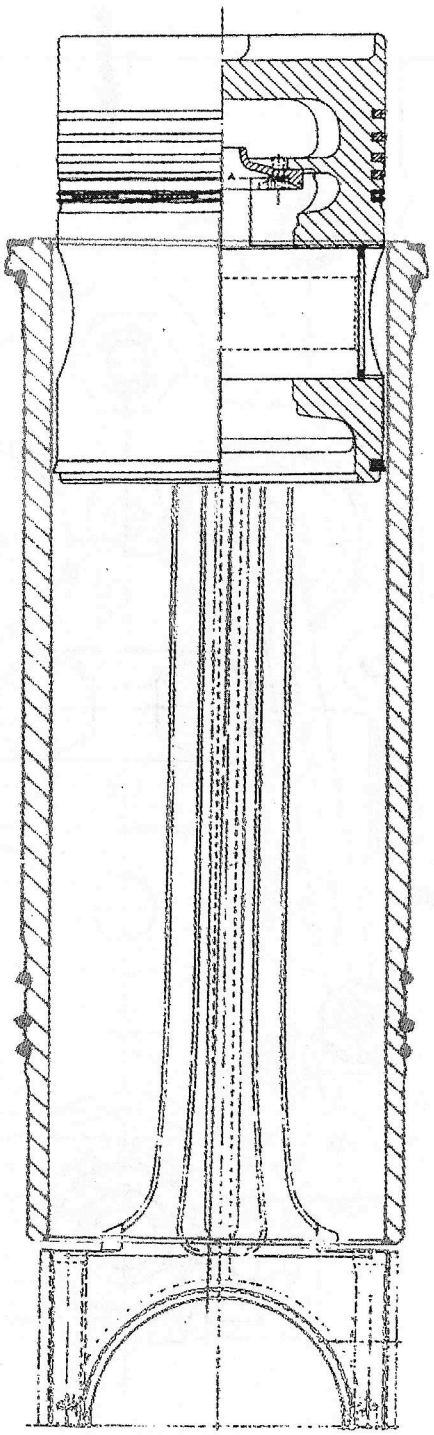


FIGURE 3

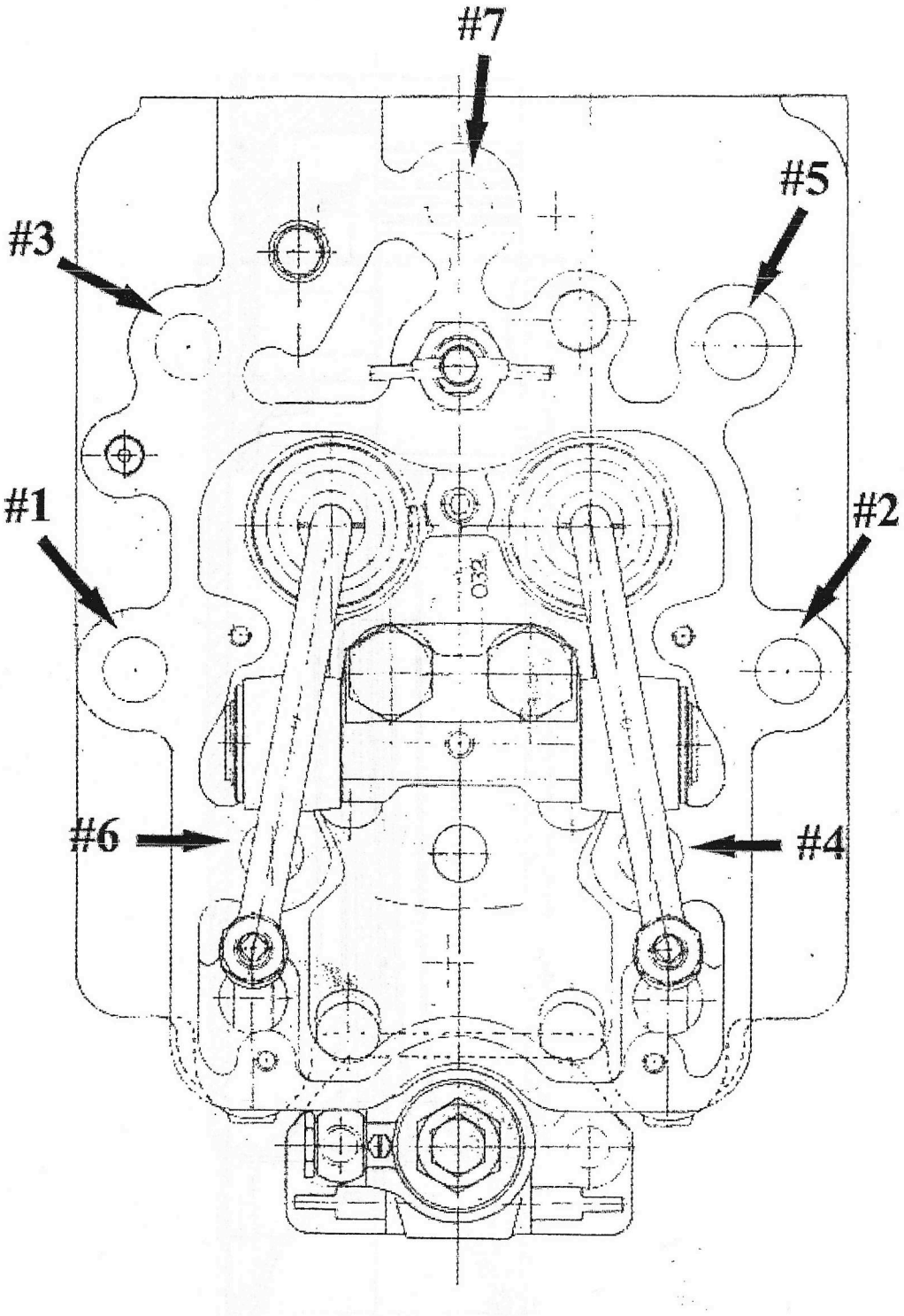


FIGURE 4

Valve clearance.
The nominal valve clearance in cold condition of the engine:
between inlet valve stem and valve lever is 0,10 mm. or .004 in.
between exhaust valve stem and valve lever is 0,25 mm. or .010in.

Tightening the stud and bolt connections.
Connections that can be tightened with a normal spanner.
These connections to be tightened with the appropriate spanners without applying lengthening pieces, etc.
Connections which may be tightened with a torsion spanner, is possible.
The following tightening torques are required for these connections:

Fixation of main bearing caps	200 ft.lbs or 27,6 kgfm.

Adjust torsion spanner on 155 ft.lbs or 21,4 kgfm, when using spanner 9612 R 016.

Fixation of camshaft bearing caps	47 ft.lbs or 6,5 kgfm.
Fixation of counter weights	280 ft.lbs or 38,6 kgfm.
Fixation of cylinder heads	320 ft.lbs or 44 kgfm.
Fixation additional bearing	200 ft.lbs or 27,6 kgfm.
Fixation rocker arm	150 ft.lbs or 27,6 kgfm.

Adjust torsion spanner on 200 ft.lbs, when using spanner 9612 R 163 (tightening torque is the same in connection with various angles of approximation!)

Connecting rod bolts	280 ft.lbs or 38,6 kgfm.

Note. Prior to being tightened thread and nut face of the bolts and nut have to be lubricated with the lube oil used for the engine. Molykote, tallow or similar lubricants are not to be used on any account.

Tie rods for fixing the crankcase on the bedplate.
The tie rods have to be lengthened by 1 or 1,2 mm.

Sequence of combustion at normal sense of rotation (this is clockwise, seen against the flywheel).
6 cylinders 1 - 3 - 5 - 6 - 4 - 2.

Oil filling of crankcase and capacity of cooling water space.

Number of cylinders	8
Oil filling l.	225
Capacity of cooling water space l.	200

Tool sizes (socket, wrench, allen)

	Metric (mm)
Air pipe	36
Bearing cap #8	30
Conrod bearing cap	32
Crank counter weight (allen cap screw)	22
Crank main	32
Crankcase door	19
Decompression air line	14
Exhaust manifold	24
Head Bolt	41
HP Inj. FO inlet	24
HP Inj. Hp line (Inj. Side)	19
HP Inj. Hp line (pump side)	22
FO return line	14
Inj. F.O. return line banjo	12
HP Inj. Pump mounting bolts	24
Injector	27
Inj. Nut (remove return line adapter banjo)	17
Inj. Pump cam cover	13
Intake manifold	24
Intermediate valve cover (allen socket)	8
Intermediate valve cover (oil line stand pipes)	17
Kiene Plug	17
Main LO tubing nut	36
Rocker LO Line Coupling	12
Rocker LO Line	14
Valve adj.	27
Valve cover	20
Valve rocker assembly	32

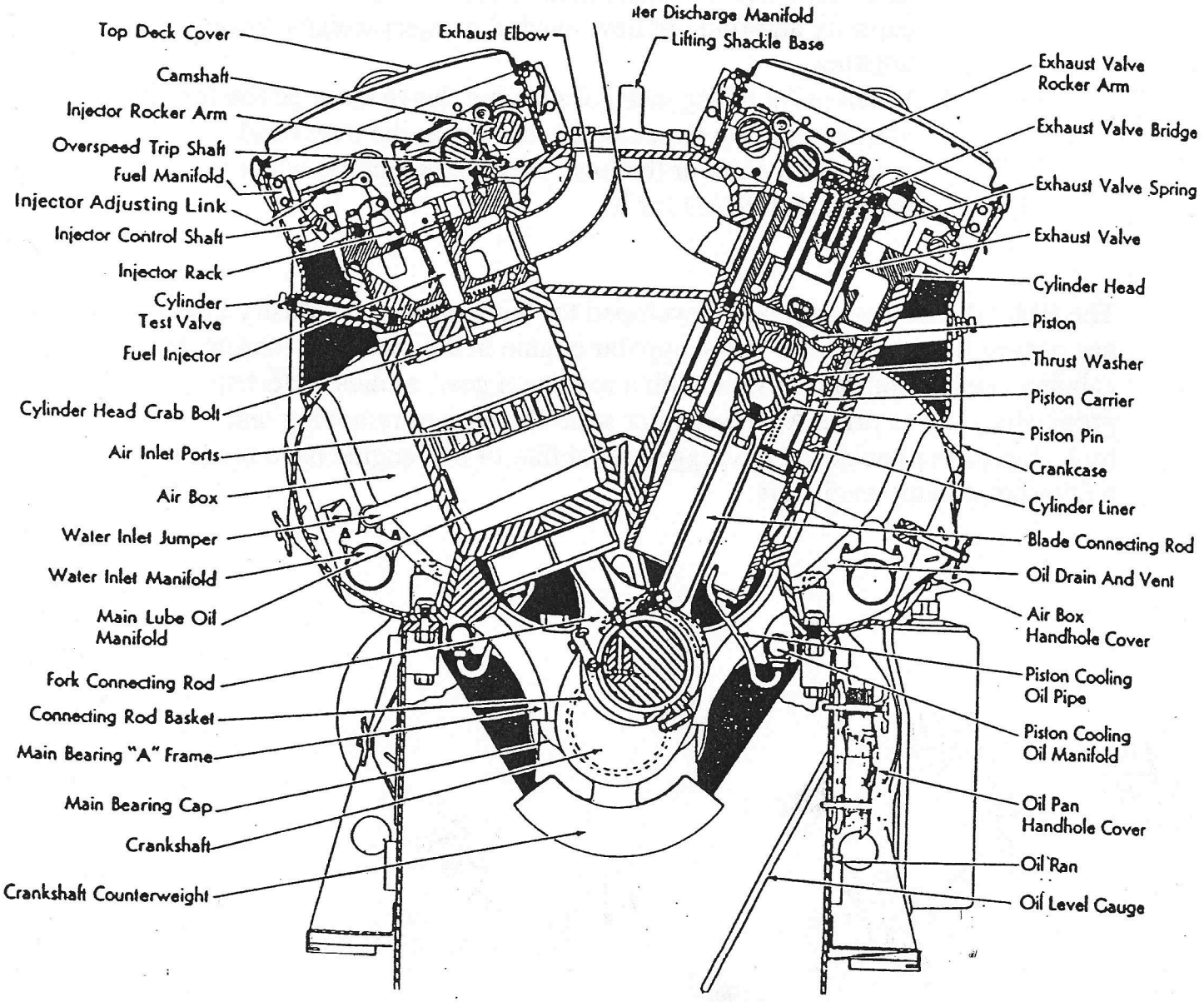
Internal Combustion Engines II

EN – 4131L

Lab #2

GENERAL MOTORS
EMD
12V-567

PISTON, LINER AND POWER PACK REMOVAL AND REPLACEMENT



Internal Combustion Engines II EN 4131
EMD

This lab session has the risk of personal injury to yourself and others. Wear eye protection and safety shoes at all times.

1. When baring over any rotating machinery ensure that the machine **CAN NOT START**.
2. When baring over any rotating machinery **only start baring when instructed to do so** by those who are in charge and inspecting/viewing the machinery. People have lost hands and life from even slow moving machinery.
3. **When using lifting gear** for hoisting, **inspect all parts** for wear, distortion, nicks and damage. Chain falls are often severely over loaded from angled loads and the use of two chain falls with the same load. Check chain fall for weight capacity and find out how much the object weighs before hoisting.
4. When using lifting gear for hoisting, **leave clear paths** for your escape. Do not stand under or near the over head connection point or the load. Always expect the worst to happen and PLAN for it.

The EMD diesel was originally developed for the locomotive industry but has proven it self as an extremely popular engine in the merchant marine. It is being used as ship propulsion, with a reduction gear, as diesel electric propulsion, and to drive A.C. generator sets. The ease of removing and replacing power packs and the rugged reliability of this engine have made it a favorite of many engineers.

Internal Combustion Engines II EN 4131
EMD

POWER PACK REMOVAL

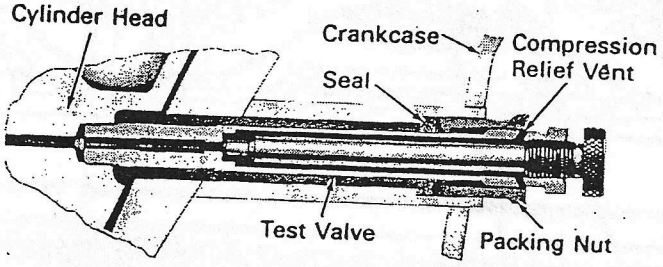
The learning objective of this lab is to demonstrate the procedures for power pack removal of a typical EMD 2 stroke cycle diesel engine.

A power pack is comprised of; the cylinder liner, cylinder head and piston/con-rod. These components are removed and a remanufactured unit installed, all as one unit or pack.

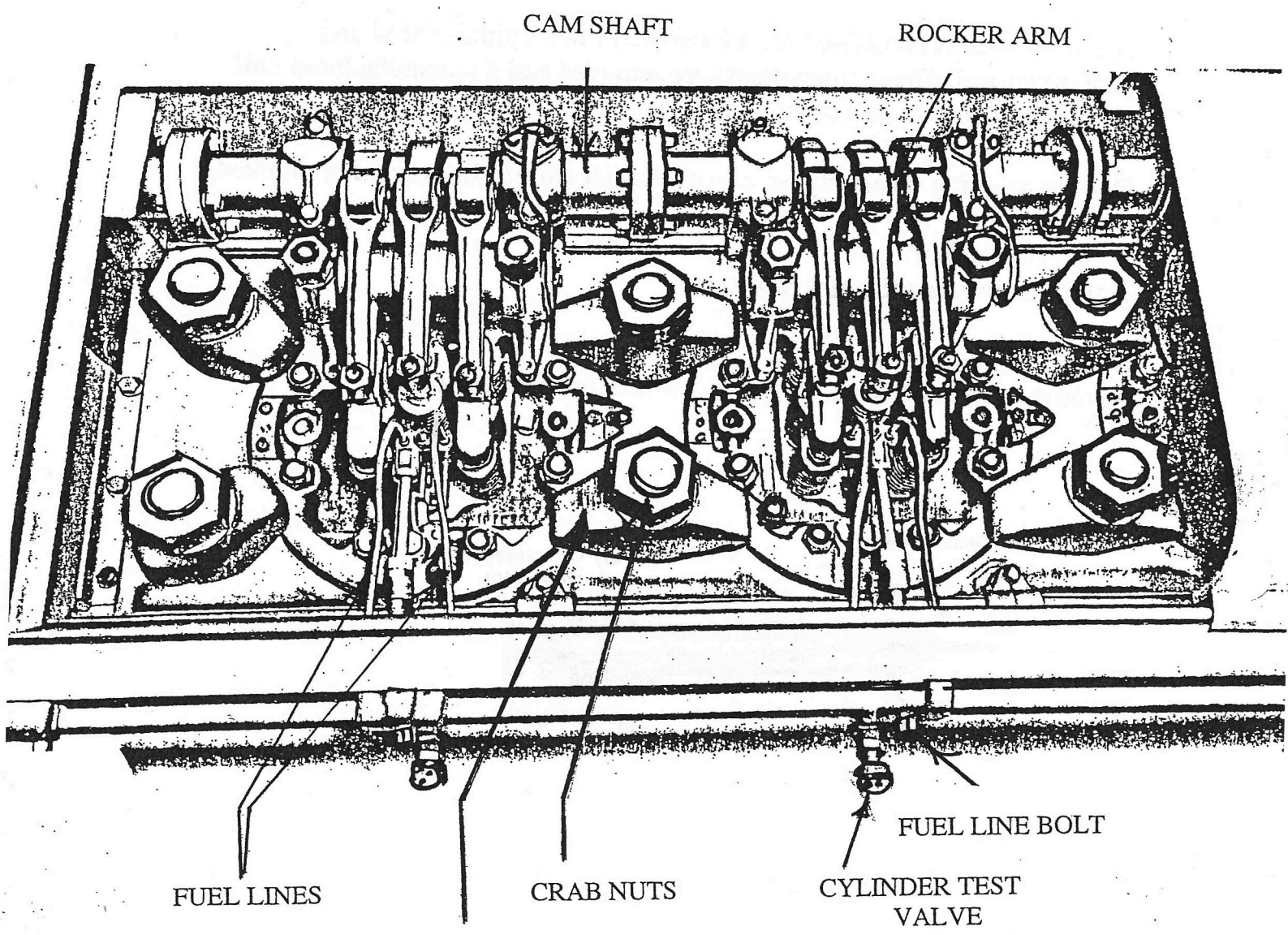
Prior to working on an engine, ensure that bit **cannot be started** or cranked over.
Drain the coolant,
Remove air box and crankcase doors.

Step 1, indicator valve

Remove cylinder test valve. Use 1-1/8 inch open end wrench

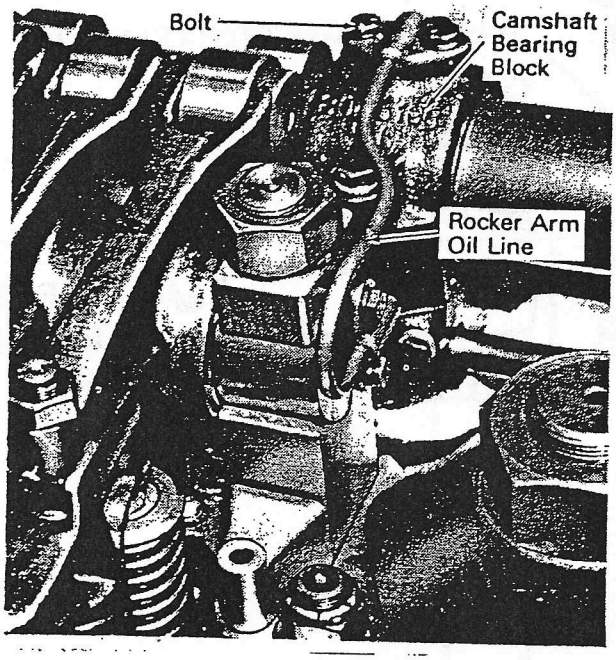


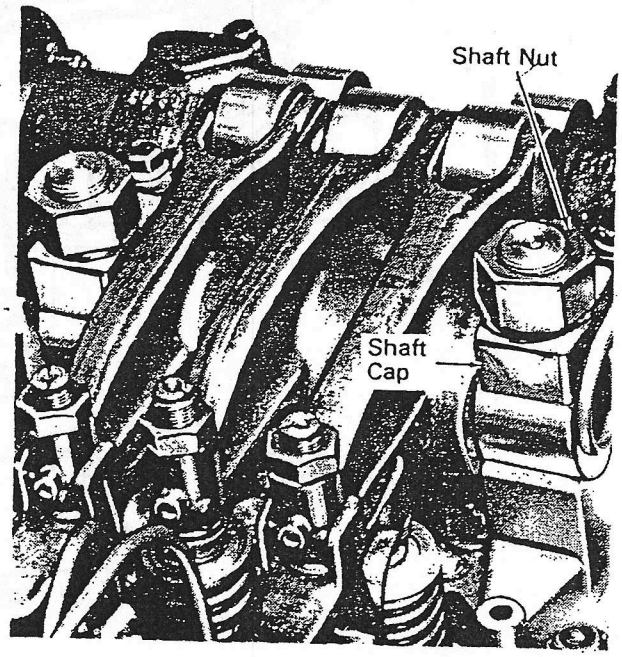
NOTE;
Failure to remove the indicator valve will result in significant damage to the engine cylinder head and indicator valve when the power pack is lifted.


CAM SHAFT
ROCKER ARM
FUEL LINE BOLT
FUEL LINES
CRAB NUTS
CYLINDER TEST VALVE
LINER HOLD DOWN CRAB

Step 2 Remove rocker arms and rocker shaft

A. Remove lube oil line from camshaft to rocker shaft
B. Remove rocker shaft nuts, use 1/1/2 inch socket, ¾ **inch** drive.
C. Remove shaft cap **NOTE** which way it goes!
D. Place rocker arms/shaft in valve cover.
E. Remove rocker shaft pedestal supports.





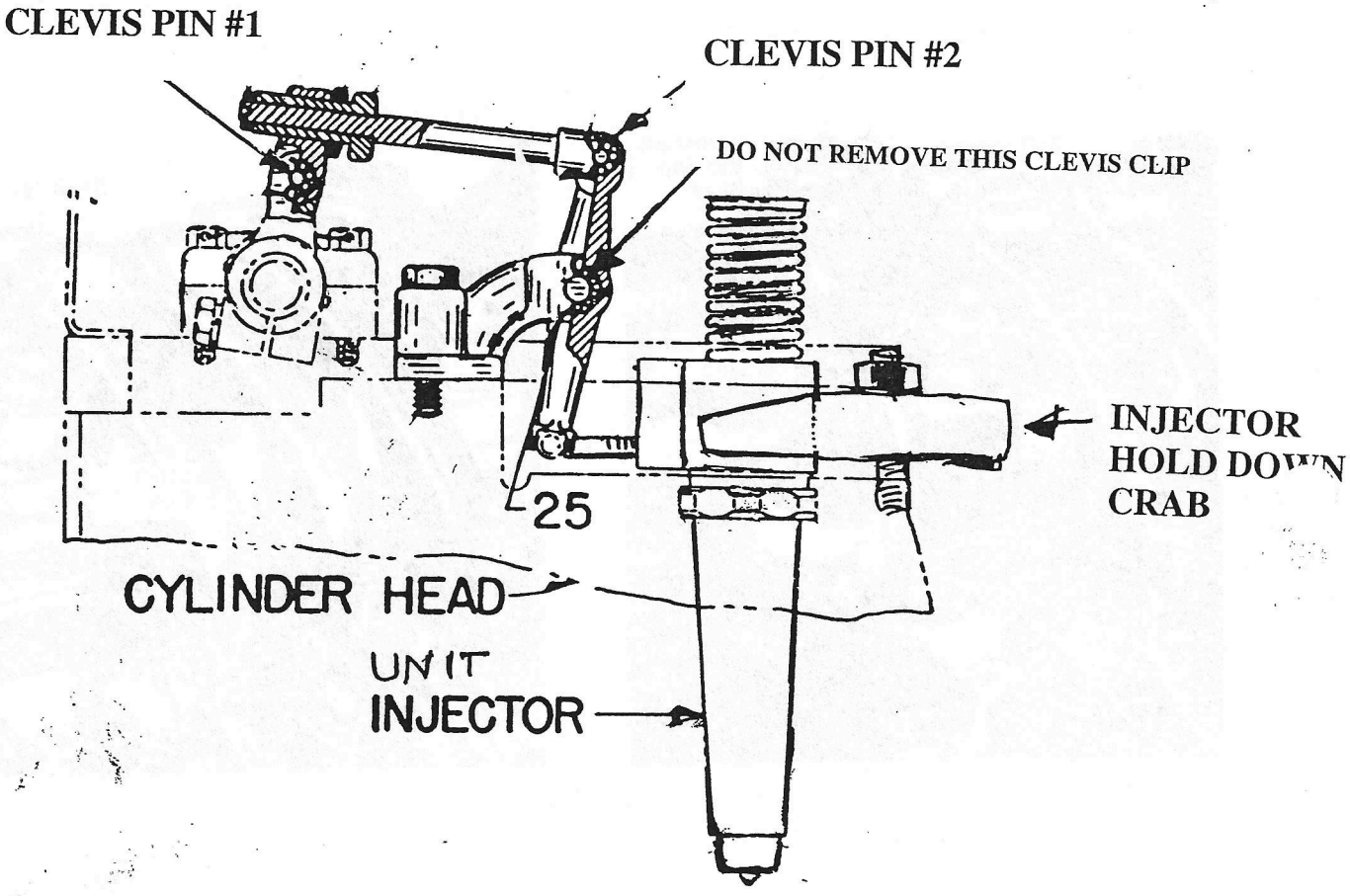
Notes;
1. The Rocker arms engage a valve bridge which has hydraulic "lash" adjustors.
2. Under the center the fuel injector rocker arm, is the cam for the over speed trip.

Step 3 Unit Injector removal

A. Remove fuel lines, one nut on injector , one bolt outside the engine, use 5/8 inch socket, ½ drive

B. Remove nut on injector hold down crab

C. Lift out injector, protect spray tip and cover fuel openings



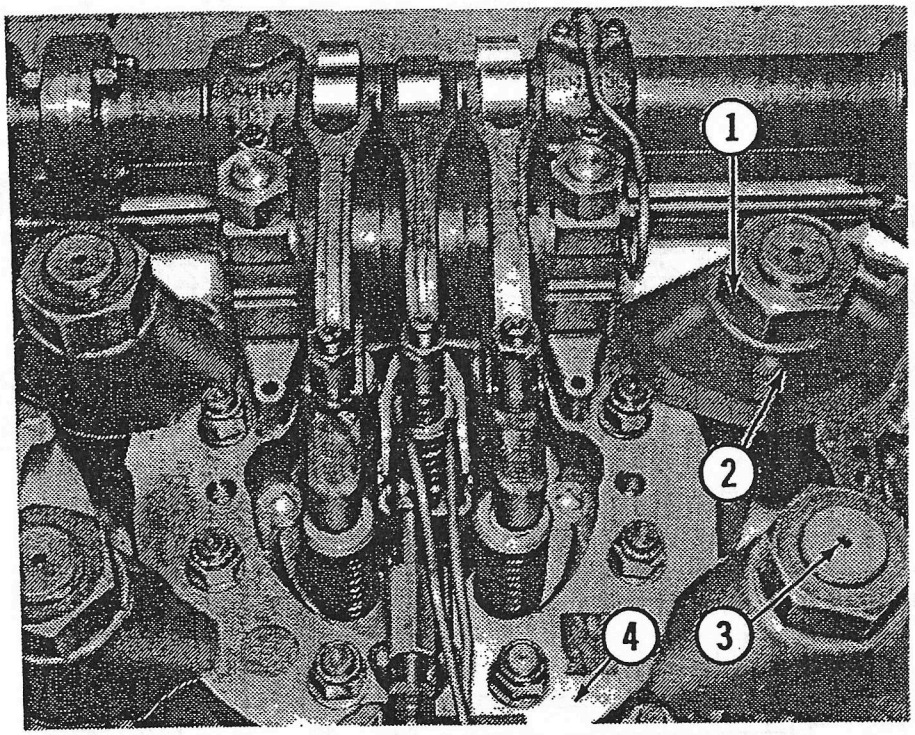
Step 4 Injector linkage removal

A. Removal small clevis pin on the injector rack metering control at both ends.

Step 5 Crab nut removal

A. Set up the torque multiplier on two nuts across the head.

The torque multiplier has a planetary gear raising torque output 18 to 1.
Note; the anti-kick back pawl must be set in the correct direction or the wrench may be damaged.



24119

1. Crab Nut
2. Crab
3. Crab Bolt
4. Cylinder Head

Install head lifting bracket, Hand thread in bolts lightly, tighten lock nuts, place threaded rod down through bracket into injector hole. Proceed to crankcase and disconnect connecting rods.

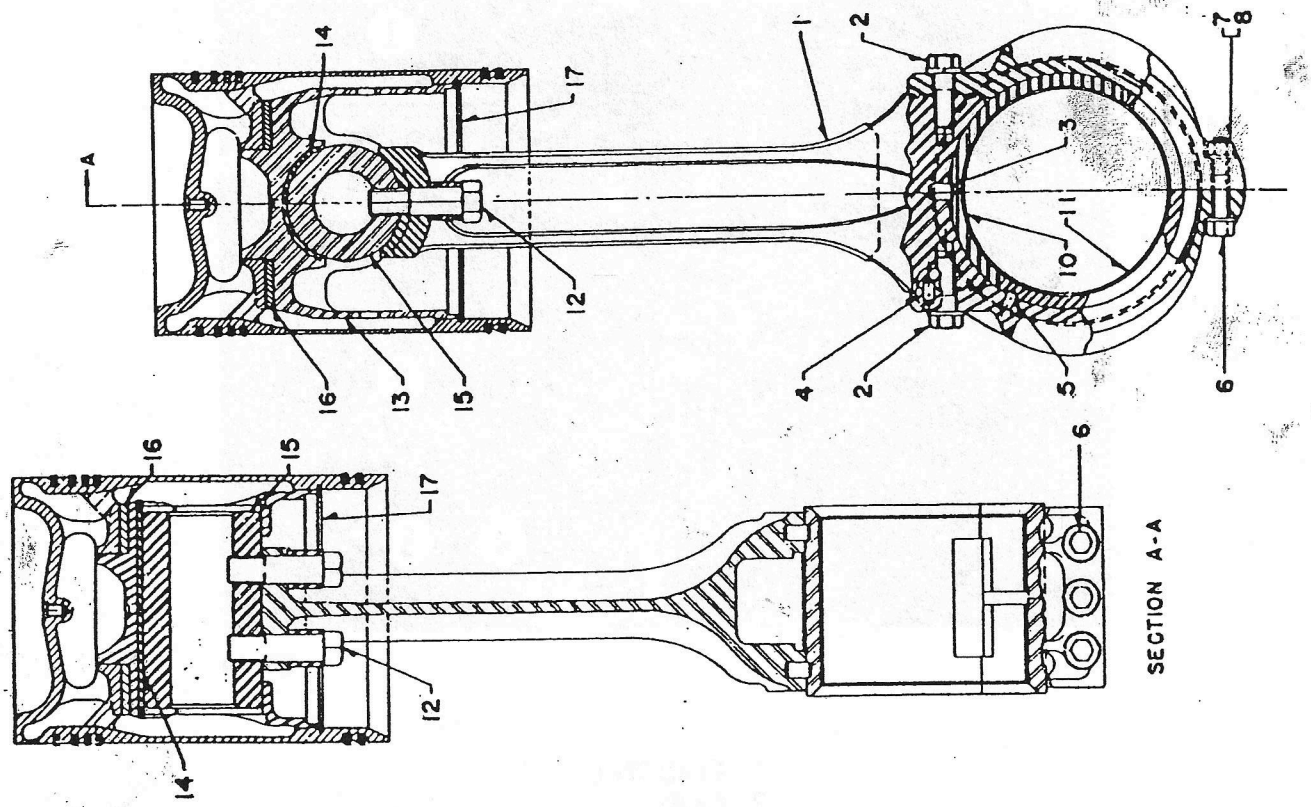
CONNECTING ROD BEARING BASKET REMOVAL

Oil "P" pipe, coolant jumper removal, bearing basket removal

A. Remove piston oil cooling pipe from liner bottom edge.
B. Remove coolant jumper
C. Remove 3 lower bearing basket bolts,items 6& 7 on sheet below, use special ¾ to ¾ holder tool wrench.
D. Remove 2 upper 7/8 inch bolts, item 2, with special tool. Catch bearing basket and shell.

NOTE: inspect for drilled holes for alignment dowel pins, ensure that this bearing basket half is installed on correct side, when reassembling!!!

E. Remove 2 upper -7/8 inch bolts on other side of bearing basket. Catch basket half and lower bearing shell, if not out already.

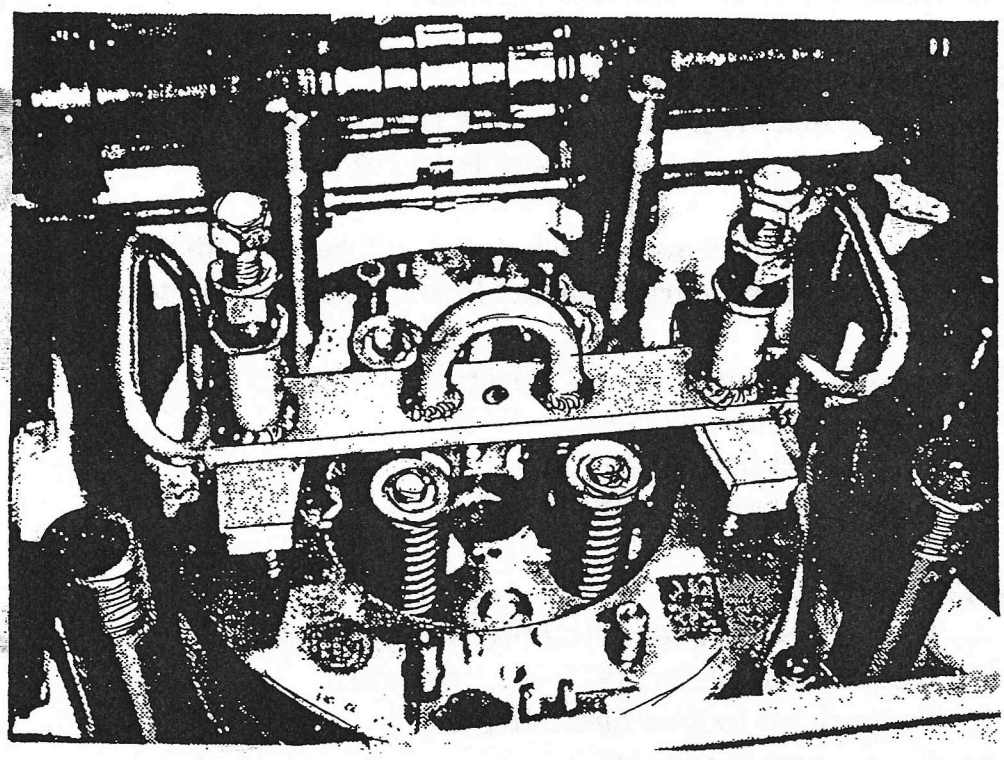


Bar engine over to TDC for forked rod, install holder tool for forked rod, bar engine counter clockwise to TDC for blade rod, forked rod should separate from crank journal.

Bar engine over to TDC for right side, flywheel counter clockwise.

A. Install head lifting bracket with threaded rod. Finger tight on bolts into head. Thread rod in to piston crown.

Note these piston crown threaded holes will fill with carbon it will be necessary to put a tap into crown and gently remove debris, vacuum out dust and lube the bolt.



Step 9 Raise Power Pack with the chain fall

Note, Always inspect lifting gear, don't stand under the falls, leave an exit route, keep hands clear.

The angle of the chain and the angle of the power pack vee **are not** the same, it will be necessary to assist the pack so it will not jam.

Prevent the pack from swinging into the engine frame as it clears the block bore.

Replace power pack, in reverse order.

Step 1 Install power pack

A. Lower pack into bore, **Note** it will hang up on the edges of the engine block bore and must be guided past these with a wooden plank.
B. Place upper bearing shell on crank pin, guide blade rod onto bearing shell top.
C. Remove head lifting bracket, bar engine over, flywheel clockwise, until blade rod and forked rod mesh.
D. Remove threaded rod holding fork rod.

Step 2 Install bearing basket

A. Ensure that the 2 dowels for fork rod align into top of upper shell.
B. Align basket halves with dowels on left side.
C. Install bolts
Torque con-rod bearing basket upper 2 bolts to 80 ft-lbs
Torque con-rod bearing basket lower 3 bolts to 40 ft-lbs

Step 3 Re-install rocker arm and injector

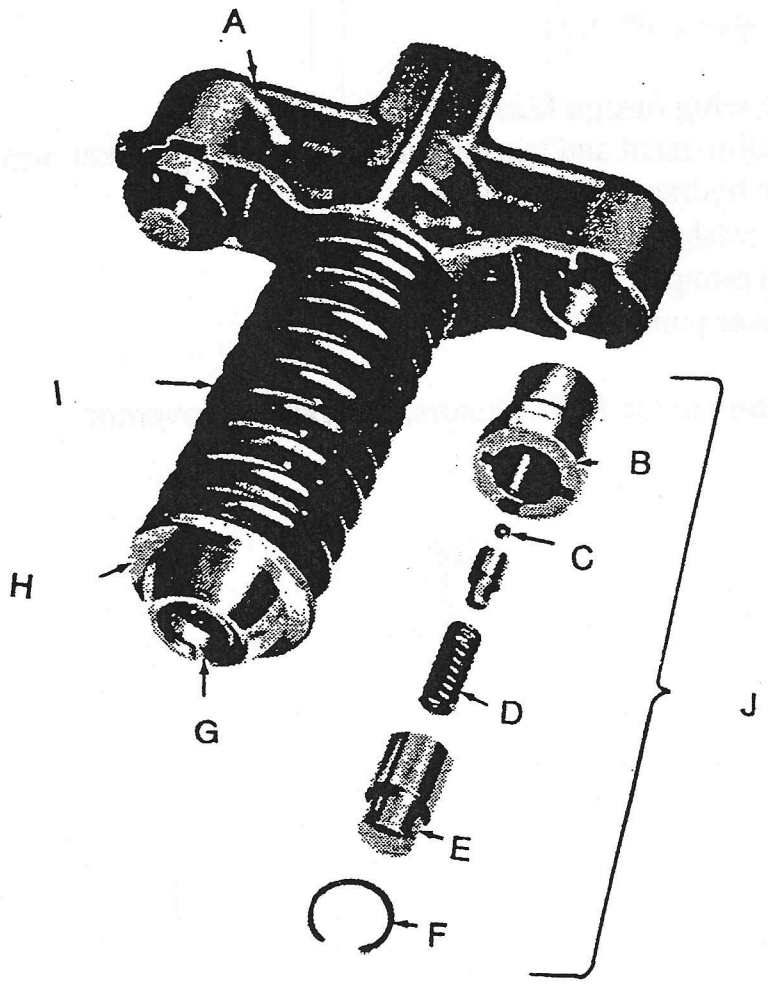
A. torque injector and crabs to 50 ft-lbs
B. Torque fuel lines to 40 ft-lbs
C. Torque rocker shaft nuts to 300 ft-lbs

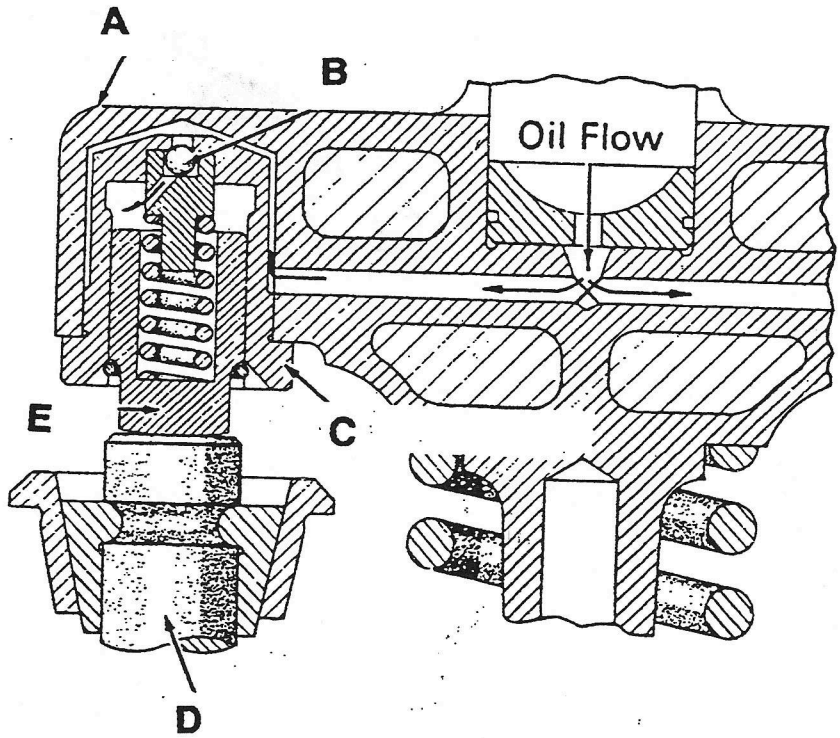
Step 4 Torque Crab nuts

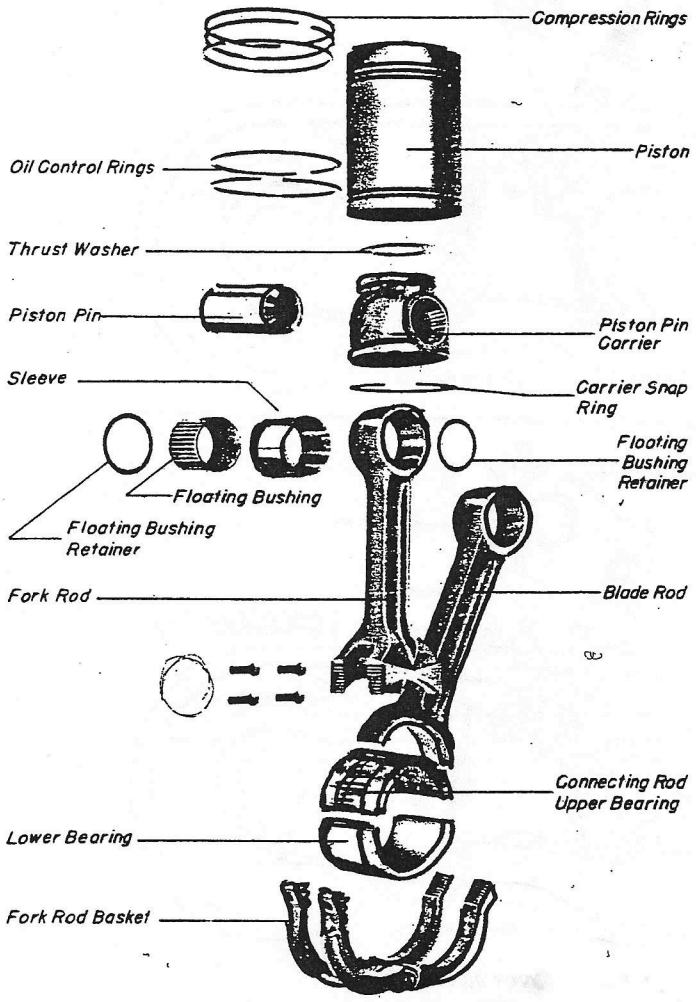
A. Torque head to liner nuts 75 ft-lbs, follow pattern.
B. Torque crab nuts to 300 ft-lbs, criss-cross.
C. Torque head to liner nuts 240 ft-lbs.
D. Torque crab nuts to 1800 ft-lbs.

Please note the following design features

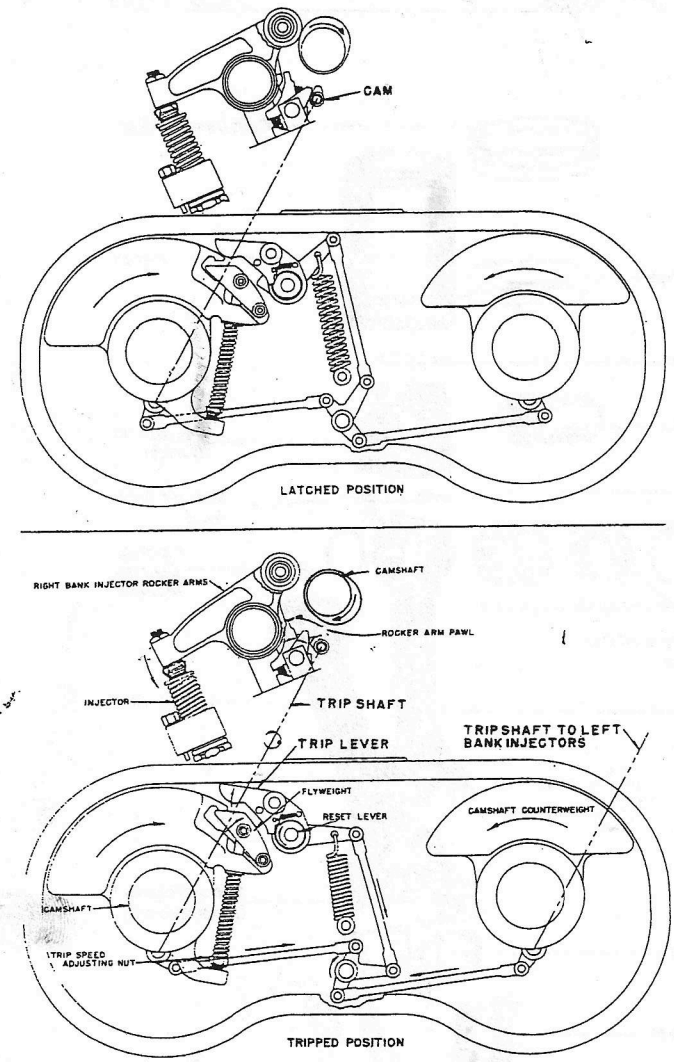
A. Over speed trip adjustment and trip cam under fuel pump rocker arm
B. Valve bridge with hydraulic lash adjusters
C. Spherical seating washers under crabs.
D. The three lube oil pumps
E. The two banks water pumps
F. Roots blowers
G. Governor connection to the fuel injectors, removing a governor


A
I
H
G
B
C
D
E
F
J


A
B
Oil Flow
E
C
D



Piston And Connecting Rod Assembly
Fig. 3-2



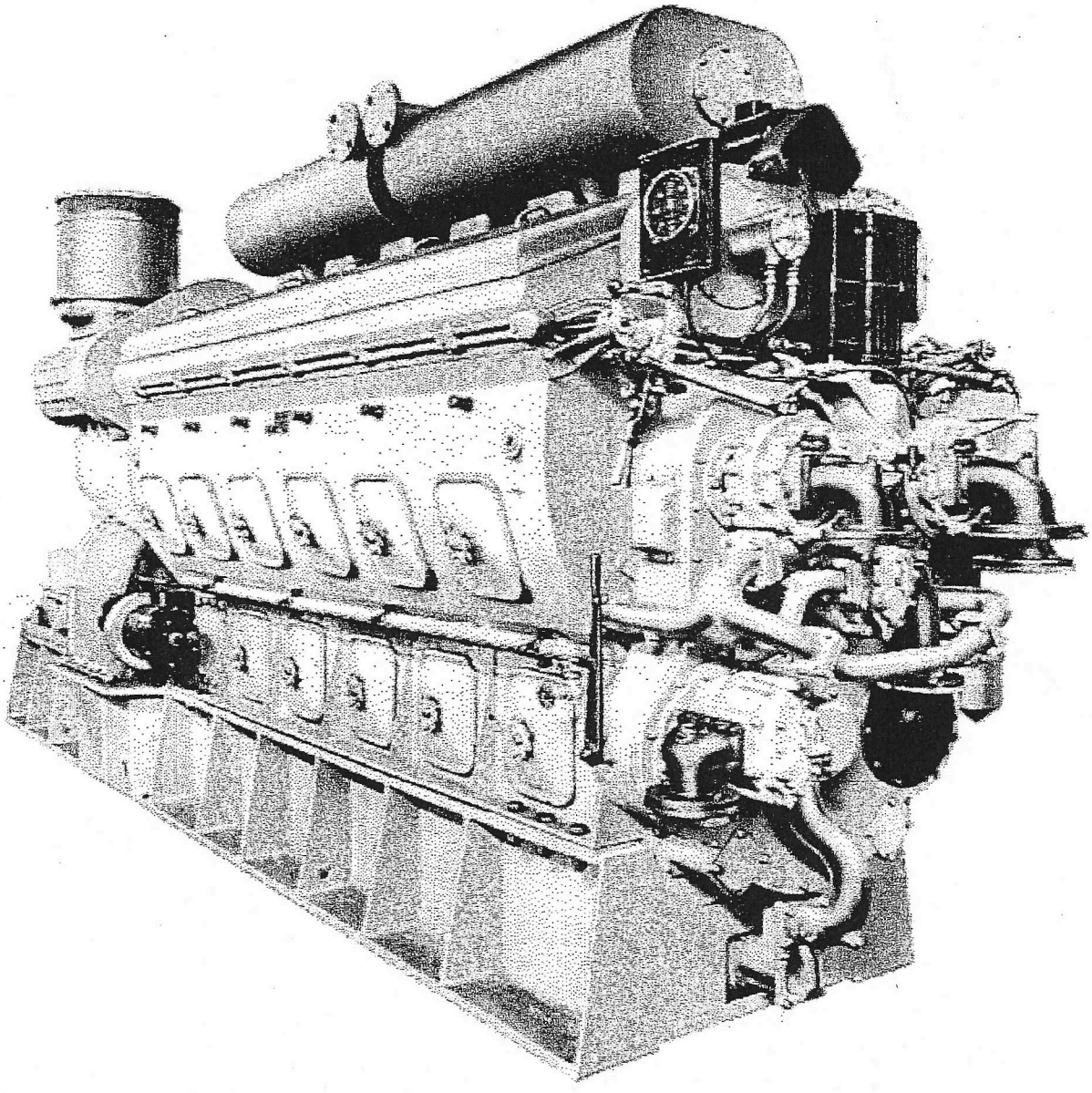
Overspeed Trip
Fig. 6-4

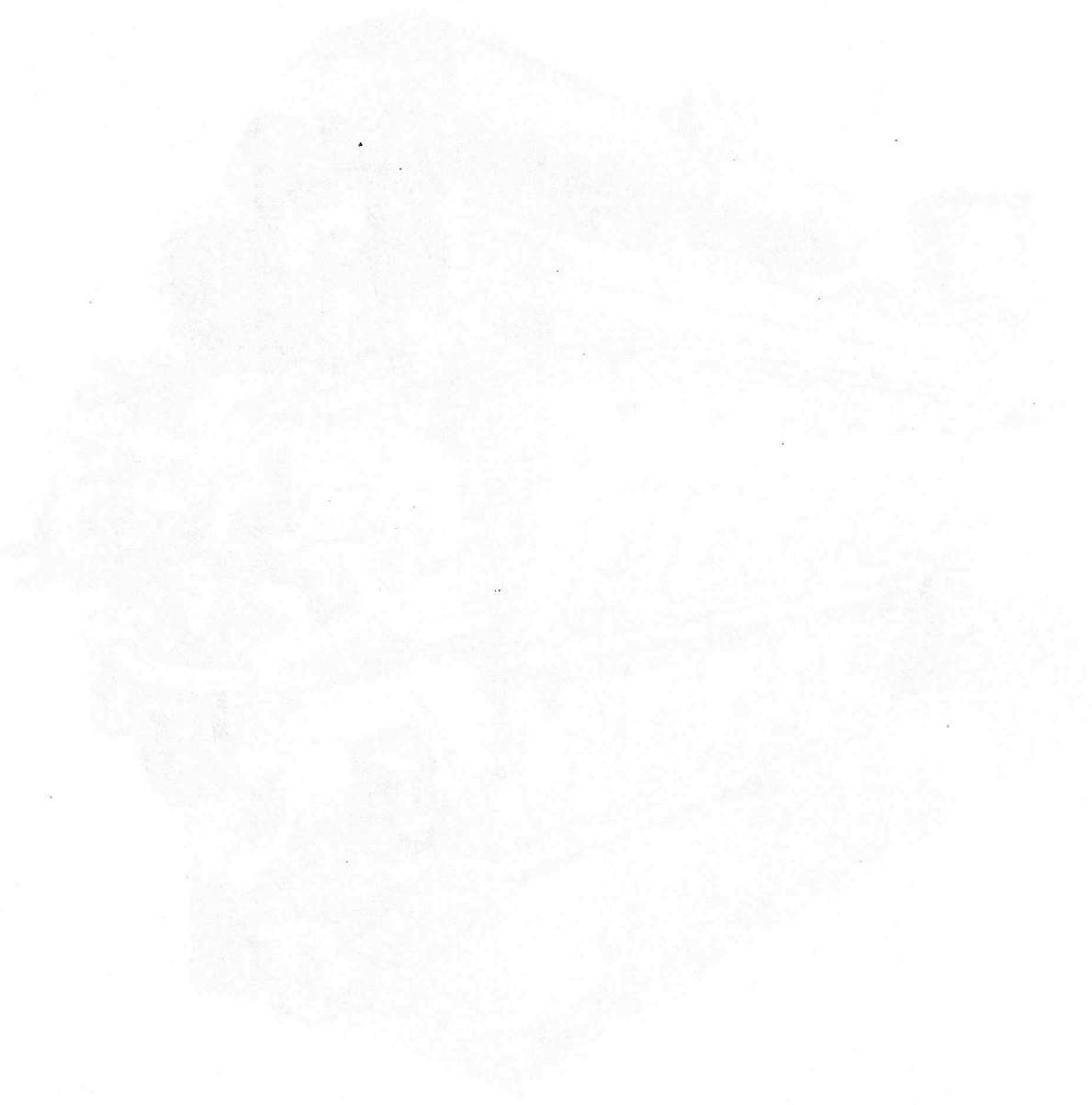
Internal Combustion Engines II

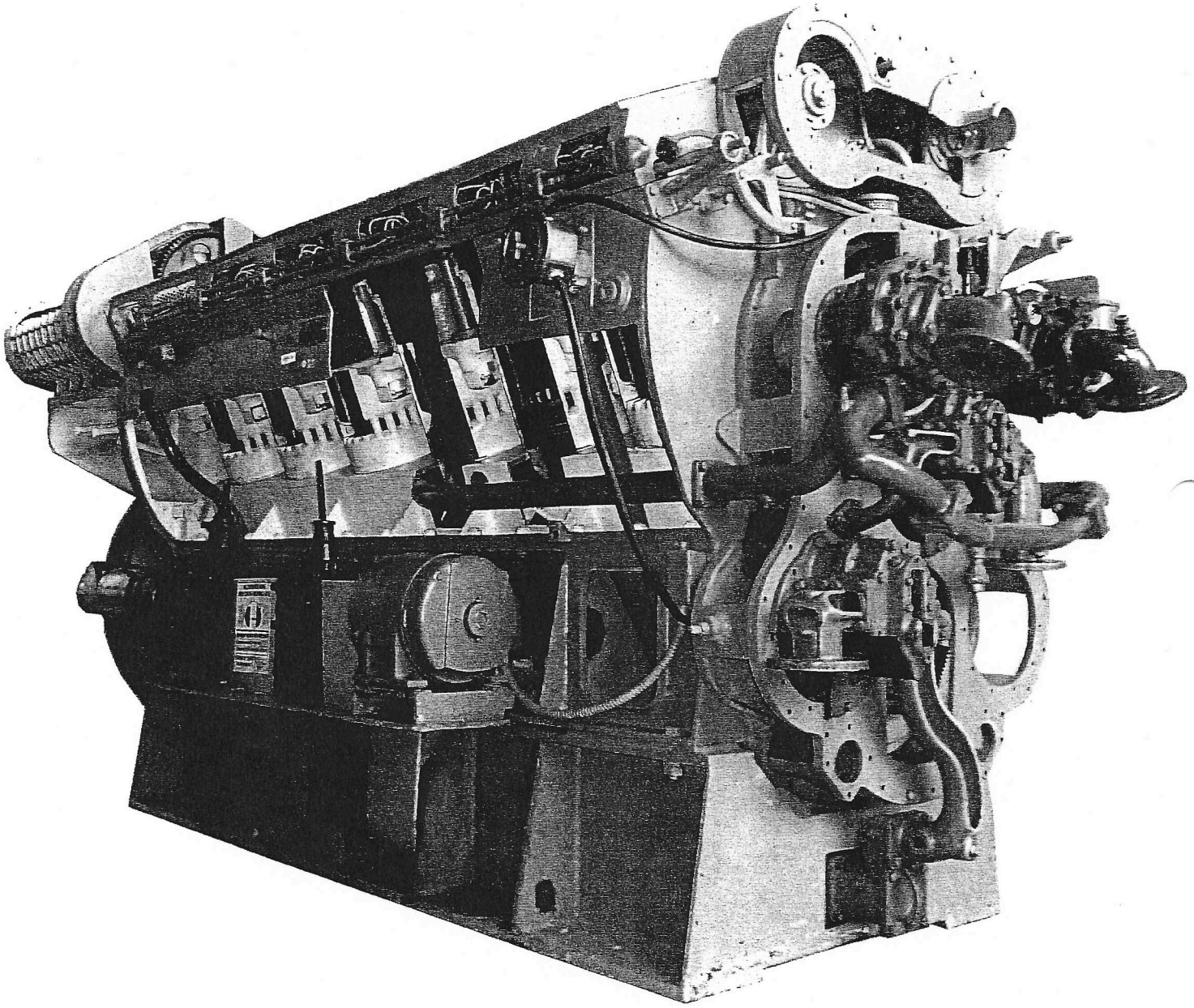
EN – 4131L

Lab #3

EMD 567A LAB



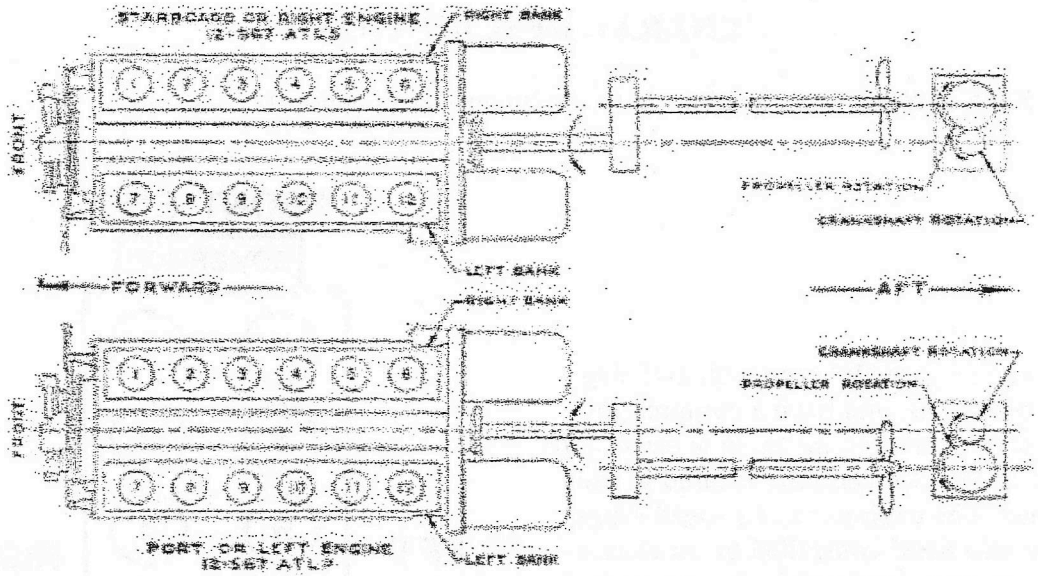




GENERAL SPECIFICATIONS & DATA

The Model 12-567 ATL Diesel engines used by the United States Navy are "V" type, two-cycle models incorporating the advantages of a relatively low weight per horse power, full scavenging air system, solid unit injection, high compression, and full horse power development at a relatively low engine speed.

The two ends of the engine will be known as FRONT or ACCESSORY end and REAR or BLOWER end. The RIGHT HAND side of the engine is determined by looking from the BLOWER end toward the ACCESSORY end. Cylinder numbering begins with 1 on the RIGHT HAND side at the ACCESSORY end, runs consecutively down the RIGHT HAND side to the BLOWER end, then continues from the ACCESSORY end down the LEFT HAND side.



LAYOUT DIAGRAM
Plate 3867

Bore	8-1/2"
Stroke	10"
Compression Ratio (nominal)	15:1
Maximum Governed Speed	744 R.P.M.
Idling Speed	275 R.P.M.
Starting Speed	70 to 75 R.P.M.
Overspeed Trip Setting	860 R.P.M.
Rotation - Viewed from Rear End - 12-567 ATLP	Clockwise
Rotation - Viewed from Rear End - 12-567 ATLS	Counter-Clockwise
Angle between Banks	45°
Nominal Horse Power (At 744 R.P.M.)	900
Total Displacement - Cu. In.	6808
Firing Order - 12-567 ATLP	1-6-2-11-3-5-9-10-3-4-7-12
12-567 ATLS	1-12-7-4-9-10-5-3-11-2-6
Number Exhaust Valves per Cylinder	4
Crankshaft Diameter	7-1/2"
Crankpin Diameter	6-1/2"
Number Main Bearings	7
Number Compression Rings	4
Number Oil Control Rings	2

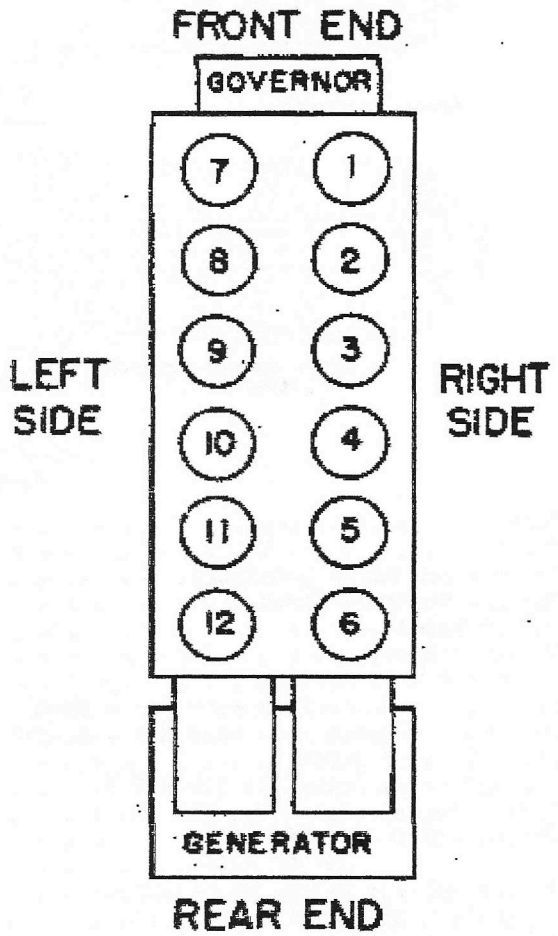
SECTION 1

GENERAL DESCRIPTION

The EMD 567A is rated at 2000 HP each. (12-cylinder Diesel engine).

The diesel engines are "V" type with a 45 deg angle between banks, and have a compression ratio of 16 to 1. Solid unit injection is employed, there being an injector centrally located in each cylinder head. The engines have a speed range from 275 to 800 RPM controlled by an electro-pneumatic governor control which is operated by movement of the engineer's throttle.

The accompanying sketch serves to identify the cylinder locations, ends and sides of the engine, as they are referred to in this manual. The governor electro-pneumatic governor control, water pumps and lubricating oil pumps are mounted on the "Front End." The blowers, oil separator and generator are mounted on the "Rear End."



The engines are fully scavenging. Two blowers are mounted on the rear of each engine. over the generator. The blowers force air into the space around the cylinders with a pressure of approximately 3 to 5 pounds per square inch. This air is used to the cylinder of burned gases and supply a fresh charge of air to the cylinder for complete combustion on the next stroke. The air is admitted to the cylinder through a row of ports in the side of the cylinder liner. These ports are uncovered by the piston at the lower end of its downward stroke. Thus, the exhaust gases are expelled around the exhaust valves and a fresh charge of air is made available for the next working stroke.

ENGINE OVERSPEED TRIP

This is a flyweight on the engine camshaft which operates small cams under each injector rocker arm, preventing injection of fuel. The trip operates at approximately 880 RPM of the engine. The overspeed trip may be caused to operate by a sudden loss of load. 110% 115%

The overspeed trip resetting lever is located on the front end of the engine directly behind the engine governor. If trip operates, it can be reset by turning lever in a counterclockwise direction.

COOLING SYSTEM

Operation of Cooling System

Water is drawn from the oil cooler by the centrifugal water pumps located on the front end of the engine. These pumps circulate the water to the bottom of each cylinder liner, up through the cored passages of the cylinder liner and cylinder head and out through the outlet manifold. From the engine, the water flows to a jacket water cooler. Here the water is cooled, returning through the oil cooler.

The water temperature dial gauge provides a means of checking the temperature of the water, in the cooling system. 165 deg F. is the ideal temperature. While we recommend an operating temperature of 150 deg F. to 180 deg F., higher temperatures are not detrimental to the engine if the water is not permitted to boil away. However, for best operating economy, temperatures above 180 deg F. should not be used. The temperatures are controlled manually or automatically by the radiator shutters.

Filling the Cooling System

The cooling systems of the engines are filled through the filler pipes located above the water head tanks.

If the cooling system of a hot engine has been drained, do not refill immediately with cold water. If this is done, the sudden change in temperature might crack or warp the cylinder liners or heads.

Caution: As specially treated water must be used in the cooling system, water should not be added except at an approved watering station. Abnormal use of cooling system water, or absence of corrosion inhibitor, as indicated by lack of color, should be noted and reported at the first maintenance point.

Draining Cooling System

To drain the engine cooling system, first the valve located below the right-hand water pump.

To drain the complete cooling system in freezing weather, open valves as above and remove pipe plugs from the water pumps.

Checking Circulation

The water temperature dial gauge located on the water tank may be used as a means of detecting an irregularity in the operation of the cooling system.

The pressure gauge on the outlet side of the water pumps should be observed periodically as a check on the operation of the cooling, system. A high pressure indicates an obstruction in the cooling system; a low pressure indicates insufficient water supply to the pump, or faulty pump.

LUBRICATING OIL SYSTEM

Description

The oil is stored in the oil pan of the engine, instead of an oil supply tank, which classifies the engine as a wet sump type.

The engine lubricating oil system is a pressure system using two positive displacement gear-type pumps combined in a single unit. One pump delivers oil for the pressure lubricating system, the other for piston cooling. The oil supply to these pumps is drawn from the lube oil tank through a common suction pipe.

A scavenging oil pump is used to draw oil from the engine oil pan through a strainer, pump it through the lube oil cooler to the lube oil filters and oil tank strainer chamber.

Operation

When the engine is started, the pressure pumps pick up oil from the bottom of the strainer chamber. This oil provides an initial supply of oil for lubricating the engine until the scavenging pump has refilled the strainer chamber. Until the scavenging oil reaches the strainer chamber, the pressure may read low on the instrument panel gauges.

A by-pass valve set at 60# will permit oil to flow directly from the scavenging pump to the oil tank to ensure an oil supply for the engine. At 800 RPM and under normal conditions the by-pass

valve may be open. At idle a pressure in excess of 30# with hot oil is an indication of a dirty oil cooler. A constant oil level is maintained in the lube oil strainer chamber of the lube oil tank by a baffle plate or "dam." Oil flowing over this dam returns to the engine oil pan. This keeps the scavenging pump suction pipe under oil.

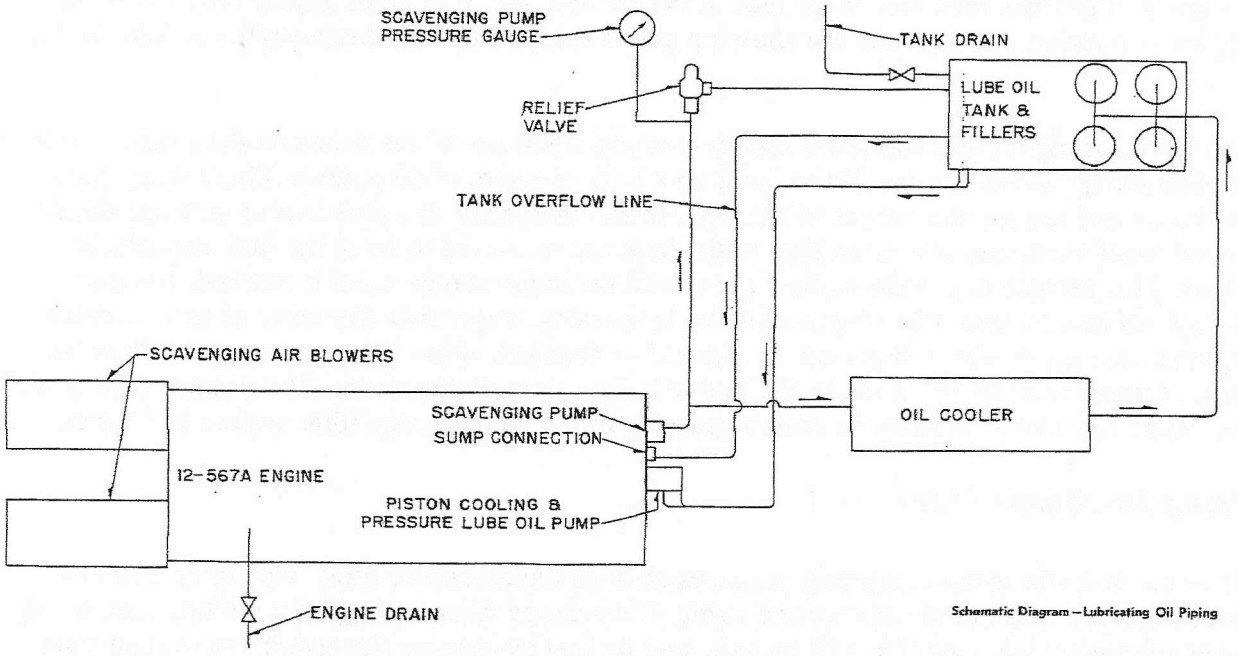
With the engine running, the oil level should always be between the "low" and "high" marks on the bayonet gauge in the engine oil pan. The oil level can be checked with the engine running at any speed.

Oil may be added by removing oil filler cover on the oil tank above the strainer chamber, and pouring required amount through strainer basket.

When the engine is stopped, oil in the cooler core chamber will flow into the oil tank, which will bring the engine oil pan bayonet gauge reading to "system charged." This level is below the "system uncharged" level because some oil is trapped in the lube oil filter, oil lines, and engine.

Oil Separator

The oil separator is mounted between the engine blowers over the main generator. Vapor from the crankcase is drawn through the oil separator to the blower intake. The metal screen in the separator condenses oil from the vapor and returns the oil to the oil pan.



Schematic Diagram – Lubricating Oil Piping

FUEL OIL SYSTEM

Description

Fuel is pumped through the pump discharge filter and sintered bronze filter to the injectors.

The injectors use only a part of the fuel pumped through them. The surplus fuel oil lubricates and cools the internal mechanism of the injectors and then returns to the fuel tank through the 5-pound relief valve and sight glass.

Fuel Sight Glass and Relief Valves

The fuel sight glass and relief valve assembly is located above the fuel pump. Its purpose is to indicate the condition of the various filters in the fuel system and the flow of fuel oil through the engine. The left-hand relief valve is set at 80 pounds, the center valve at 100 pounds, and the right-hand valve at 5 pounds. These valves are adjusted at the factory and the adjustment SHOULD NOT BE CHANGED.

The return fuel from the engine passes through the right-hand sight glass and relief valve (5-pound). A drop in the fuel level in this glass, or an empty glass, will indicate that the engine is not receiving its full supply of fuel. Air or gas in the fuel system will appear in this glass in the form of bubbles. Air entering the fuel line at any point on the suction side of the fuel pump will cause the engine to misfire or stop. When the engine is shut down and fuel pump running, the presence of bubbles indicates an air leak in the auction line. If bubbles appear only when the engine is running, the injectors are allowing gas to escape from the engine cylinder into the fuel line.

The left-hand sight glass will show fuel by-passing when any of the filters on the pressure side of the fuel pump collect enough dirt to build up a back pressure of 60 pounds. This fuel by-passes the filters and engine and returns to the tank. In an emergency, the globe valve between the 60-pound relief valve and the return pipe to the tank can be closed to force the fuel through the filters. This permits operation of the engine until the maintenance point is reached. Engines should not be operated with 60-pound valve by-passing longer than the required time to reach a maintenance point where filters can be cleaned or changed. If the filters are neglected and the back pressure reaches 100 pounds, the fuel will flow through the center (100-pound) sight glass and relief valve and return to the tank, bypassing th. entire discharge filter system and the engine.

Pump Discharge Filter

After the fuel leaves the fuel pump, it passes through the discharge filter. This filter contains three elements made of closely wound string. If discharge filter is clogged with dirt. wax, or any other substance, the condition will be indicated by fuel by-passing through the 60-pound sight glass and relief valve.

Duplex Sintered Bronze Filter

The duplex sintered bronze filters are mounted on the front end of the engine. The two sintered bronze elements are connected by a three-way valve so that the flow of fuel through the filter can be controlled by the position of the valve handle. When the handle is moved to the left, the left-hand element is cut off and fuel flows through the right-hand element. Moving handle to right cuts off right-hand element. The handle should be either to the left or right, so that only one filter element is in use at a time.

If the element in use becomes dirty, fuel will flow through the 60-pound sight glass. Should this occur, turn handle to opposite side. If this does not correct the. condition, it will indicate that either both elements are dirty or the discharge filter is dirty.

Fuel Pump

The fuel pump assembly consists of an electric motor and a pump of the rotor gear type. The pump is driven by the motor shaft through a flexible coupling. Do not leave the fuel pump running unnecessarily.

Injector Filters

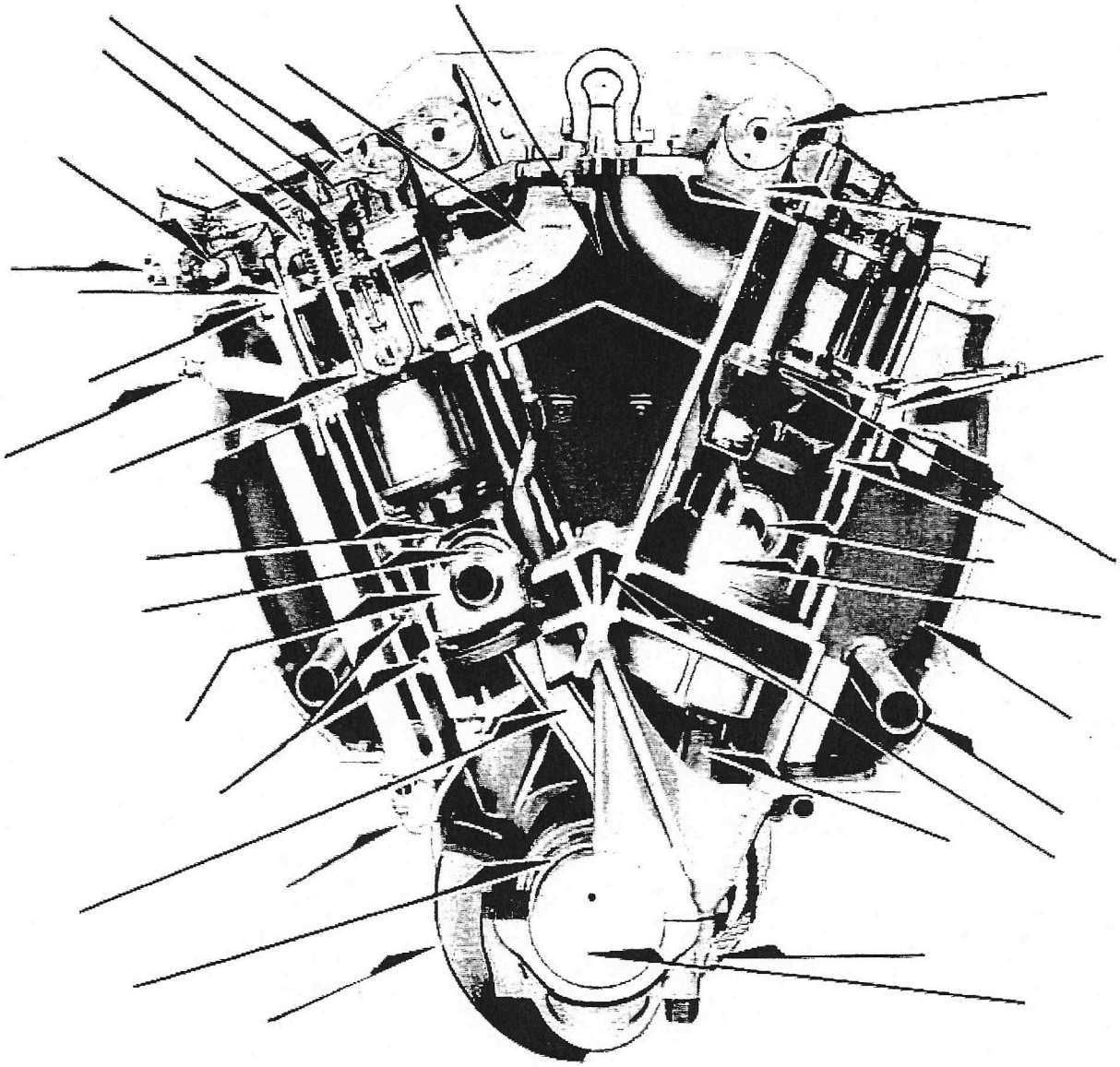
From the duplex sintered bronze filter, the fuel oil flows to the fuel manifold on the engine. As the fuel enters the injector, it is filtered for the fourth time by the sintered bronze filter mounted in the injector body. The purpose of all this filtering is to protect the finely machined parts of the injector.

As the surplus fuel leaves the injector, it passes through another filter of the same type to prevent a reverse flow of fuel from carrying dirt into the injector when the engine is shut down. These filters should be discarded when dirty, and new ones installed.

Lab Exercise:

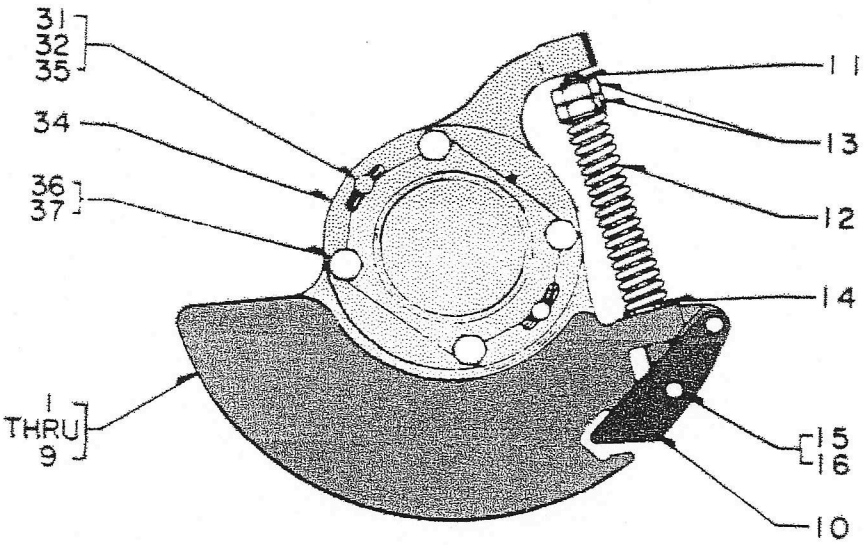
1. Find all of the components listed on the bottom of the following page. Label those items that have a line leading to the picture above the item list.
2. Trace the following systems:
    - Lube oil
    - Fuel Oil
    - Jacket water system
    - Scavenging Air
    - Exhaust
3. Discuss the Overspeed trip mechanism and reset.
4. Look at and determine the function of the gears on the drive end of the engine
5. Look at and determine the function of the gears on the free end of the engine
6. Find the Harmonic balancer and discuss its purpose.
7. Label the drawing of the engine front (free end) using the list below:

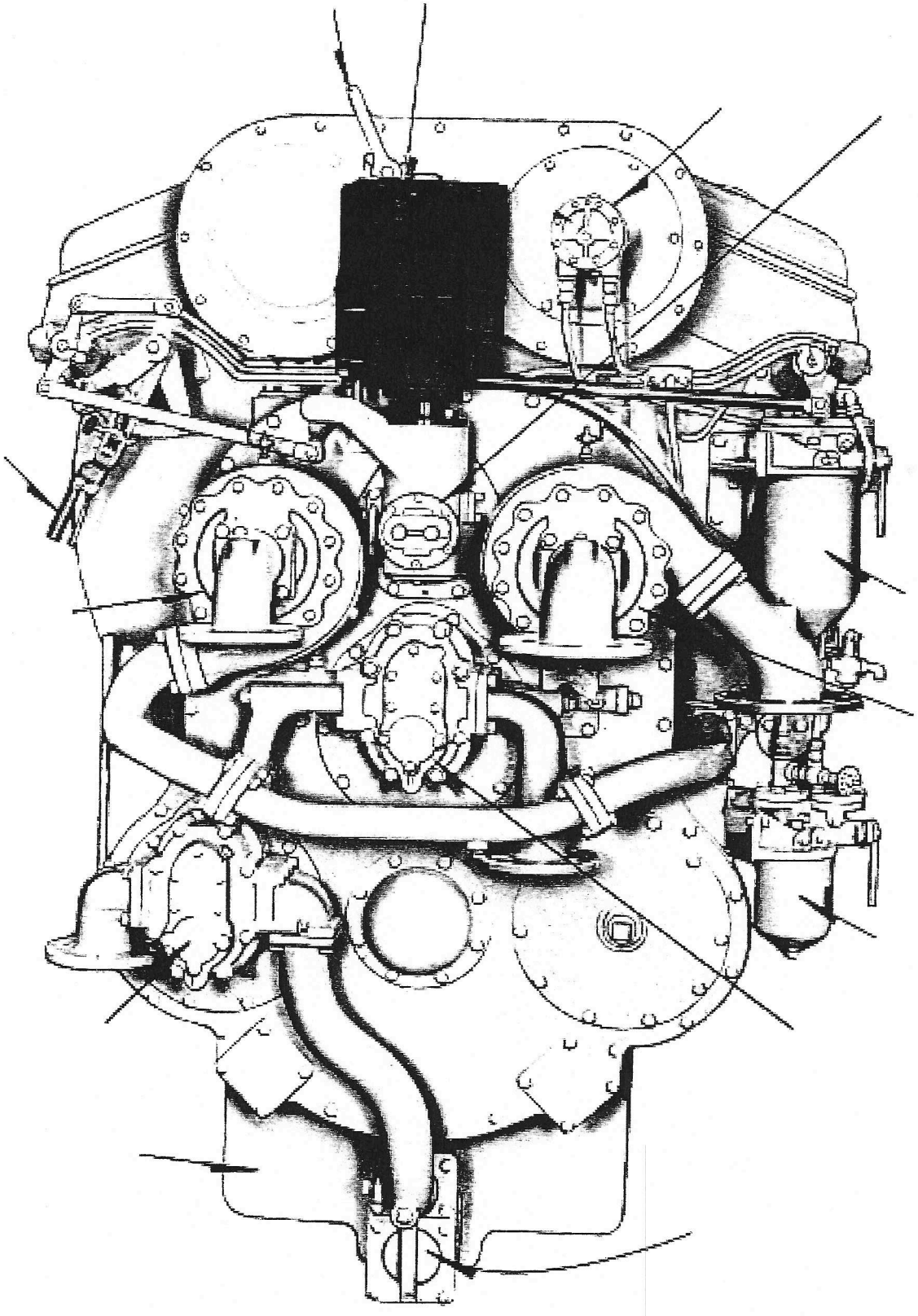
Fresh water pump
Fuel Filter
Fuel oil pump
Fuel Strainer
Governor
Lubricating and piston cooling pump
Lubricating Oil Pan
Oil Pan Strainer
Overspeed trip reset lever
Scavenging oil Pump
Sea Water pump
Tachometer drive
Throttle handle



ELECTRO-MOTIVE SERIES 567A & 567B ENGINES

Air Box
Camshaft
Connecting Rod - Basket
Connecting Rod - Basket
Connecting Rod - Blade
Crank Shaft
Crank Shaft Counterweight
Cylinder Head
Cylinder Head Crab Bolt
Cylinder Liner
Cylinder Test Valve
Exhaust Valve Bridge
Exhaust Valve Springs
Exhaust Valves
Fork Connecting Rod
Fuel Injector
Fuel Manifold
Head Gasket - Copper Asbestos
Head Stud and Nut
Injector Control Shaft
Liner Seal Ring - Synthetic Rubber
Liner Stud
Main Bearing Cap
Main L.O. Manifold
Oil Drain and vent
Oil Level Gauge (Dipstick)
Overspeed Trip Shaft
Piston
Piston Cooling Oil ("P") Pipe
Piston Cooling Oil Manifild
Piston Pin
Piston Pin Bearing
Rocker Arm
Water Discharge Manifold
Water Inlet Manifold


31
32
35
34
36
37
1
THRU
9
11
13
12
14
15
16
10



FRONT END
MODERN 12-567 A ENGINE
PLATE 3218

CATERPILLAR®

NEW TECHNOLOGY DIESEL LAB

C9 Marine Engine

C9A1-UP
C9Y1-UP

Engine Description

The Caterpillar Marine Engine has the following characteristics:

- Four stroke cycle
- Direct fuel injection
- Hydraulically actuated electronic unit injection
- Turbocharging
- Aftercooling system which uses raw water or sea water

Engine Specifications

Note: The front end of the engine is opposite the flywheel end of the engine. The left side and the right side of the engine are determined from the flywheel end. The number 1 cylinder is the front cylinder.

Table 1

C9 Marine Engine Specifications	
Arrangement and Cylinders	In-Line 6 cylinder
Bore	112 mm (4.4 inch)
Stroke	149 mm (5.9 inch)
Aspiration	Turbocharged Aftercooled
Displacement	8.8 L (540 in^3)
Firing Order	1-5-3-6-2-4
Rotation (flywheel end)	Counterclockwise
Compression Ratio	16.1:1

Electronic Engine Features

The Caterpillar Marine Engines are designed for electronic controls. The integral on board computer controls the operation of the engine. Current operating conditions are monitored. The Electronic Control Module (ECM) controls the response of the engine to these conditions and to the demands of the operator. These conditions and operator demands determine the precise control of fuel injection by the ECM. The electronic engine control system provides the following features:

- Engine Monitoring
- Engine speed governing
- Automatic air/fuel ratio control
- Torque rise shaping
- Injection timing control
- System diagnostics

OBJECTIVE:

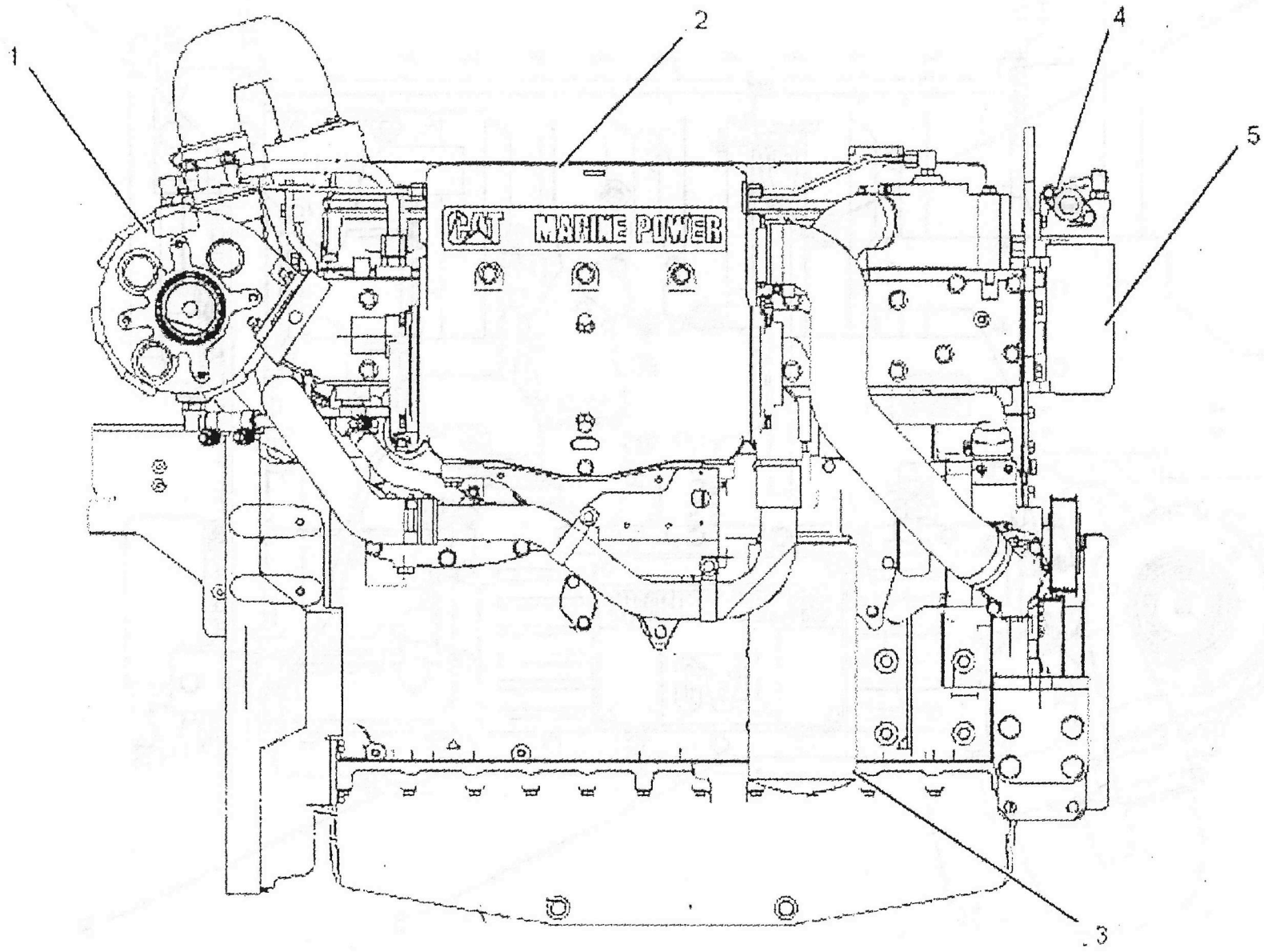
1. At the conclusion of this lab the student should be able to:
    - Identify the major accessory components
    - Trace out the systems on the CAT C-9 engine
    - Identify the sensors used for the Electronic Control Module (ECM)
    - Explain the engine wiring and control
    - Describe the operation of the Hydraulic Electronic Unit Injector (HEUI) system
    - Explain what is available to technicians for monitoring and troubleshooting the operation of the C-9
    - Create a Data Log graph
    - Change operating parameters of the engine.
    - Perform an injector trim calibration

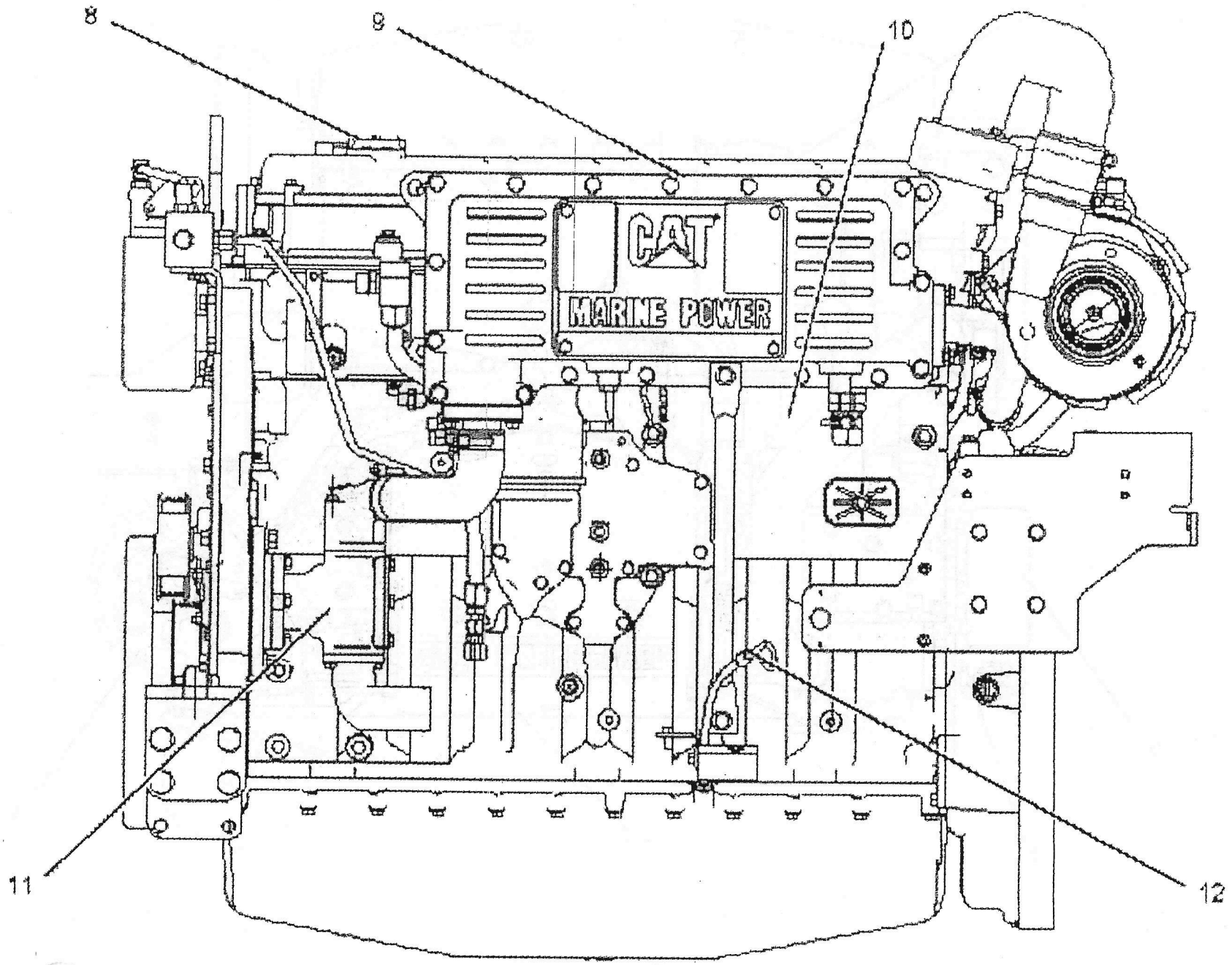
PROCEDURE:

1. Identify and label items 1-5 on proceeding page and items 8-12 on the page following.
2. Trace the following systems:
    - Fuel supply (to where it enters engine)
    - Fuel return
    - HEUI Oil system
    - Raw water system
    - Air from filter to intake
    - Exhaust from engine
3. Locate all sensors pictured in the handout pages
4. Remove valve cover and identify:
    - Exhaust valves (and bridge)
    - Intake valves
    - HEUI injector

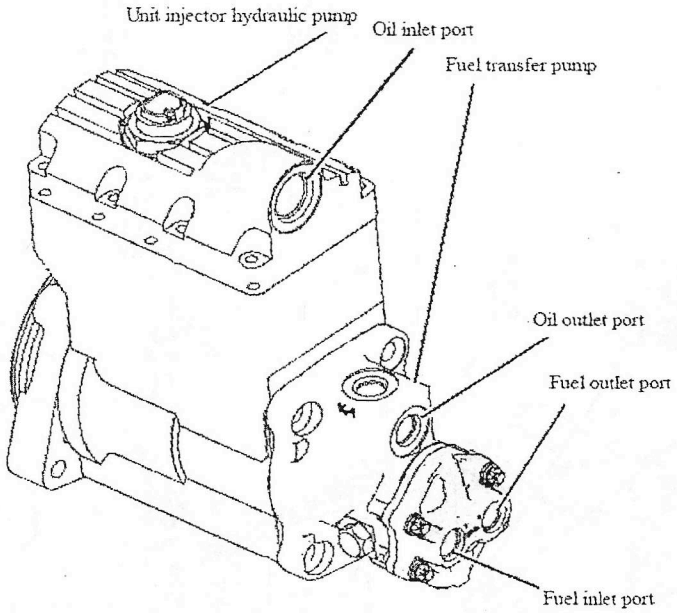
The instructor will review the following:

5. The electrical and control diagram
6. Caterpillar ET software
    - View Engine Description
    - Check for Active Codes
    - Check for Logged Active Codes
    - Perform the following Diagnostic Tests
        - Injector Solenoid Test (Engine off)
        - Wiggle Test (Engine off)
        - Create a static fault and show the engine monitoring panel alarm and also ET results
        - Cylinder Cutout Test (Engine running)
    - Review Information available
        - Status, ECM Summary, Current Totals
        - Data Log
        - Create real time graphing
        - Prognostic Download
        - Histogram
        - Product Status Report
    - Display Engine Configuration
        - Make a change to engine speed
    - Discuss Timing Calibrations and Injector Trim


1
2
3
4
5
CAT
MARINE POWER


8
9
10
11
12
CAT
MARINE POWER

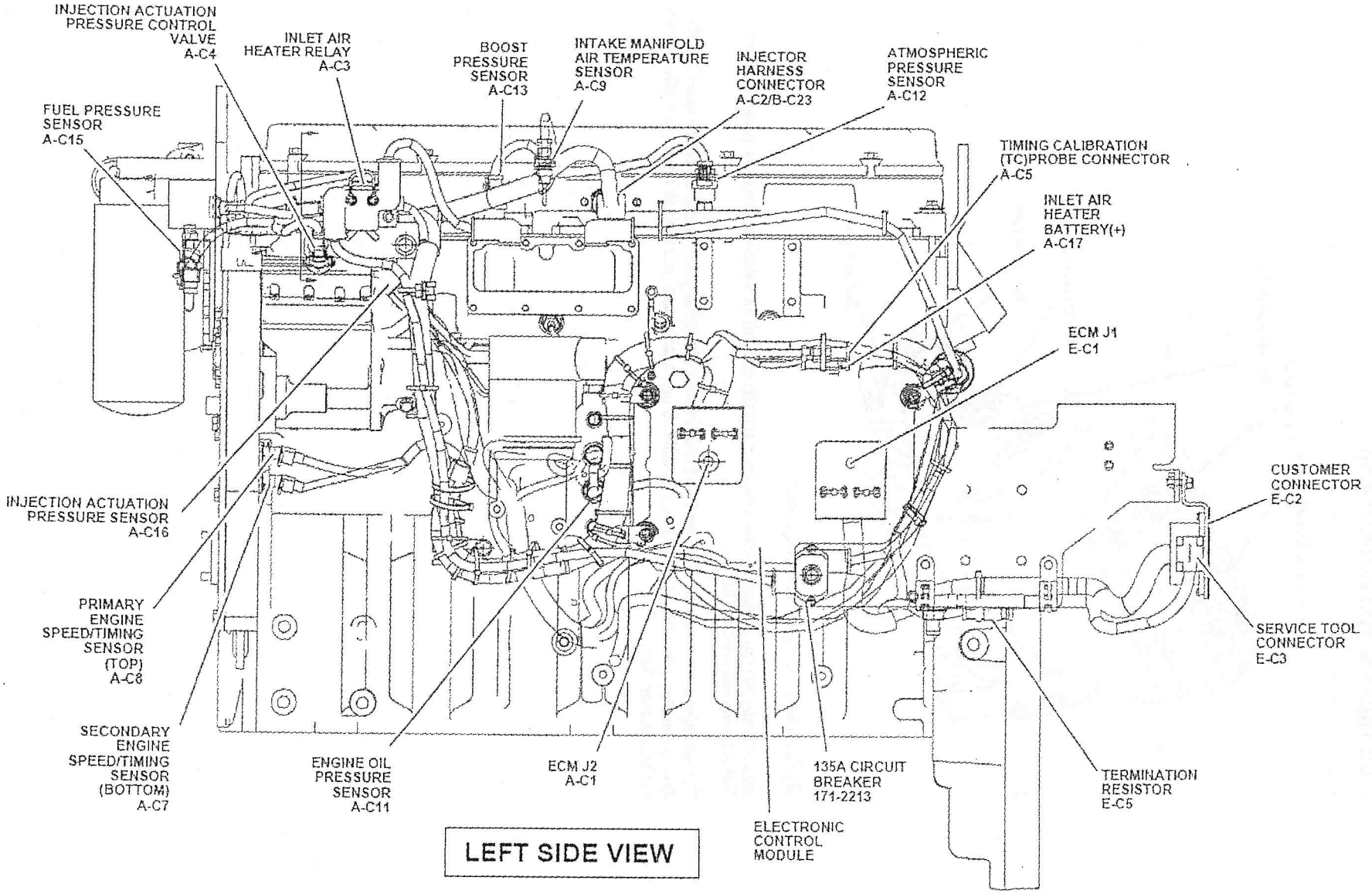
Unit Injector Hydraulic Pump

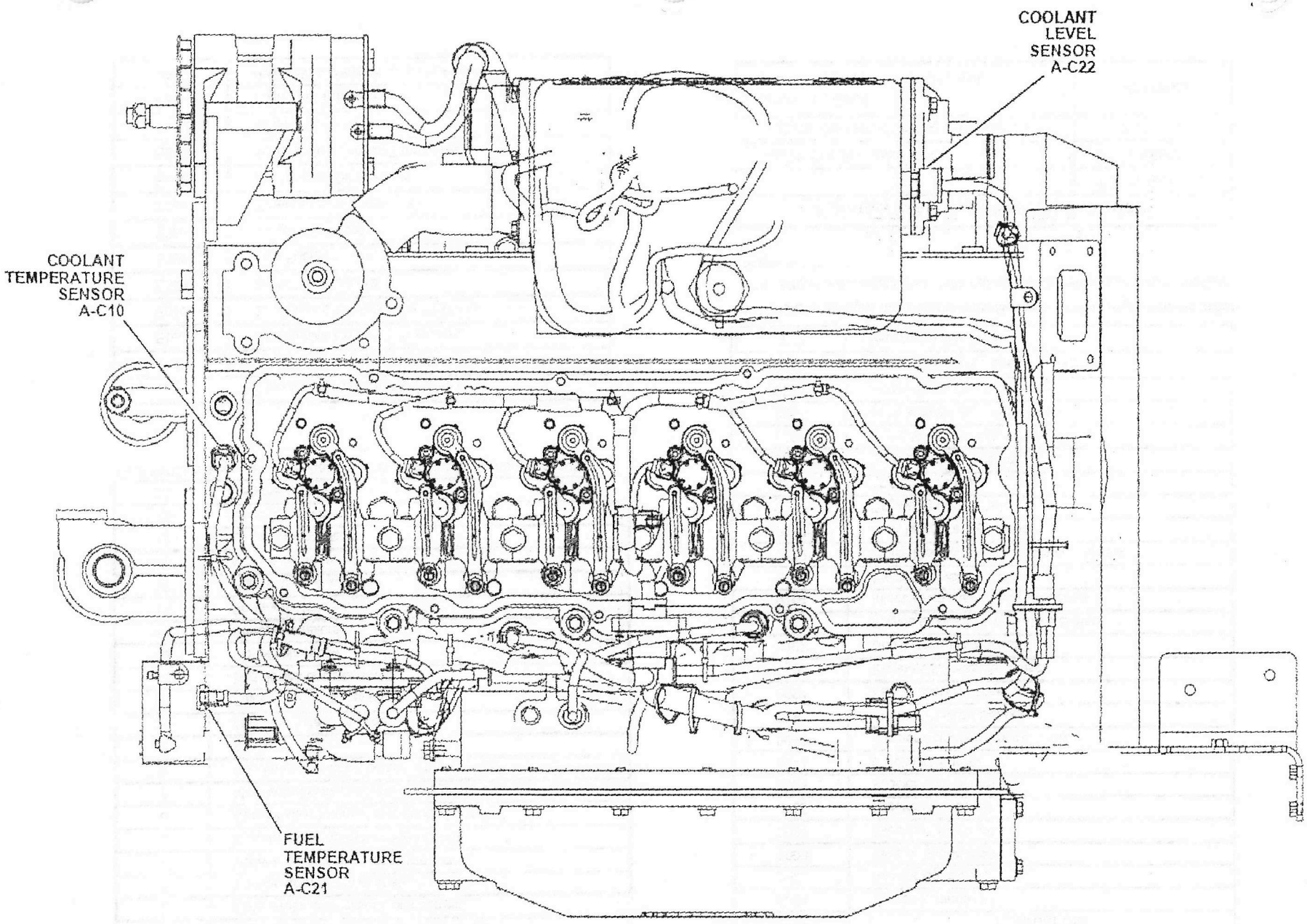


Hydraulic Electronic Unit Injectors

Hydraulically Actuated Electronic Unit Injectors (HEUI) perform the following functions: pumping of fuel, fuel metering and injection timing.

The unit injectors are controlled by the ECM which uses the camshaft position and the engine speed signals from the engine speed/timing sensors and the inlet air pressure sensors. The engine's rated rpm is identified on the Information Plate.


INJECTION ACTUATION PRESSURE CONTROL VALVE A-C4
INLET AIR HEATER RELAY A-C3
BOOST PRESSURE SENSOR A-C13
INTAKE MANIFOLD AIR TEMPERATURE SENSOR A-C9
INJECTOR HARNESS CONNECTOR A-C2/B-C23
ATMOSPHERIC PRESSURE SENSOR A-C12
FUEL PRESSURE SENSOR A-C15
TIMING CALIBRATION (TC)PROBE CONNECTOR A-C5
INLET AIR HEATER BATTERY(+) A-C17
ECM J1 E-C1
CUSTOMER CONNECTOR E-C2
INJECTION ACTUATION PRESSURE SENSOR A-C16
PRIMARY ENGINE SPEED/TIMING SENSOR (TOP) A-C8
SERVICE TOOL CONNECTOR E-C3
SECONDARY ENGINE SPEED/TIMING SENSOR (BOTTOM) A-C7
ENGINE OIL PRESSURE SENSOR A-C11
ECM J2 A-C1
135A CIRCUIT BREAKER 171-2213
TERMINATION RESISTOR E-C5
ELECTRONIC CONTROL MODULE
LEFT SIDE VIEW


COOLANT
LEVEL
SENSOR
A-C22
COOLANT
TEMPERATURE
SENSOR
A-C10
FUEL
TEMPERATURE
SENSOR
A-C21

TOP VIEW

Failure Mode Identifiers (FMI)[1]	
FMI No.	Failure Description
0	Data valid but above normal operational range.
1	Data valid but below normal operational range.
2	Data erratic, intermittent, or incorrect.
3	Voltage above normal or shorted high.
4	Voltage below normal or shorted low.
5	Current below normal or open circuit.
6	Current above normal or grounded circuit.
7	Mechanical system not responding properly.
8	Abnormal frequency, pulse width, or period.
9	Abnormal update.
10	Abnormal rate of change.
11	Failure mode not identifiable.
12	Bad device or component.
13	Out of calibration.
14	Parameter failures.
15	Parameter failures.
16	Parameter not available.
17	Module not responding.
18	Sensor supply action.
19	Condition not met.
20	Parameter failures.

[1]The FMI is a diagnostic code that indicates what type of failure has occurred.

Event Identifiers (EID)	
EID	Event
E057	Low Engine Coolant Level Derate.
E059	Low Engine Coolant Level Warning.
E096	High Fuel Pressure.
E198	Low Fuel Pressure.
E255	Diagnostic Reset.
E264	Emergency Stop Activated.
E360	Low Engine Oil Pressure.
E361	High Engine Coolant Temperature.
E362	Engine Overspeed.
E363	High Fuel Temperature.
E539	High Intake Manifold Air Temperature

Component Identifiers (CID[1]) Module Identifier (MID[2]) (MID No. 036)	
CID	Component
0001	Injector Cylinder #1
0002	Injector Cylinder #2
0003	Injector Cylinder #3
0004	Injector Cylinder #4
0005	Injector Cylinder #5
0006	Injector Cylinder #6
0041	8 Volt DC Supply
0042	Injector Actuation Control Valve
0091	Throttle Position Sensor
0094	Fuel Pressure Sensor
0100	Engine Oil Pressure Sensor
0102	Boost Pressure Sensor
0110	Engine Coolant Temperature Sensor
0164	Injector Actuation Pressure Sensor
0168	Electrical System Voltage
0172	Intake Manifold Air Temperature Sensor
0174	Fuel Temperature Sensor
0190	Engine Speed Sensor
0253	Personality Module
0261	Engine Timing Calibration
0262	5 Volt Sensor Supply
0268	Programmed Parameter Action
0274	Atmospheric Pressure Sensor
0342	Secondary Engine Speed Sensor
0617	Inlet Air Heater Relay

[1] The CID is a diagnostic code that indicates which circuit registered the action.

[2] The MID is a diagnostic code that indicates which electronic control module diagnosed the action.

Related Electrical Service Manuals	
Title	Form Number
Troubleshooting Guide	RENR5032
Systems Operation / Testing and Adjusting	SENR9663
Installation Guide (Marine Engine Electronic Displays)	SENR5002

Internal Combustion Engines II

EN – 4131L

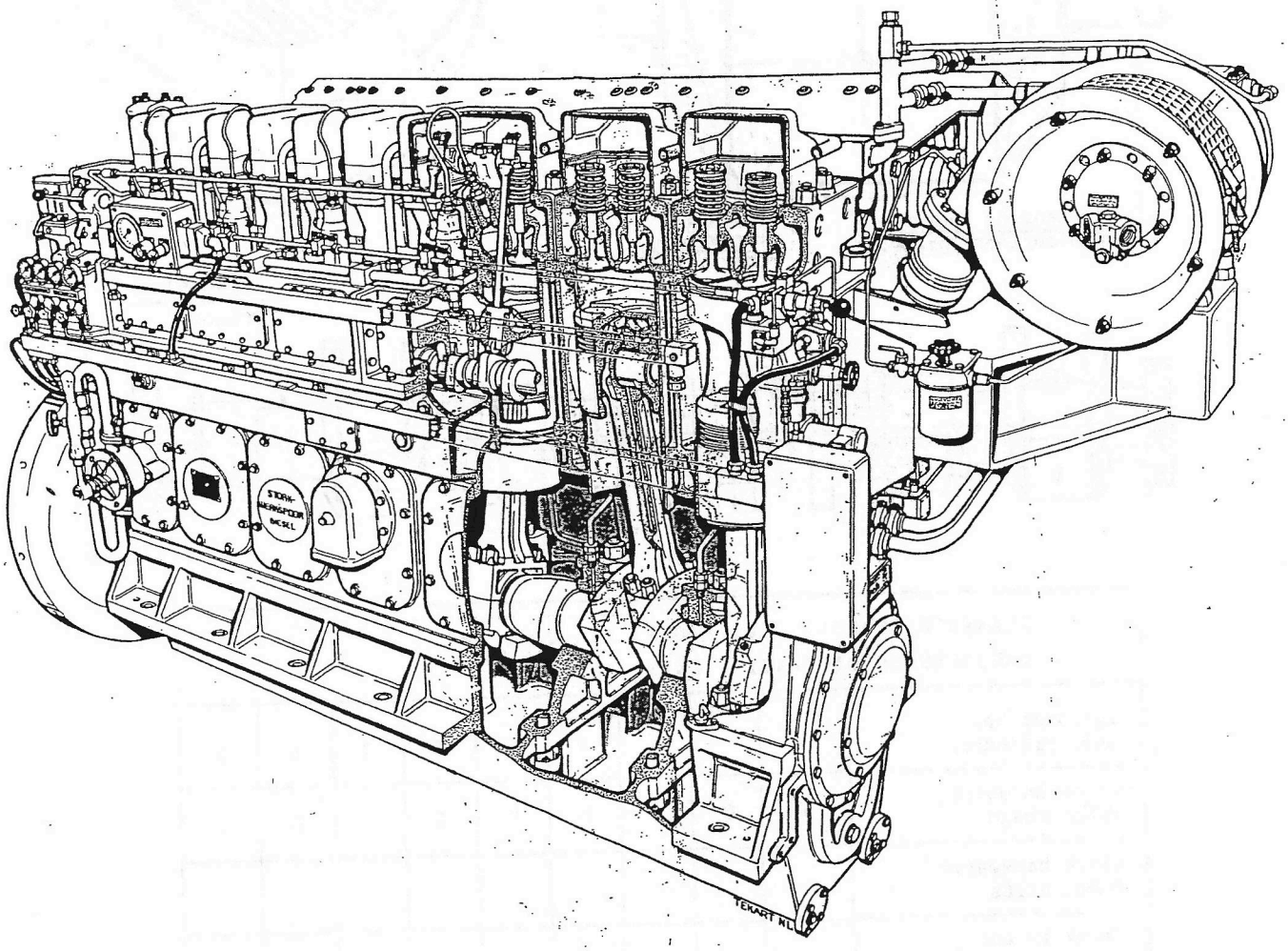
Lab #4

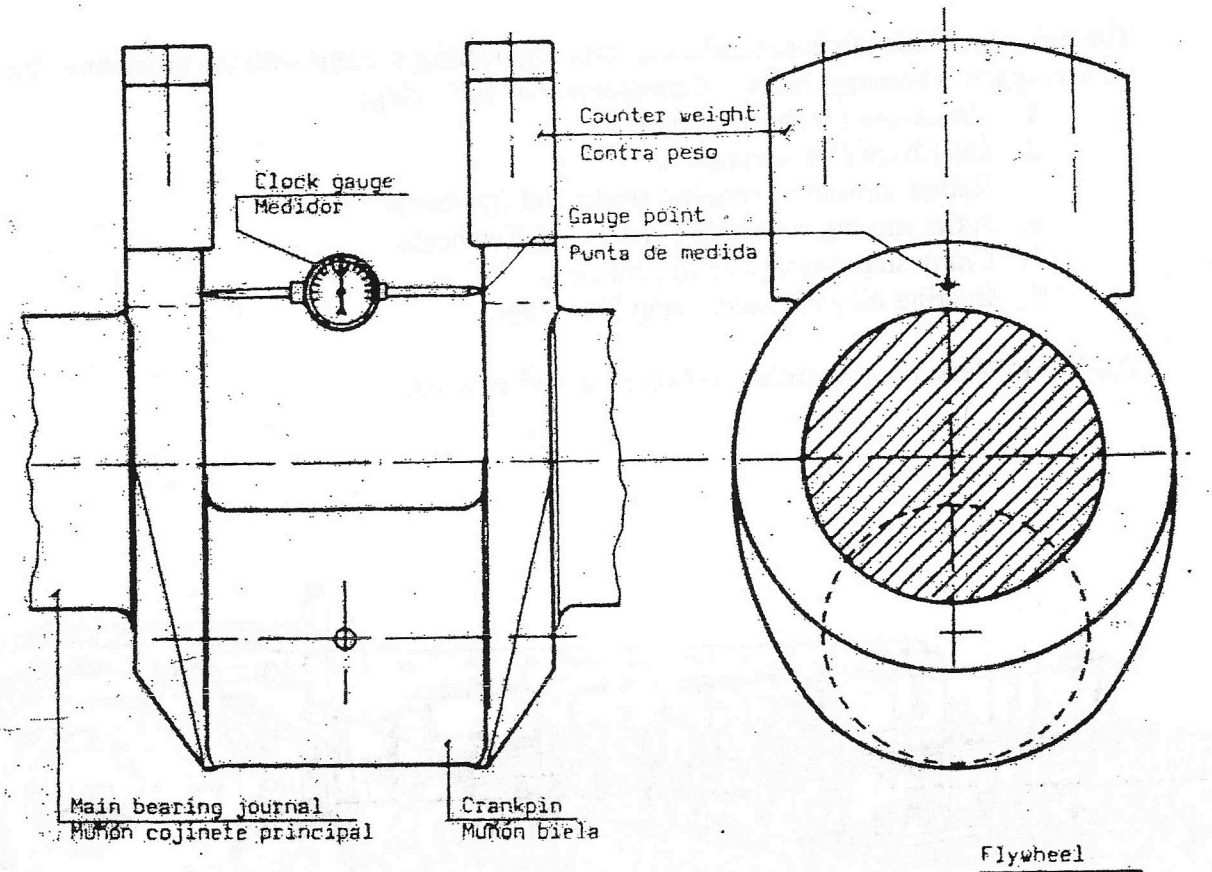
MASSACHUSETTS MARITIME ACADEMY
INTERNAL COMBUSTION ENGINES II

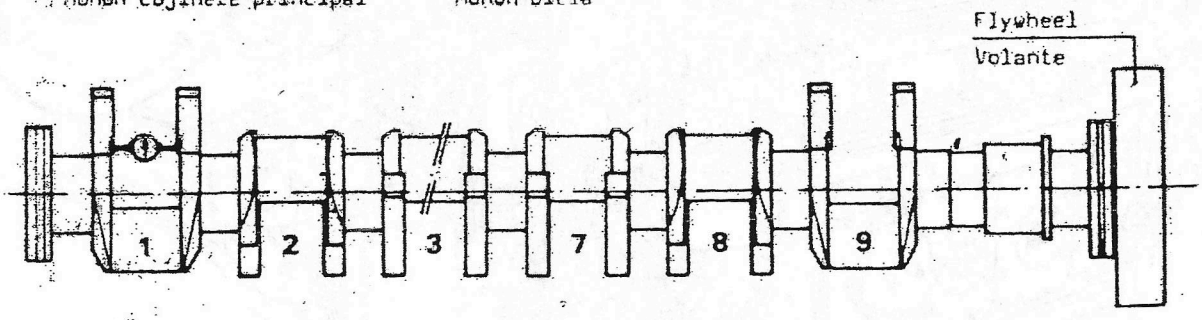
The purpose of this lab is to familiarize the engineering student with the procedures for removing main bearing shells and measuring the following;

1. Crank shaft web deflection.
2. Gear back lash clearance.
3. Radial run-out of rotating shafts and flywheels.
4. Axial run-out of rotating shafts and flywheels.
5. Crank shaft thrust bearing clearance.
6. Bearing oil clearance, using Plastigage.

The Stork-Werkspoor 4 stroke cycle engine will be used.







CRANKWEB SPACING DEVIATIONS (in 0,01 mm).
VARIACIONES DISTANCIAL ENTRE MUÑONES

Cylinder No. / Num. cilindros	1	2	3	4	5	6	7	8	9
Crank in bottom / Muñon abajo	0	0	0	0	0	0	0	0	0
Crank backwards / Muñon atrás									
Crank in top / Muñon arriba									
Crank control side / Muñon lado servicio									

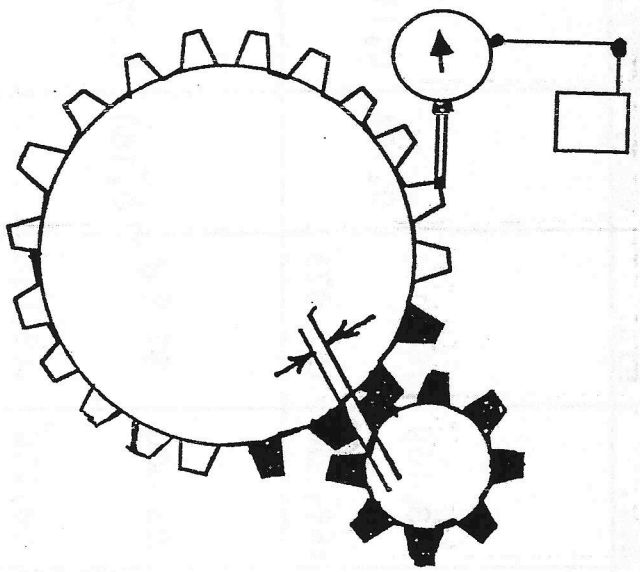
Part	Limit size		Nominal clearance		No go dimension	Max. clearance admissible
	Max.	Min.	Max.	Min.		
Main bearing (1102 R 148-149) and main thrust bearing (1102 R 147-150) bore	168,169	168,114	0,194	0,114	F	0,300
Crankshaft diameter	168,000	167,975				
Main thrust bearing (1102 R 147-150) axial length	88,000	87,946	0,180	0,072		0,400
Crankshaft axial between the webs	88,126	88,072				
Connecting rod bearing (1401 R 191) bore	157,159	157,104	0,184	0,104	F	0,250
Crankpin diameter	157,000	156,975				

SECOND HALF

1. Set up the provided dial indicator and measure **RADIAL runout**.of the flywheel on the Lister diesel engine.
2. Set up the provided dial indicator and measure **AXIAL runout**.of the flywheel on the Lister diesel engine.
3. Set up the provided dial indicator and measure **THRUST BEARING CLEARANCE** on the Lister diesel engine.
   What circumstances would reqiure the measuring of radial or axial runout on the flywheel?

   What affect will excessive runout have on the engine?

   When installing a flywheel you discover that the flywheel has excessive runout, what should you do?



4. Set up the dial indicator and measure **GEAR BACKLASH** on the camshaft drive gear.
   A. Remove crankcase cover to expose gear.
   Why is gear backlash measured during installation of the gears?
   What will cause gear back lash to increase?

5. **Remove center main bearing cap**; roll out upper main bearing shell with tool provided.
6. **Replace upper bearing shell.**

7. Conduct **plastigage measurement** of center main bearing on Westerbeke on project table and determine bearing oil clearance.
   A. Remove center main bearing cap Wipe off oil from journal and shell.
   B. Place strip of plastigage on shell.
   C. Retorque shell to 60 ft-lbs.
   D. Remove shell compare flattened plastigage to package. Determine clearance as per manual.
   E. Clean off plastigage with oily rag and replace shell, retorque and rotate shaft by hand.

INSTRUCTIONS
for using Plastigage®

1. Remove the bearing cap and wipe the oil from the bearing insert and crankshaft journal.
   NOTE: When checking main bearing clearances with the engine in a position where the main bearing caps are supportin of the crankshaft and flywheel, an erroneous reading due to the weight of the crankshaft and flywheel can be eliminatec ing the weight of the crankshaft by means of a jack under the counterweight adjoining the bearing being checked.
2. Place a piece of Plastigage the full length of the bearing insert about ¼" off center. (Figure 1.)
3. Rotate the crank about 30° from the bottom dead center and reinstall the bearing cap. Tighten the bolts with a torqu wrench as recommended by the manufacturer.
4. Remove the bearing cap. The flattened Plastigage will be found adhering to either the bearing shell or the cranksh
5. Compare the width of the flattened Plastigage at its WIDEST point with the graduations on the envelope. (Figure 2.) within the graduation on the envelope indicates the bearing clearance in thousandths of an inch or in millimeters de which side of the envelope is used. TAPER is indicated when one end of the flattened Plastigage is wider than the oth each end of the flattened Plastigage. The difference between the readings is the approximate amount of taper.
6. New bearings should be installed if bearing clearance is not within specifications. Excessive taper indicates that a new crankshaft is required.

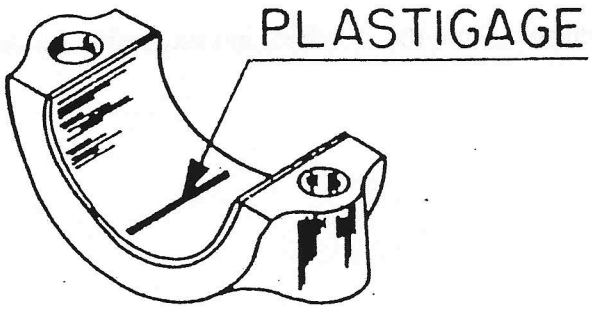


FIGURE 1

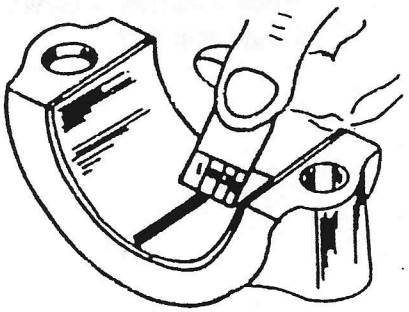


FIGURE 2

Questions for lab session 2

What will cause crankshaft endplay to increase over time?

Will the engine crankshaft thrust bearing be able to handle propeller thrust loads?

When would radial and axial run-out of the flywheel be checked on a diesel engine?

What are two causes of excessive axial runout on a flywheel?

What causes gear backlash to increase as diesel engine is operated?

If an engine was started and run what possible problems could occur if the flywheel had excessive radial runout?

Why is gear backlash measured when installing new gears?

What could possibly occur if gear backlash was insufficient when gears are installed, and the engine is started?

What could happen if oil clearance is too small when a bearing is installed, and the engine is started?

List and briefly explain the steps for taking a plastigage oil clearance on a main bearing?

Why is it necessary to pack some oil pumps with grease prior to staring the engine after the pump has been overhauled?

List the flow path of lube oil from the suction screen through the engine. Include all filters, coolers and engine components lubricated in their correct order?

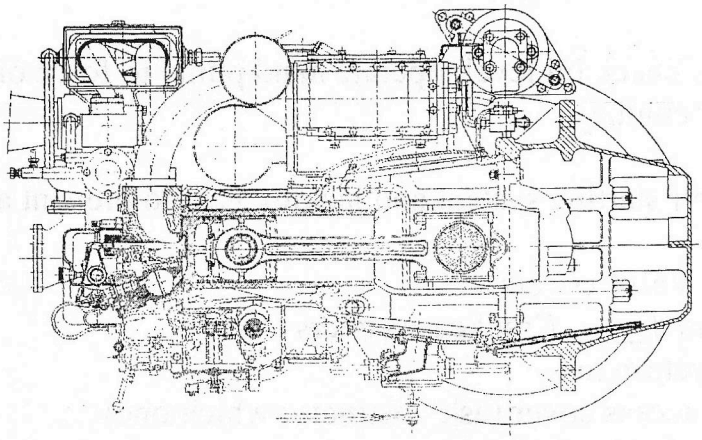
Should bearings be installed dry (no oil) on their backings?

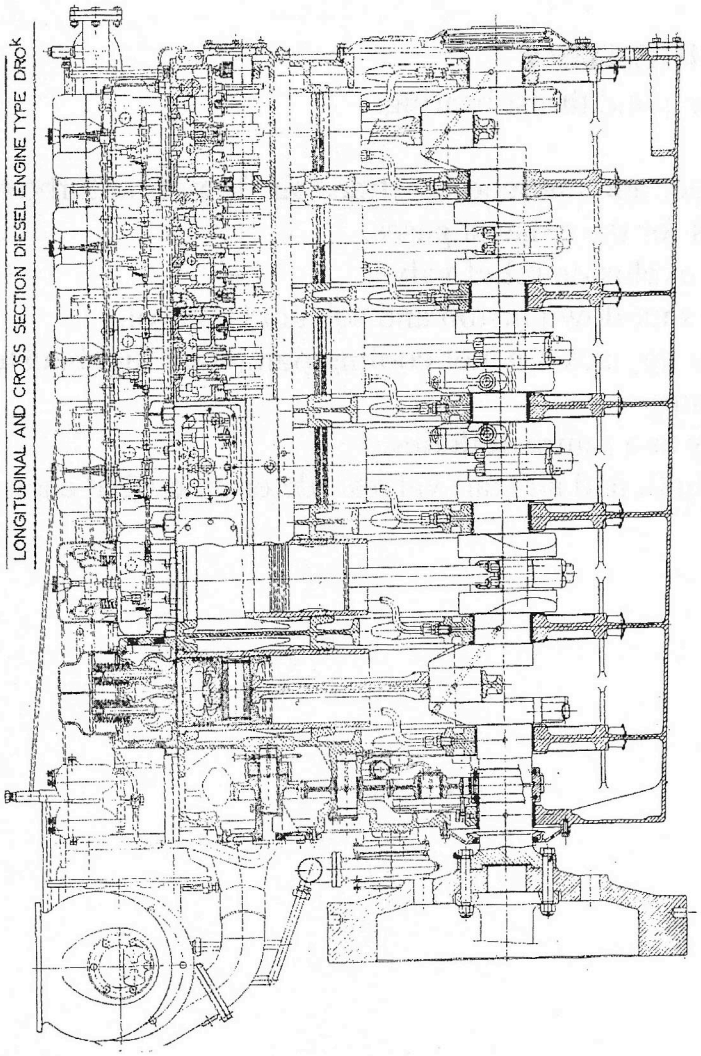
What circumstances would require the measuring of radial or axial runout on the flywheel?

What affect will excessive runout have on the engine?

When installing a flywheel you discover that the flywheel has excessive runout, what should you do?

MASSACHUSETTS MARITIME ACADEMY
INTERNAL COMBUSTION ENGINES II, EN4131
STORK WERKSPOOR MAIN PROPULSION DIESEL
Air Start, Fuel Oil, Valve Lash





The purpose of this lab is to familiarize the student with a typical medium speed, four stroke-cycle engines found aboard tugboats and larger vessels as both main propulsion and generators. The lab will include fuel injection pumps and timing of these pumps, and direct cylinder air starting systems

Prior to beginning, check oil level, operate hand pump to force oil to the bearings, then manually bar over engine.

1. Secure the air starting system and jacking gear to prevent accidental rotation.
2. Remove;
    a. #___ Valve covers
    b. #5 and #_____ Crankcase covers
    c. F.O. return rail
    d. Cam access cover (ask instructor which one)

(For tool sizes see back of handout)

LOCATE AND IDENTIFY

1. Main bearing and thrust bearing.
2. Tie rods.
3. Turbocharger and intercoolers (trace air flow from turbo to cylinders)
4. Pyrometers for the exhaust gases.
5. Crankcase explosion relief valve.
6. Pneumatic shut down piston and solenoid control.
7. Lube oil pump, jacket water cooling pump and fuel booster pump. (Classify each type of pump)
8. Fuel supply and return galleries.
9. Cam and shaft, and air start valves. (determine what each cam lobe drives)

Air Start Valve Timing

1. Check out the operation of the air start valve (*figure 1* (A))
    a. Trace out the Start air line
    b. Trace out the decompression line
2. Loosen the start air line from the head (NOT the block) on the cylinder being worked on. While observing the sliding valve (*figure 1* (B)) apply start air pressure.
    a. What did you notice happen?
3. Rotate the crankshaft 180 ° (BDC for that cylinder)
    a. Apply air start pressure again.
    b. What did you notice this time? Why?
4. Loosen (one full turn) the banjo fitting from the decompression valve for the cylinder being worked on.
    a. Move the start air valve to the decompression mode.
    b. What happened?
5. Disassemble the start air valve assembly on spare head (*figure 1* (C & D))
6. Reassemble the start air valve and mount into cylinder head
7. How can you tell if the start air valve is leaking (between the valve and seat)?

F.O. Injection Pump Timing

1. Disassemble/reassemble F.O. injection pump (*see figure 2*).
2. Rotate crankshaft to 8.5 ° before TDC for the cylinder being worked on (verify using timing marks on the flywheel).
3. Set injection pump timing by adjusting the injection pump cam follower till the timing mark on the plunger gland aligns with the mark on the pump body viewing port (*see figure 3*)

Valve Timing

1. Rotate piston to TDC on power stroke.
    a. Prior to setting valve lash, how do you determine that you are in fact at TDC <u>on the compression stroke</u> (versus the exhaust stroke)?
    b. How do you determine which valve is the intake valve and which is the exhaust valve?
2. Set valve lash to the proper specification (see *Technical Data Sheet*)

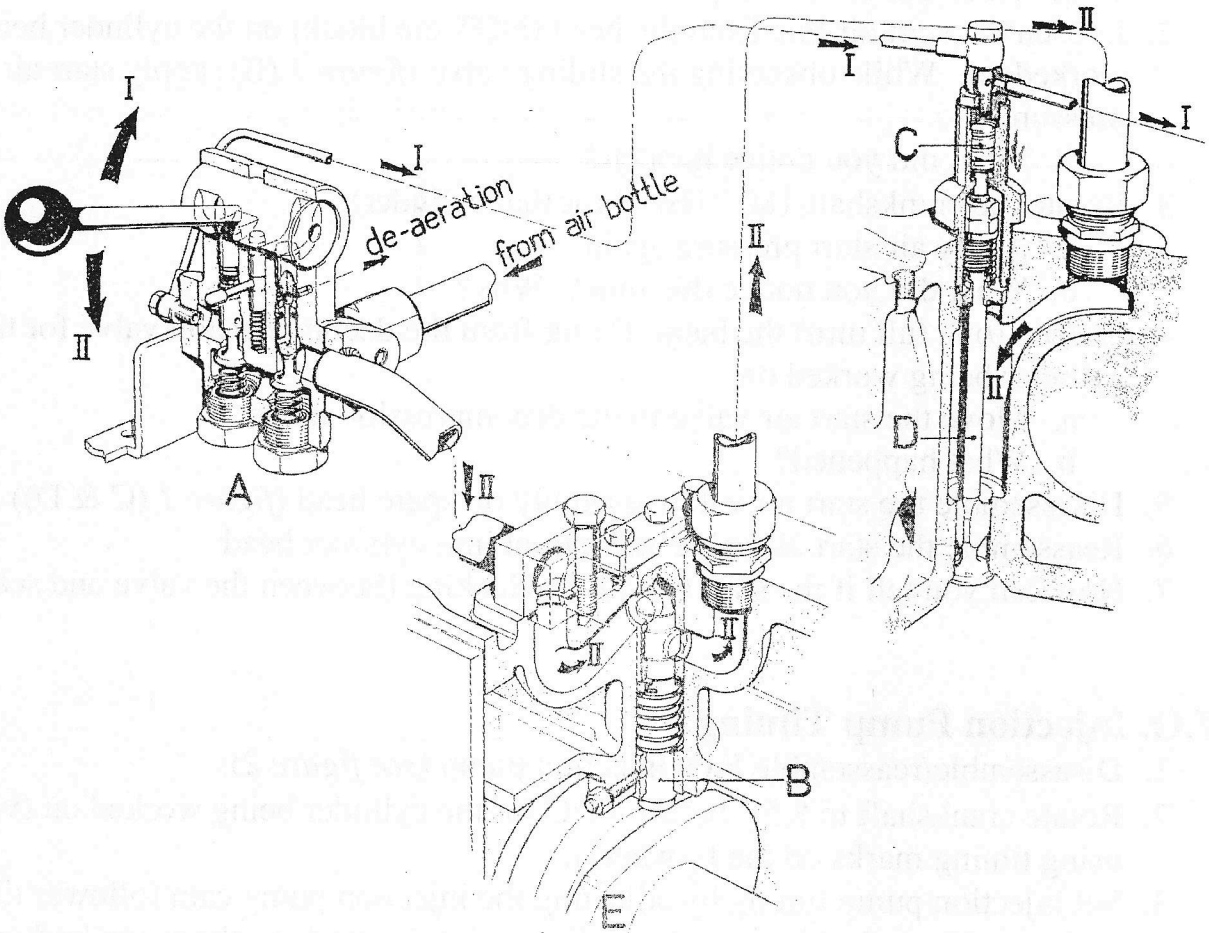
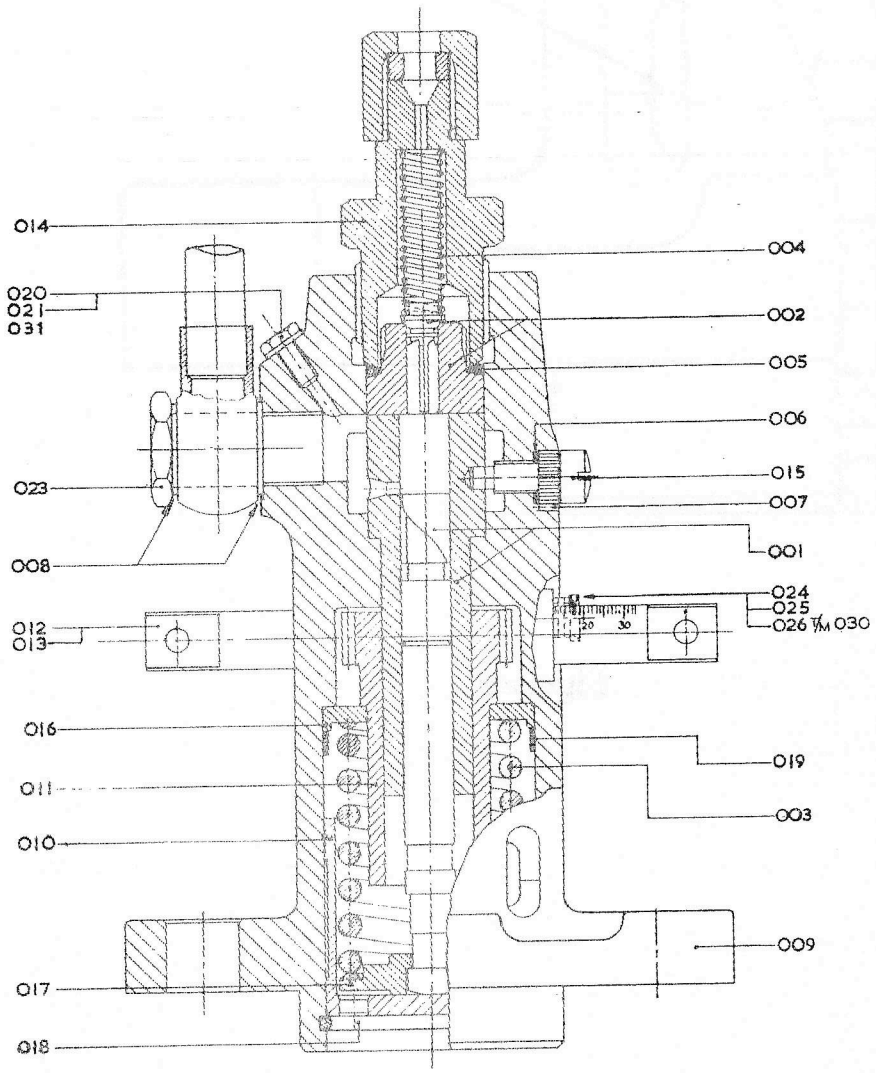


FIGURE 1



031 Locking spring
030 Spring washer
029 Filling ring
028 Filling ring
027 Filling ring

position indicator
025 Screw for plunger indicator
024 Plunger position
023 Bolt for banjo fitting
022
screw
021 Joint ring for vent
020 Vent screw
topmost spring plate
019 Spring washer for plunger gland (under)
018 Spring washer for
017 Undermost spring plate
016 Topmost spring plate cylinder
015 Locking screw for pump of delivery valve
014 Spring holder for spring rack
013 Locking screw for gear adjustment
012 Gear rack for plunger for plunger adjustment
011 Gear wheel with bush
010 Plunger gland
009 Fuel pump casing

of banjo fitting
008 Joint ring for connection cylinder
lock screw for plunger
007 Lead filling for locking cylinder
screw for plunger
006 Joint ring under locking valve seat
005 Joint ring for delivery valve
004 Spring for delivery
003 Spring for pump plunger seat
002 Delivery valve with
001 Plunger

Figure 2

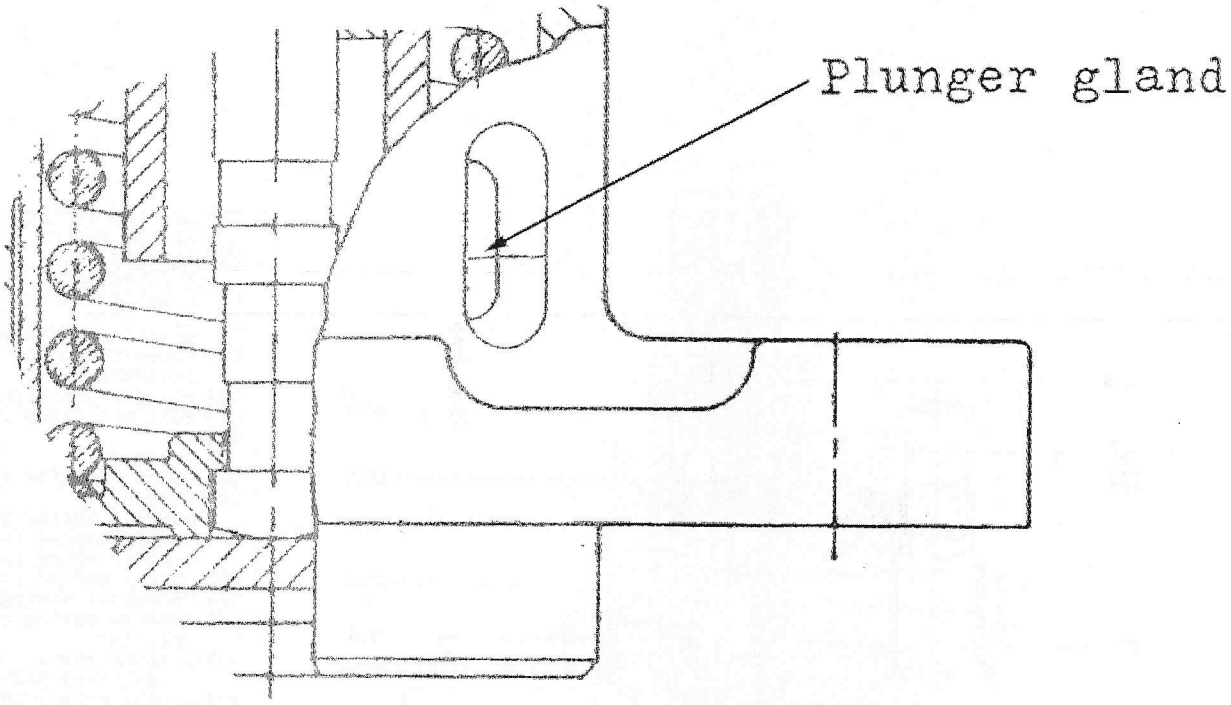


Figure 3

TECHNICAL DATA.

Engine type DR(o)210(k).

1. Dimensions.

Cylinder diameter	210 mm
Stroke	300 mm
Speed max.	900 rpm/min.
Swept volume	10,4 l/cil.
Compression ratio without turbocharging	1 : 15
Compression ratio with turbocharging	: 14,7

2. Pressures and temperatures.

Starting air			15 - 30 kg/cm2
Lubricating oil pressure on main bearings (at normal lub. oil temp.):			
At 900 r.p.m.	normal	abt.	3 kg/cm2
	maximum		3,2 kg/cm2
At 750 r.p.m.	normal	abt.	2,7 kg/cm2
	maximum		2,9 kg/cm2
Cooling water temperature after engine			
	normal	abt.	75° C.
max. temp. continuously admissible			80° C.
max. lub. oil temp. for the engine			70° C.

3. Fuel pump (of Bosch manufacture).

Plunger diameter 16 mm

Tightening of the sleeve nut for fixing the delivery valve seat.
The sleeve nut 3x to be tightened with 20 kgfm (145 ft.lbs).
Between times the sleeve nut must be unscrewed.

4. Atomiser (of Bosch manufacture).

Atomiser type	DN 8 S 138
Opening pressure	140 kg/cm2

If this pressure falls below 125 kg/cm2, readjust it at 140 kg/cm2.

5. Nominal opening and closing times of the valves in crank degrees.
Engine with turbo-charging.
Starting valve.
The starting valve is opened in the top dead centre.
The starting valve is closed 48° before the bottom dead centre.

Inlet valve.
At a roller clearance of 0,10 mm. (For adjustment see point 7).

The inlet valve is opened	87° before top dead centre.
The inlet valve is closed	41° after bottom dead centre.

Exhaust valve.
At a roller clearance of 0,25 mm. (For adjustment see point 7).

The exhaust valve is opened	61° before bottom dead centre.
The exhaust valve is closed	67° after top dead centre.

Injection timing.
The injection timing is 8,5° before top dead centre.
The maximum deviation admissible is 1°.

6. Sequence of combustion at normal sense of rotation (this is clockwise, seen against the flywheel).
6 cylinders 1 - 3 - 5 - 6 - 4 - 2.

Tool sizes (socket, wrench, allen)

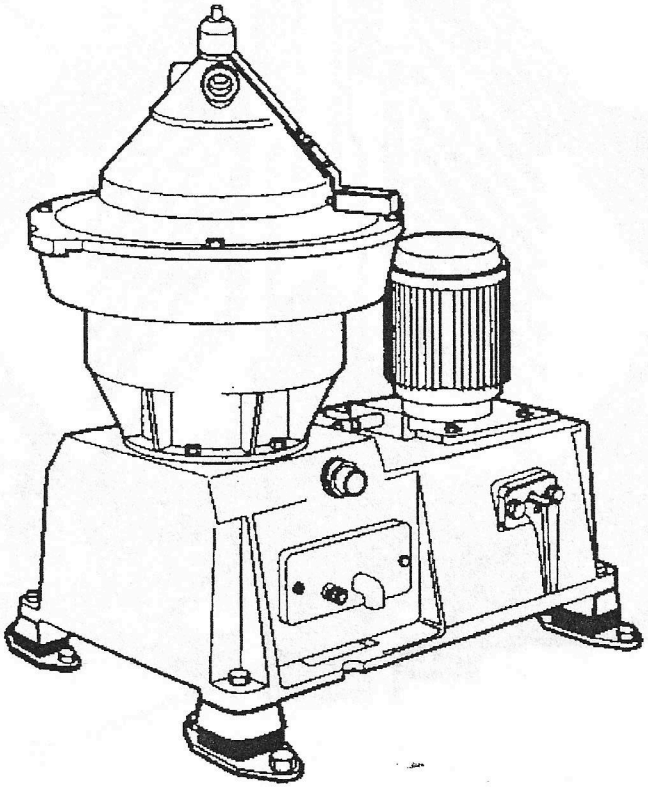
	Metric (mm)
Air pipe	36
Air Start Valve	36
Camshaft access cover	13
Crankcase door	19
Decompression air line	14
F.O. return rail	13
HP Inj. FO inlet	24
HP Inj. Hp line (Inj. Side)	19
HP Inj. Hp line (pump side)	22
HP Inj. Hp line return line	14
HP Inj. Hp line return line banjo	12
HP Inj. Pump barrell lock pin (#015)	12
HP Inj. Pump mounting bolts	24
HP Inj. Pump outlet nut (#014)	36
HP Inj. Pump timing	17/22
Precombustion Chamber	14
Precombustion Chamber jacking screw (10 x 1.5 x 80)	17
Valve adj.	27
Valve cover	20

Internal Combustion Engines II

EN – 4131L

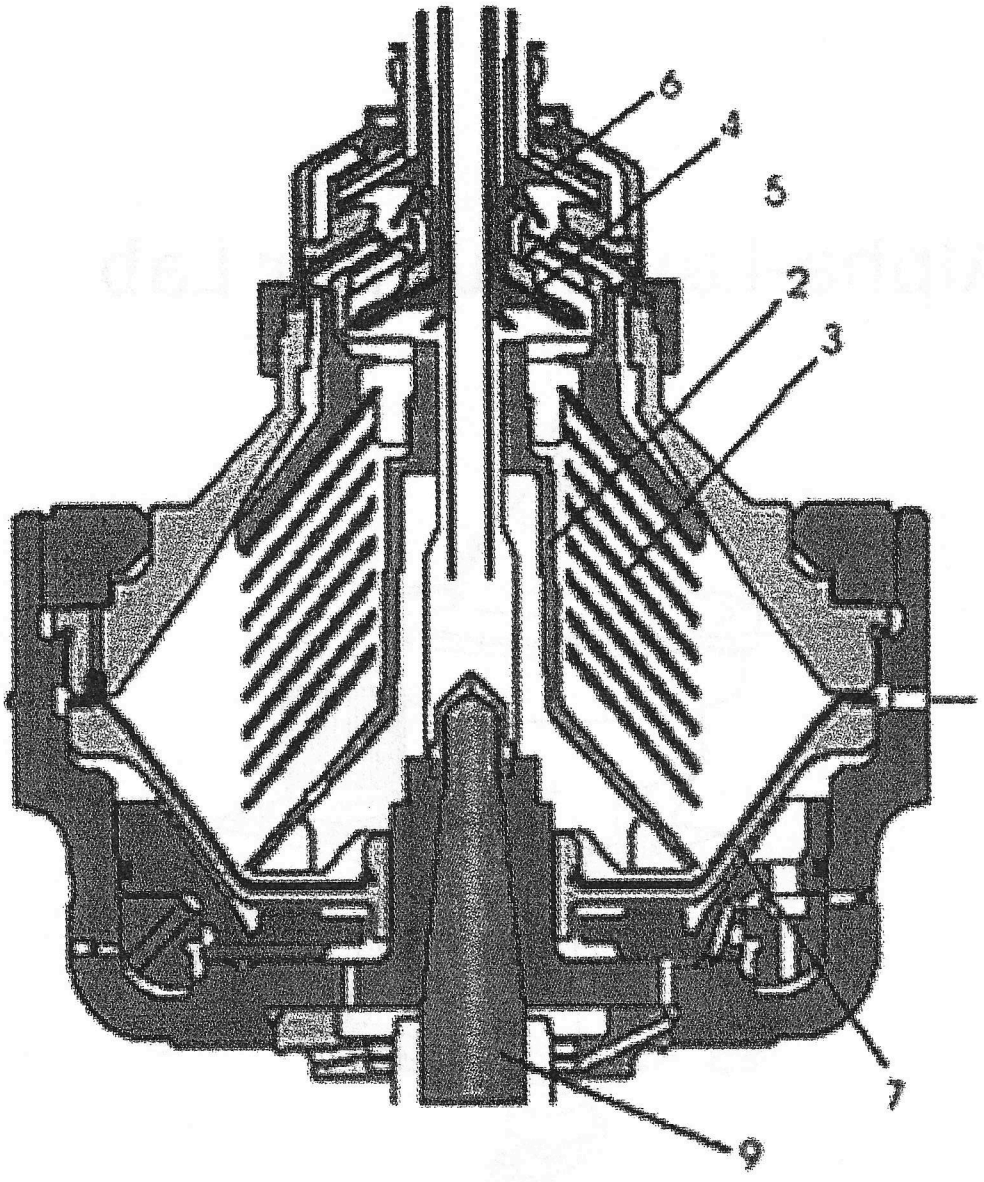
Lab #5

Alpha-Laval Purifier Lab



The P150 separator.

Working principle :::



The feed is introduced to the rotating centrifuge bowl from the top via a stationary inlet pipe (1), and is accelerated in a distributor (2) before entering the disc stack (3). It is between the discs that the separation of the two liquid phases and the solids takes place.

The oil phase moves towards the centre of the bowl and is discharged by a paring disc (4). The water phase leaves the bowl over the top disc (5) and through a paring disc (6). The heavier solids phase is collected at the bowl periphery, from where it is discharged intermittently.

The solids discharge is achieved by a hydraulic system below the separation space in the bowl, which at preset intervals forces the sliding bowl bottom (7) to drop down, thus opening the solids ports (8) at the bowl periphery. The bowl is mounted on a vertical spindle (9) driven by a vertically mounted motor, via a belt drive.

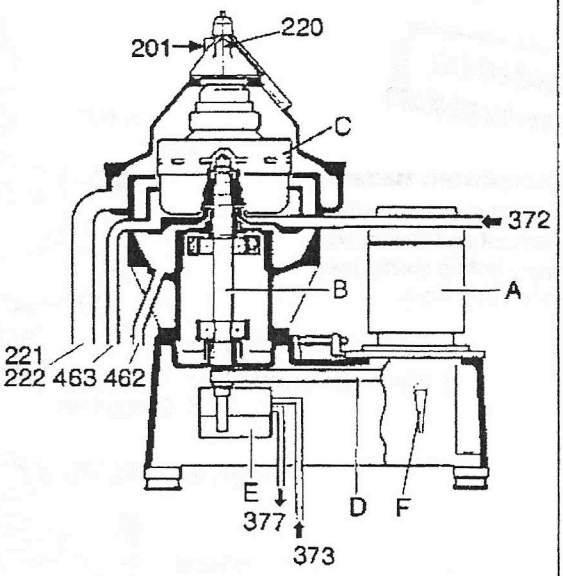
Design

The P150 separator comprises a frame consisting of the frame lower part, the intermediate part and the frame top part with a frame hood.

The separator bowl (C) is driven by an electric motor (A) via a flat-belt power transmission (D) and bowl spindle (B). The motor drive is equipped with a friction coupling to prevent overload.

The bowl is of disc type and hydraulically operated at sludge discharges. The hollow bowl spindle (B) features an impeller which pumps closing water from a built-in tank to the operating system for sludge discharge.

The main inlets and outlets are shown with their connection numbers in the illustration. The connections are listed in chapter *4 Technical Reference, page 92*, where also the basic size drawing can be found.



Sectional view
Main parts, inlets and outlets

A Electric motor
B Bowl spindle
C Bowl
D Flat belt
E Closing water tank

201 Oil inlet
220 Oil outlet
221, 222 Water/sludge outlet
372 Opening water inlet
373 Bowl closing water
377 Overflow
462 Drain
463 Drain

Outline of function

The separation process takes place in the rotating bowl. Unseparated oil is fed into the bowl through the inlet (201). The oil is cleaned in the bowl and leaves the separator through the outlet (220) via a paring chamber.

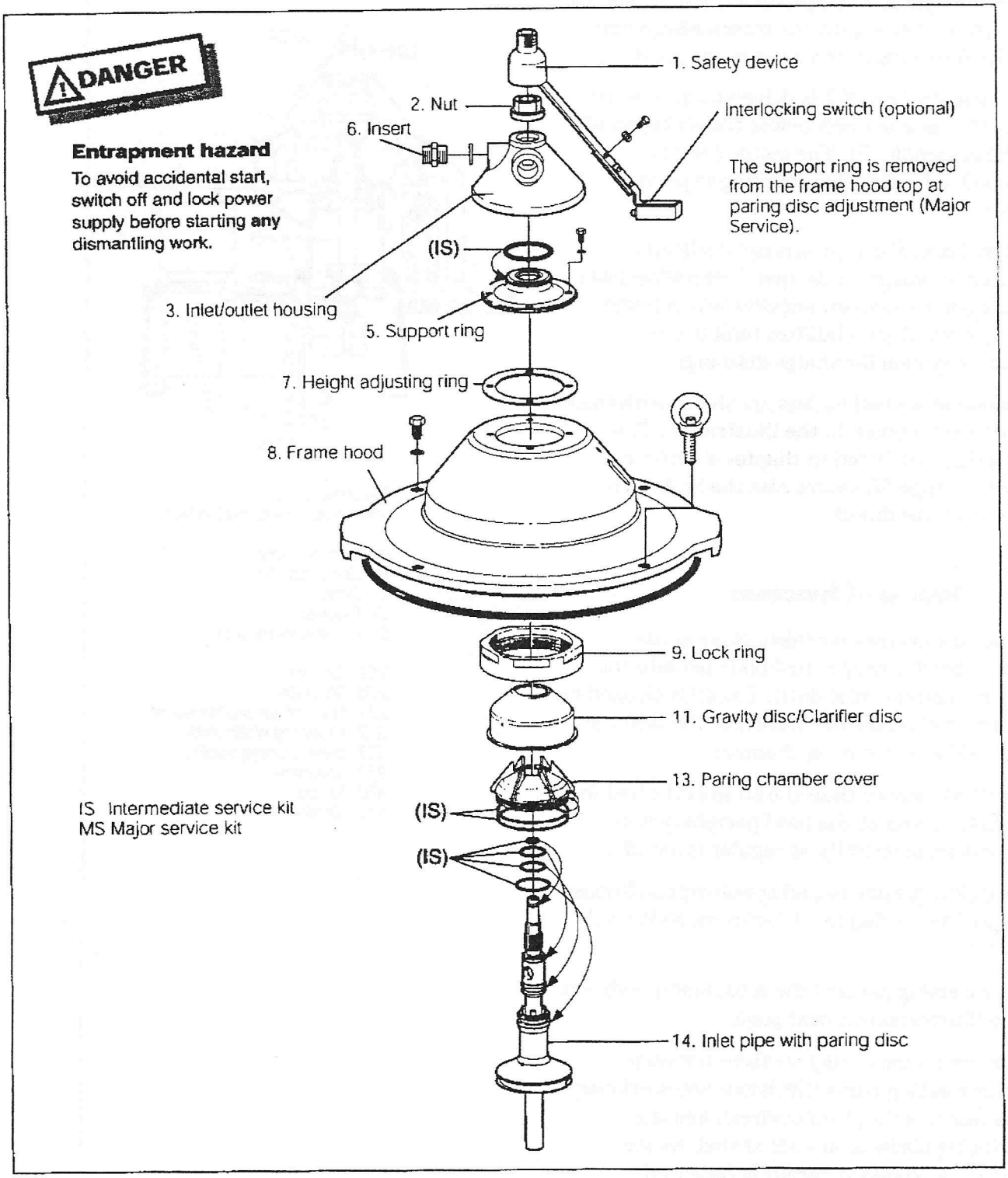
Impurities heavier than the oil are collected in the sludge space at the bowl periphery and removed automatically at regular intervals.

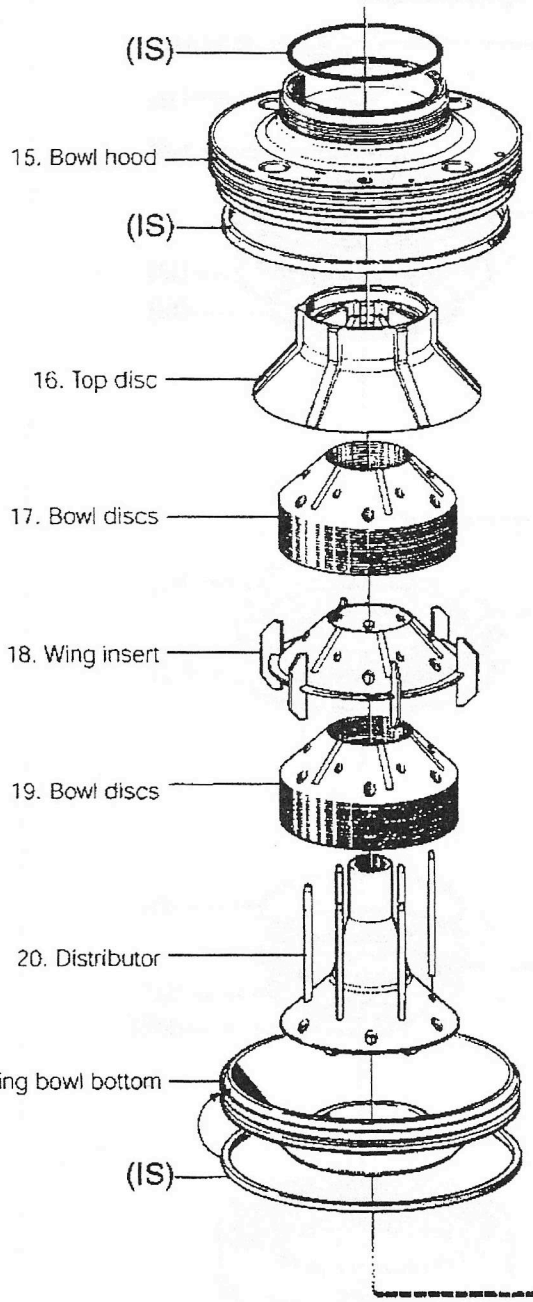
Permissible pressures and operating conditions are specified in chapter *4 Technical Reference, page 92*.

The processing parts of the separator are shown in the illustration on next page.

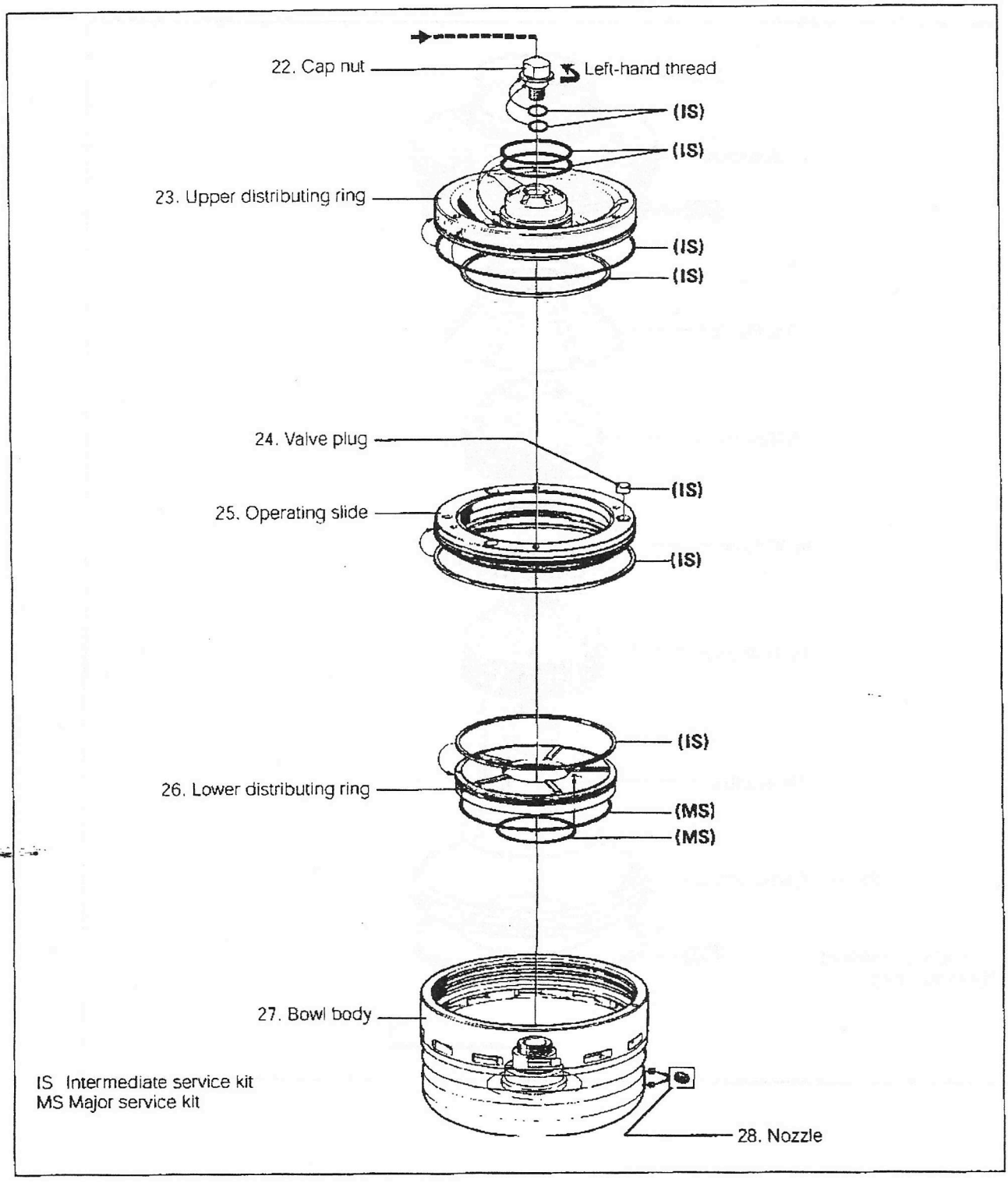
There are no contacting surfaces between process rotating parts (the bowl) and stationary parts (inlet, outlet, feed devices), and the interfacing surfaces are not sealed. As the separation process is carefully balanced regarding pressures and fluid levels, any leakages will not occur as long as the correct running conditions are maintained.

Inlet/outlet and bowl





IS Intermediate service kit
MS Major service kit

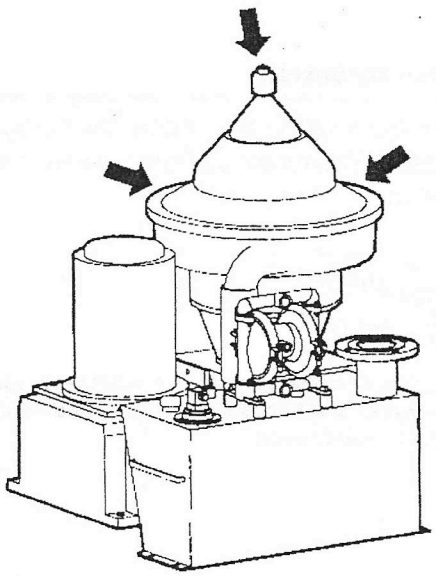


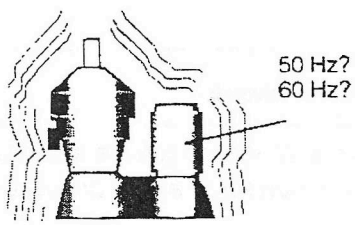
IS Intermediate service kit
MS Major service kit

1 Operating

1.1 Before Startup

1 Check that the separator is correctly assembled and connected to power supply of correct voltage and frequency.





WARNING

Breakdown hazard

Assemble the separator completely before start. All couplings, covers, and guards must be in place and properly tightened. Non compliance may lead to breakdown.

WARNING

Electrical hazard

Follow local regulations for electrical installation and earthing (grounding).

WARNING

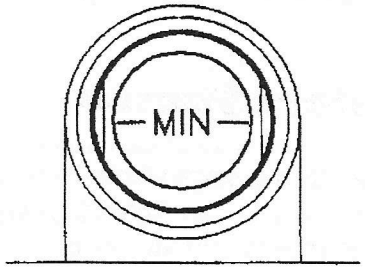
Breakdown hazard

Check that the power frequency is in agreement with the machine plate. If incorrect, resulting overspeed may cause breakdown.

WARNING

Use the separation system for the purpose, and within the limits, specified by Alfa Laval. Failure to do so could cause a violent breakdown.

2 Check the oil sump level. Top up if necessary. The oil level should be slightly above middle of the sight glass.

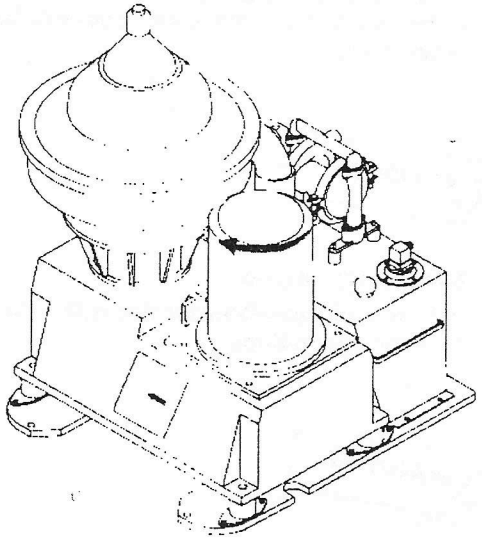


NOTE

Too much or too little oil can damage the separator bearings.

Rotation Direction

Check the rotation of the bowl by doing a quick start/stop. The motor fan must rotate in a clockwise direction.



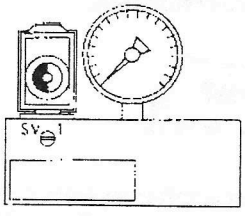
CAUTION

If power cable polarity has been reversed, the separator will rotate in reverse, and vital rotating parts can loosen.

Air Valve Block

Use the pressure gauge situated in the air valve block to check that the air supply is correct.

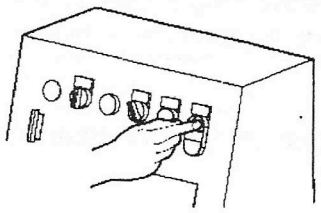
See the *System Reference/Installation Instructions* booklet.



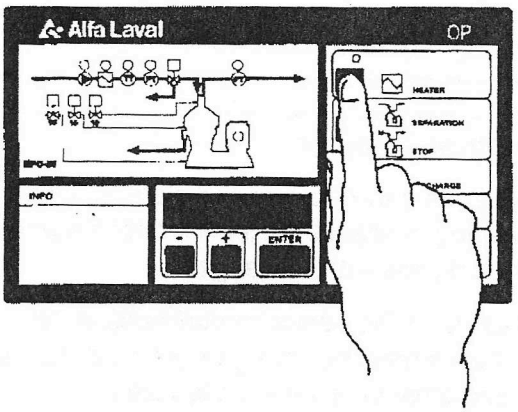
1.3 Startup

Before startup make sure that all the main supply valves for air, oil, and water are open. Open heating media supply valve if applicable. Switch on the power supplies. Make sure the control selection switch is in the manual position.

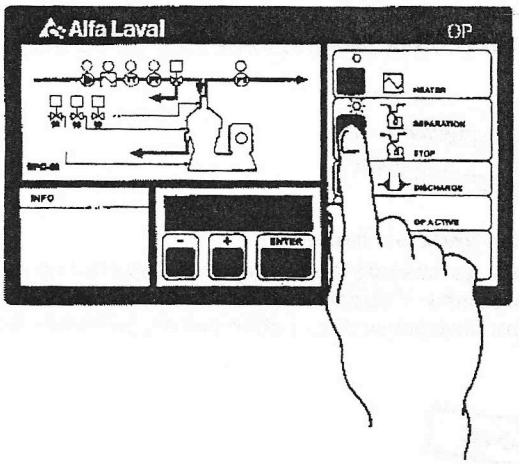
1 Start the oil feed pump from the pump starter.



2 If necessary, vent air from the heater through the relief valve (if applicable).
Switch on the heater from the operator panel (if applicable).

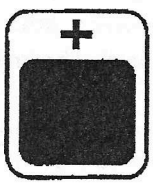


3 Press the process start/stop button



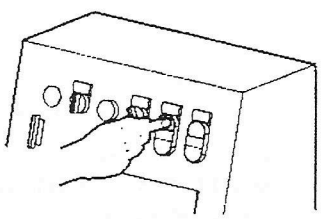
Before the separator can be started, a number of questions scroll across the display which have to be answered:

'Assembled according to manual? + = YES, − = NO'



4 If the bowl has been dismantled and assembled according to the instructions in the *Service Manual*, press the '+' button.

5 Start the separator from the starter unit.



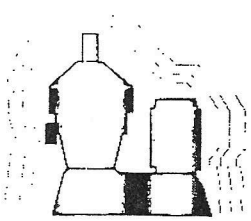
6 Listen and observe.

Vibration may occur during start up, when passing critical speeds.This is normal and should pass without danger.

If vibration increases, or continues at full speed, press the emergency stop button and stand clear until the vibration stops.

The cause of vibration must be determined and corrected before starting again!

See the *Alarms and Fault Finding* booklet.



Breakdown hazard

Always observe the separator during start-up after assembly. If strong vibration occurs, stop by using the Emergency Stop button and evacuate the room.

If the system is equipped with a vibration sensor, and has control of heater and feed pump, the Auto Start can be used.

7 Ensure that the separator is at full speed (see ammeter on starter). 'Start.' is shown on the display.

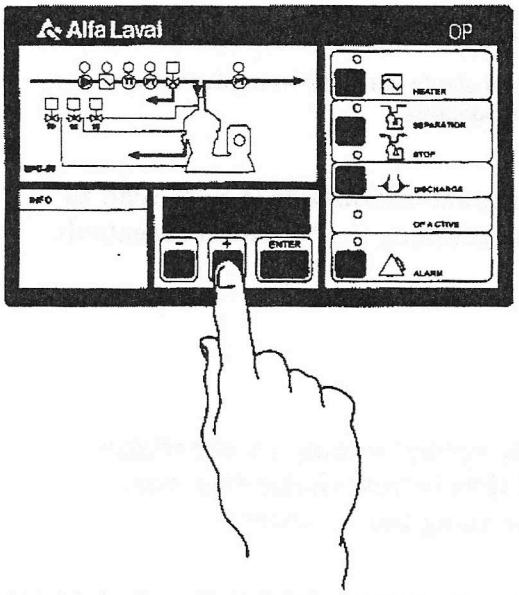
8 Check the oil feed temperature by pressing the '+' button twice.

9 Wait until the oil feed temperature is correct:

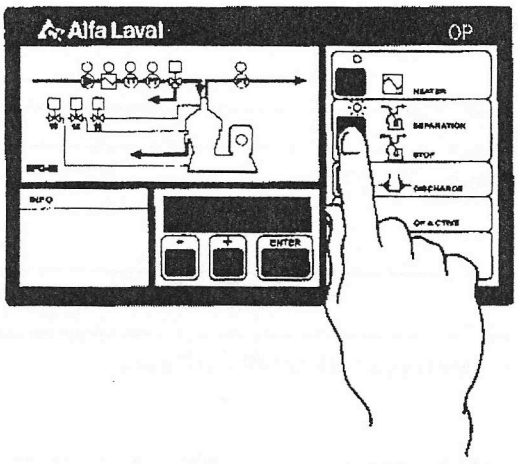
Heavy fuel mode 98 °C

Lube oil mode 95 °C (trunk engines), or 90 °C (cross-head engines)

Diesel oil mode 40 °C



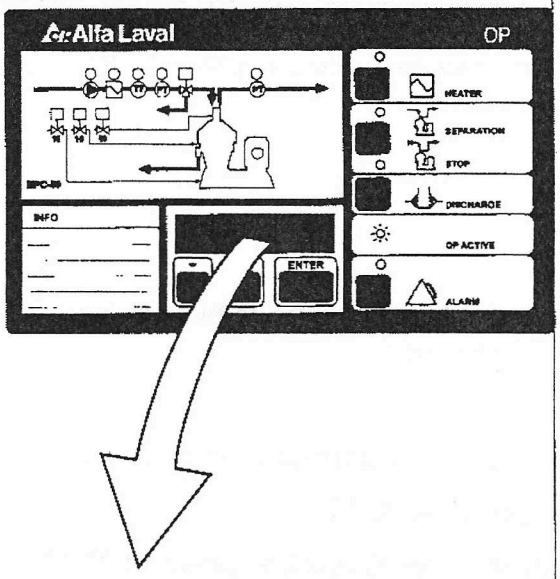
10 When 'Standby' is shown on the display, and the oil is at the correct temperature, press the process start/stop button on the operator panel to start the separation process.



NOTE

The values displayed in the examples beow are not recommendations.

More operational information may be read as required, by pressing the '+' button repeatedly.



To return to normal display, i.e. the trigger value, and time to next sludge discharge, continue pressing the '+' button.

1 Oil feed temperature. For the correct separation temperature see the *System Reference/Installation Instructions* booklet.

TT1 98 °C

2 Oil pressure, oil inlet

PT1 1.4

3 Oil pressure, oil outlet

PT4 1.4

4 Accumulated operating time in hours

Run time 5 hours

1.5 Stop

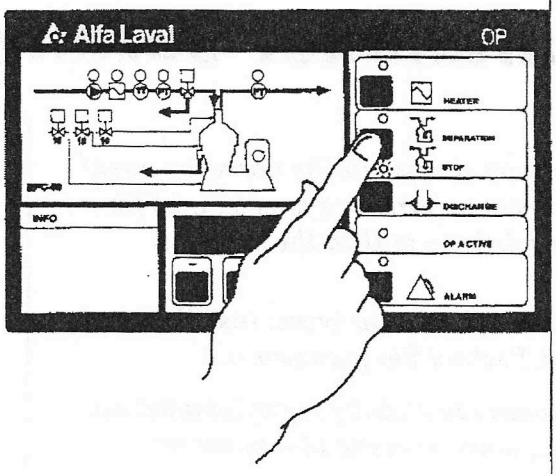
To stop the system:

1 Stop the system by pushing the process start/ stop button button on the operator panel.

A sludge discharge is initiated.

The yellow LED for separator stop sequence starts to flash.

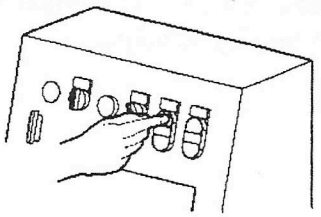
The stop sequence LED changes to steady yellow, and the green LED for separation system operation goes out, when the sludge discharge is completed.



2 Wait until the oil feed temperature starts to drop. Read the temperature by pressing the '+' button.

3 When the oil feed temperature has started to drop, the feed pump will be stopped automatically (if controlled from the control unit).

Wait until the separator has come to a complete standstill (after about 20 minutes).



CAUTION

Breakdown hazard

Stop the separator by means of the control unit, and not by turning off the motor.

CAUTION

Never attempt to clean the bowl by manual discharge in connection with stop.

Parameter Setting

The parameters are set in the operator panel for the different separator systems, and for different conditions within the systems.

There are three parameter types: Installation, Process, and Factory Set parameters.

The parameters are initially set at installation. The process parameters can also be set as required during operation.

Parameters not in use are not displayed.

The parameter list in this booklet is valid for Purifier Units 100 and 150.

General principle

The 'ENTER' button is used to:

- enter into a parameter list
- enter into a parameter
- accept/store a new parameter value.

The '+' or the '–' buttons are used to change the value flashing in the display window.

The following lists are available for viewing from a menu in the EPC-50 control unit:

- Install (parameters)
- Factory (parameters)
- Alarms
- Test

For detailed information see each list.

To open the menu and select a list, proceed as follows:

1. Push the 'ENTER' button. The process parameter list is now open.
2. Push the '+' button until 'End' is displayed.
3. Push the 'ENTER' button and the '+' button at the same time. 'Install' will show flashing on the display.
4. Use the '+' button to select a list.
5. Use the 'Enter' button to enter into the selected list.
6. To leave the list, push the '+' and the '–' buttons at the same time.
7. To leave the menu, press the '+' button repeatedly until 'Exit' is displayed. Push the 'ENTER' button.

To change parameters, proceed as follows:

1 Push the 'ENTER' button.

'Time to discharge P1 60' is shown. 'P1 is the parameter, and '60' is the set value.

The '1' of the 'P1' is flashing.

2 Push the '+' button until the number of the parameter you wish to program appears in the display window.

The chosen parameter number is now flashing.

3 Push the 'ENTER' button.

The chosen parameter number is now shown on the left side in the display. The parameter value is shown flashing on the right side of the display.

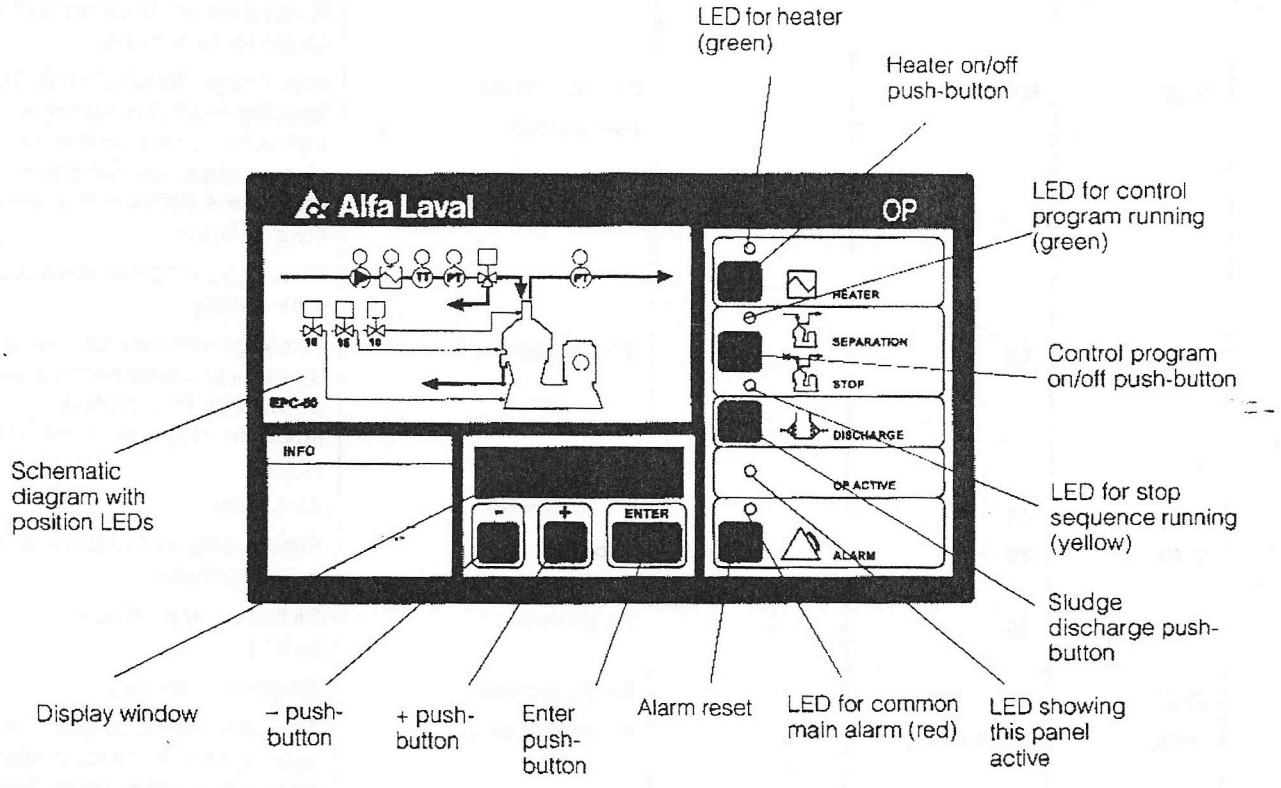
4 Push the '+' or '–' button to change the parameter value.

5 Push the 'ENTER' button. The new value is stored.

The parameter number is now flashing.

6 Push the '+' or '–' button to go to the next parameter to be changed.

7 To leave the list, push the '+' and the '–' buttons at the same time. The display shows 'Standst.' or, when in operation, the trigger value to the left, and time remaining to discharge on the right.



Timer Sequence Parameters

When expected feedback from a timer is given, the timer is interrupted and the next timer starts.

If feedback is not received within the preset time, an alarm is given.

Timers for start are 50 - 59.

Timers for operation are 60 - 69.

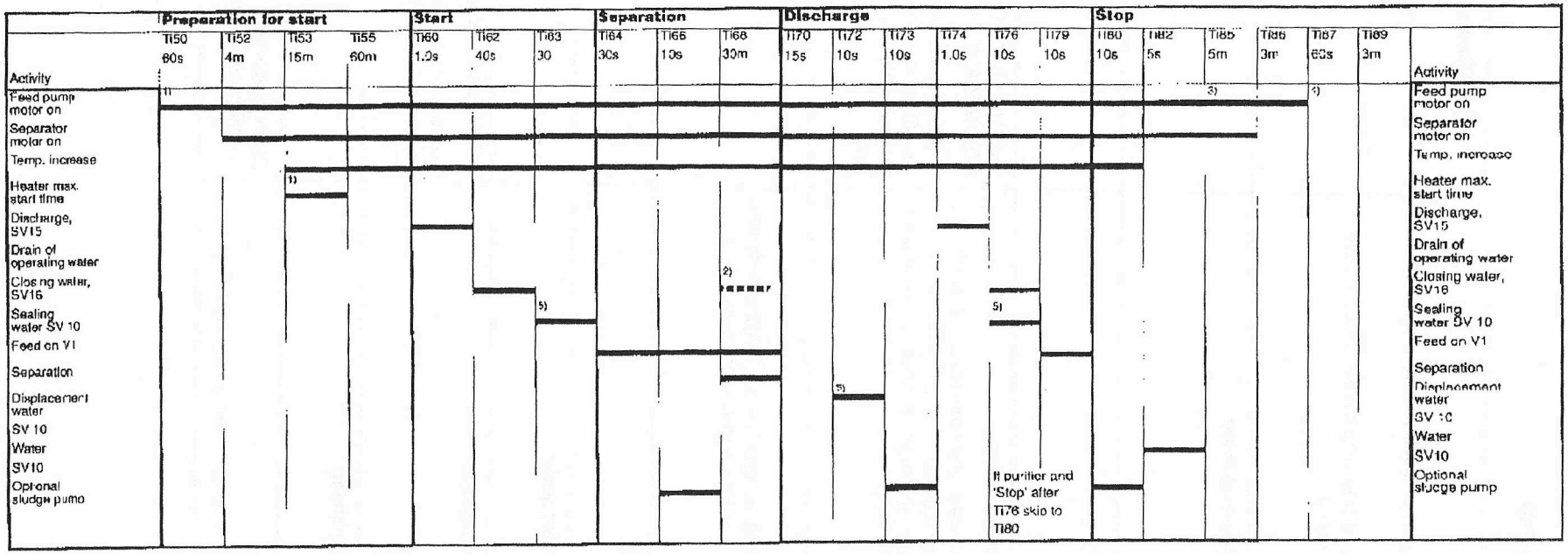
Timers for discharge are 70 - 79.

Timers for stop are 80 - 89.

If pump is started independent of Alfa Laval starter, X6:4 - X40 must be connected to a free closing contact at the external pump contactor.

Parameter	Factory set value	Plant set value	Range	Description
Ti 50	60		2 – 300 seconds	Feed pump on
Ti 52	4		0 – 60 minutes	Separator start-up
TI 53	15		0 – 60 minutes	Heater on (temp. feedback) Temperature above low limit (Pr 17, Pr 20) expected to confirm that the heater works normally.
Ti 55	60		0 – 120 minutes 0 = no standby	Max. time for 'Standby' mode. During 'Standby' mode, the system is waiting for an order to start the process sequence. The process sequence is started with a push of the start button. When Ti 55 = 0 the process starts without delay.
TI 60	1.0		0.1 – 5.0 seconds	Discharge – after a power blackout to prevent a period between discharges greater than Pr 1. (This is not a proper discharge, since the bowl is empty.)
TI 62	40		0 – 30 seconds	Close bowl
TI 63	30		Seconds	Sealing water added (does not apply in clarifier mode)
TI 64	30		0 – 60 seconds	Oil feed on. Max 60 secs. Interrupted by PT4
TI 66	10		0 – 30 seconds	Sludge tank draining
TI 68	30 (= P1)		0 – 300 minutes	Time between discharges. This is the same as Pr 1. If one is changed, the other one is automatically changed.
TI 70	15		0 – 30 seconds	Oil feed off. Oil outlet pressure below low limit (Pr 11) expected.
Ti 72	10		Seconds	Displacement of oil

5 Sequence Diagram



1) Interrupted by feedback signal
2) Pulse 1 sec. every 15 min.
3) Interrupted by decreasing temperature
4) Interrupted by pump off feedback
5) Not when running as a clarifier

Flow rates for S 100, S 150

SV10: 8.0 l/m

SV15: 18 l/m

SV16: 0.9 l/m

NOTE

Note! This diagram is valid for normal operation only. See the flow chart on page *19* for a more detailed sequence description.

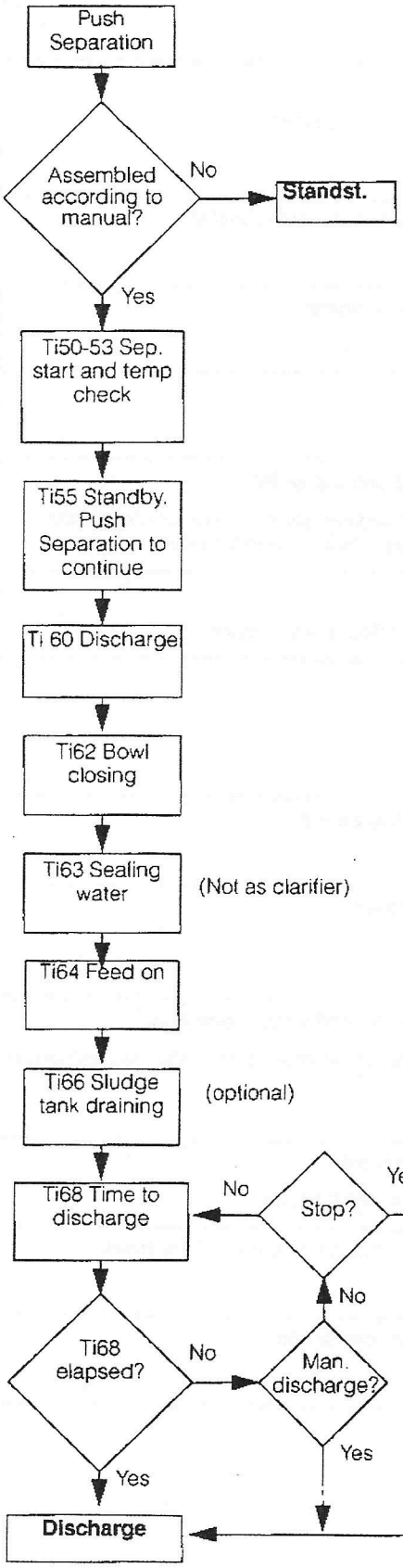
Separation Sequence

	Timer	Action	⚠ Alarms
Start	**Ti 56 = 3 sec.** SV 15	**Discharge** To ensure that the operating system gets sufficient water before closing.	
	Ti 57 = 15 sec.	**Draining of operating water**	
	Ti 58 = 15 sec. SV 16	**Bowl closing**	
	Ti 59 = calculated V 4, SV 10	**Calibration of water flow** Bowl filled with water until pressure is indicated in the oil outlet (Parameter Fa6 = 0.5 bar). Flow rate is calculated based on the known bowl volume and time taken to fill with water.	**'NO PT4 PRESSURE FEEDBACK DURING Ti 59'** Ti 59 has a max. value of 170 sec. Alarm is given if no pressure response within this time.
	Ti 60 = 5 sec. SV 15	**Discharge** Normal start begins here. The discharge is performed to empty the bowl before start after power failure.	
	Ti 62 = 40 sec. SV 16	**Bowl closing**	
	Ti 63 = 30 sec. SV 10	**Filling of sealing water**	
Separation	**Ti 64 = 30 sec.** V 1	**Feed on to separator**	**'Oil backpressure PT4 – LOW'** Alarm is given if no pressure response in oil outlet within Ti 64.
	Ti 66 = 10 sec. Sludge pump (optional)	**Sludge tank draining**	
	Ti 68 = 30 min. V1 (SV16)	**Separation** Closing water is fed for 1 sec. every 5 minutes.	During separation all necessary functions are supervised.

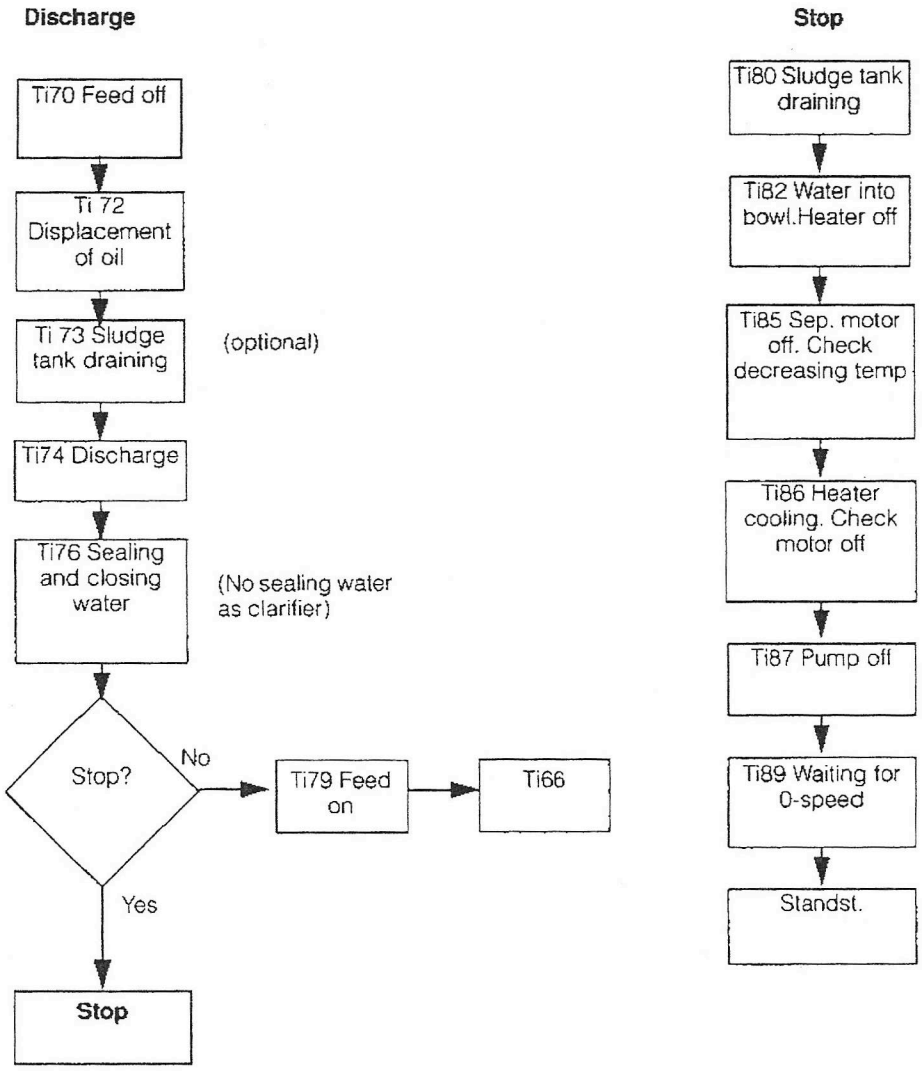
	Timer	Action	⚠ Alarms
Discharge	**Ti 70 = 15 sec.**	**Feed off.** Oil outlet pressure decreases.	**'OIL PRESSURE PT4 HIGH DURING Ti70'.** Alarm given if no pressure feedback.
	Ti 72 = 0 – 10 sec. SV10, SV16	**Displacement and closing water**	
	Ti 73 = 10 sec Sludge pump (optional)	**Sludge tank draining**	
	Ti 74 = 1.0 sec. SV15, SV16	**Discharge**	
	Ti 76 = 10 sec. SV10, SV16	**Closing and sealing water** Closing and sealing water is fed in purifier mode; Closing water is fed in clarifier mode.	
	Ti 79 = 10 sec. V1	**Feed on.** Stabilizing of flow and pressure	
	Ti 66 and 68 repeated. **or Ti 80**		
Stop	**Ti 80 = 10 s** Sludge pump (optional)	**Sludge tank draining**	
	Ti 82 = 5 sec. SV10 Heater off	**Water to the bowl.**	
	Ti 85 = 5 min. Separator motor off	**Waiting for oil feed temp. decrease.** Timer is interrupted when temp. decrease below low limit.	**'Temperature - NOT DECREASING'** If temp. not decreased within Ti 85.
	Ti 86 = 3 min.	**Check motor off** Time for cooling of heater	
	Ti 87 = 60 sec. Feed pump off	Timer is interrupted by pump off feedback.	
	Ti 89 = 3 min.	**Waiting for zero speed** (brake on)	

EPC 50 Sequences

Process Start



Separation


Discharge
Ti70 Feed off
Ti 72 Displacement of oil
Ti 73 Sludge tank draining
(optional)
Ti74 Discharge
Ti76 Sealing and closing water
(No sealing water as clarifier)
Stop?
No
Ti79 Feed on
Ti66
Yes
Stop
Stop
Ti80 Sludge tank draining
Ti82 Water into bowl.Heater off
Ti85 Sep. motor off. Check decreasing temp
Ti86 Heater cooling. Check motor off
Ti87 Pump off
Ti89 Waiting for 0-speed
Standst.

MASSACHUSETTS MARITIME ACADEMY
USTS ENTERPRISE

EMERGENCY DIESEL GENERATOR (E.D.G.) INSTRUCTIONS

W.EIDENT,'

USCG CFR's REQUIRES THAT EDG's BE TESTED, **UNDER LOAD**, FOR A TOTAL OF **2** HOURS PER MONTH

I. PRE -START CHECK LIST PRIOR TO WEEKLY TESTS

1. **Check oil level dipstick.** Note; One side of stick indicates stopped oil level, the other for running level. Use 15W-40 oil if low.

2. **Check expansion tank level.** Add 50/50 antifreeze if low.

3. **Ensure Air-shut down damper** from turbocharger is open.

4. **Check Battery starting voltage, 24 Volts or higher.**

5. **Inspect exterior of engine** for loose gear, leaks and unfinished work.

6. **Check fuel tank level.** Tank gauge near deck, by fuel valves, below battery charger.

7. **Check that the fuel supply and return valves are open.**

8. **Ensure that the RED stop button (near oil dipstick) is out.** Pull and twist to reset to run mode.

9. **Press to reset BLUE** circuit breakers, if tripped.

10. CHECK RACOR FUEL FILTER CLEAR BOWL FOR WATER, VALVE POSITION.

II. TO START MANUALLY - NO LOAD.

Complete steps 1-9 on pre-start check list.

1. Set **toggle switch to "ON"**. Toggle located to the right of voltage regulator on emergency switchboard.

2. Set **Off-Auto-Man** rotary mode switch to "Man".

3. Diesel should start.

III. WHEN EDG IS RUNNING

1. Check **oil pressure**. 65-70 PSI, cold starting pressure will be higher.

2. Check **Jacket Water temperature**. Not exceeding 195*F.

3. Check **fuel pressure** 40 psi.

4. **RPM** = 1800.

5. Visually inspect that inlet and outlet **room air louvers are open** and that air is flowing through the room.

6. Check E.D.G. **switchboard**:
   450 Volts, 60 Hertz.

IV. TO SHUT DOWN - AFTER NO LOAD TEST.

1. Set **Off-Auto-Man** rotary mode switch to "**Off**".

2. If EDG is to be left in automatic start-up mode; when diesel has stopped rotating, **set to "AUTO"**.

V. AUTOMATIC START-UP MODE for EDG

AS per USCG CFR's; In automatic mode the emergency diesel should start up upon loss of Voltage from main bus after a time delay of not more than **20** seconds, and be able to take full rated load within **45** seconds of cranking. Also the batteries must be capable of **6** consecutive normal crank cycles. The fuel tank must hold enough fuel for the EDG to run for **36** hours under full load. (passenger vessels regs.).

On the emergency switchboard.

1. **Set Off-Auto-Man** rotary mode switch "AUTO".

2. Set toggle switch to "ON".

VI. TO SIMULATE A LOSS OF MAIN BUS VOLTAGE OR TO INITIATE AUTO START

This test will place the emergency bus load on the EDG, which is required for the 2 hour monthly load test.

1. **Trip open** (push down), **main bus-tie circuit breaker**, located to the right of EDG bus-tie breaker.

2. EDG should start after a short delay and come on line automatically.

3. Check running condition as per section **III.**

4. **Load not to exceed 310 kW.** Normal load 70 to 80 kW.

VII. To reset Emergency power supply from main bus after power is restored and to shut down Emergency Diesel generator, (EDG).

1. **Trip Emergency Generator bus-tie circuit breaker, 3P 450VAC-580AT,** by pushing in **RED** trip button.

2. **Reset main bus-tie circuit breaker,** this breaker trips opens on low voltage, (to the right of EDG bus-tie breaker) push down, then up, to close it. Power should now be fed from main bus.

3. Turn **Off-Auto-Man** rotary mode switch to **"Off"** to shut down the emergency diesel engine.

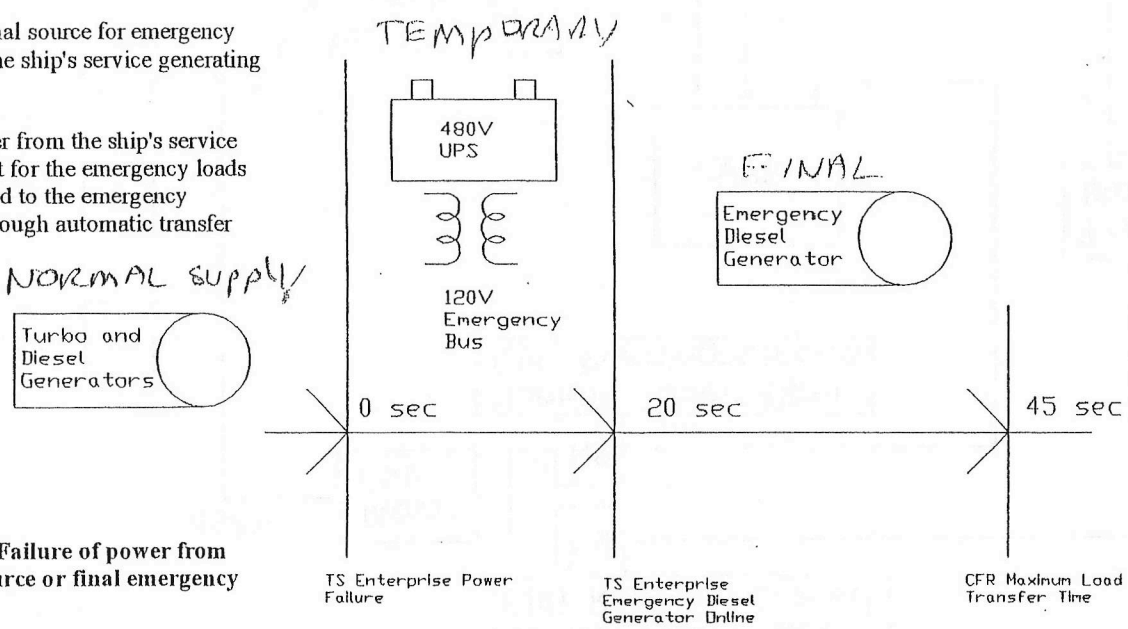
4. When diesel has stopped, **place mode switch to "AUTO"** to have the EDG ready to auto-start.

Subpart 112.20-Emergency Systems Having a Temporary and a Final Emergency Power Source

Sec. 112.20-3 Normal source for emergency loads.

(a) The normal source for emergency loads must be the ship's service generating plant.

(b) The power from the ship's service generating plant for the emergency loads must be supplied to the emergency switchboard through automatic transfer switches.



Sec. 112.20-5 Failure of power from the normal source or final emergency power source.

(a) If there is a reduction of potential of the normal source by 15 to 40 percent, the loads under Sec. 112.15-1 must be automatically supplied from the temporary emergency power source.

(b) For systems in which a reduction of frequency of the normal source or final emergency power source adversely affects the emergency system and emergency loads, there must be means to transfer the loads under Sec. 112.15-1 to the temporary emergency power source upon a reduction in the frequency of the normal source or final emergency power source.

Sec. 112.20-15 Transfer of emergency loads.

(a) When the potential of the final emergency power source reaches 85 to 95 percent of normal value, the emergency loads under Sec. 112.15-5 must transfer automatically to the final emergency power source and, on a passenger vessel, this transfer must be accomplished in no more than 45 seconds after failure of the normal source of power.

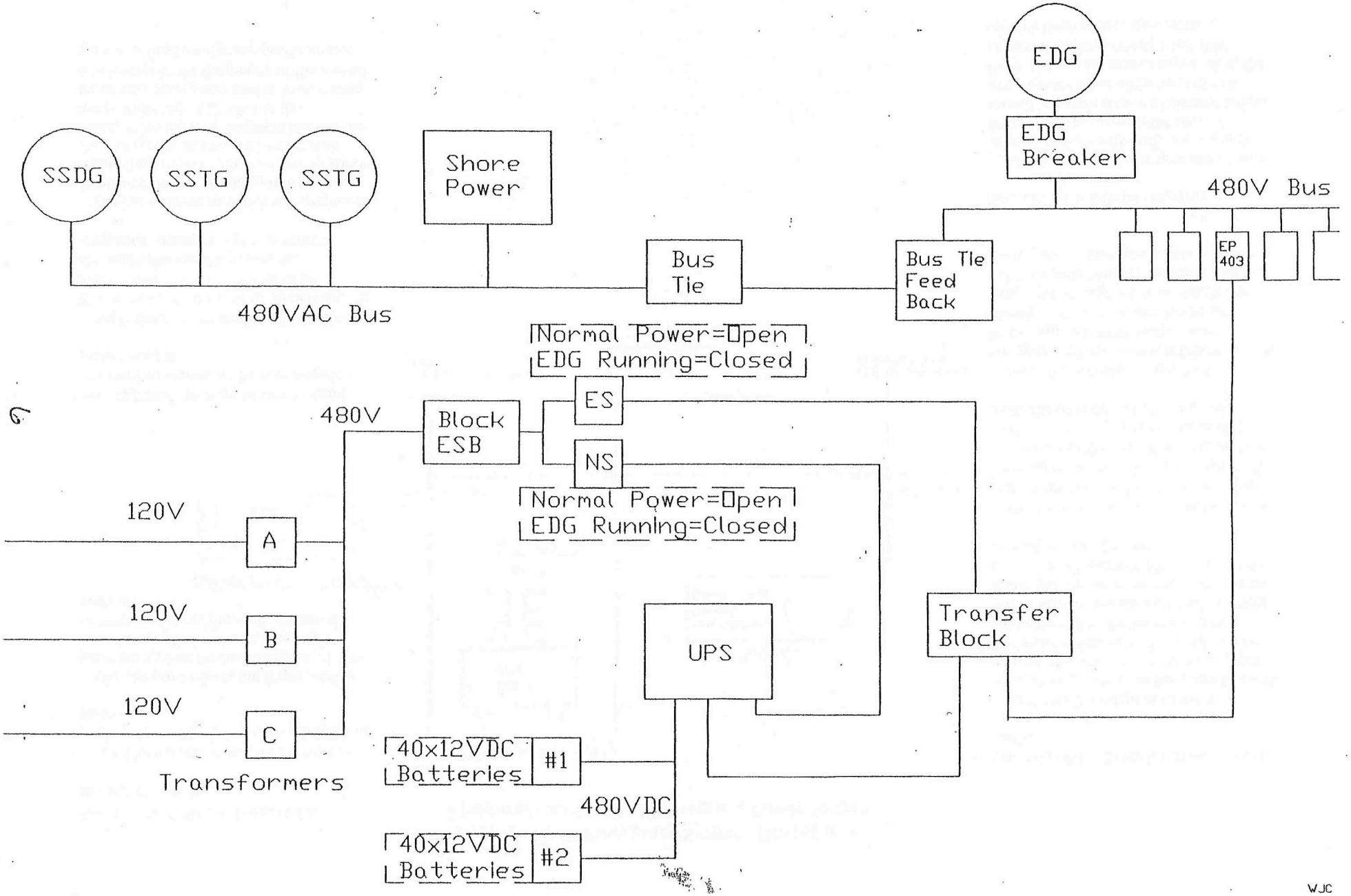
(b) When the potential from the normal source has been restored, the emergency loads must be manually or automatically transferred to the normal source, and the final emergency power source must be manually or automatically stopped.

(c) If the potential of the final emergency power source is less than 75 to 85 percent of normal value while supplying the emergency loads, the temporary emergency loads under Sec. 112.15-1 must transfer automatically to the temporary emergency power source.

Sec. 112.50-5 Electric starting.

An electric starting system must have a starting battery with sufficient capacity for at least six consecutive starts. A second, separate source of starting energy may provide three of the required six starts. If a second source is provided, the electrical starting system need only provide three consecutive starts.

T. Enterprise Emergency Electrical System

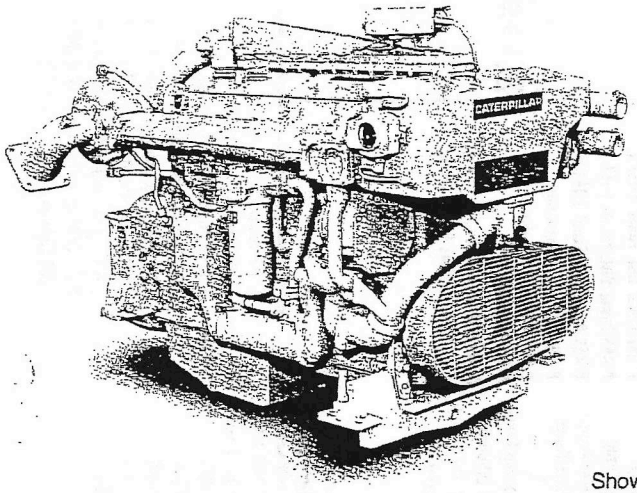


CATERPILLAR®

Marine Engine

3406C

272-433 bkW/365-580 bhp
1800-2100 rpm



Shown with
Accessory Equipment

SPECIFICATIONS

In-line 6, 4-Stroke-Cycle Diesel
Bore—mm (in) 137 (5.4)
Stroke—mm (in) 165 (6.5)
Displacement—L (cu in) 14.6 (893)
Rotation (from flywheel end) Counterclockwise
Compression Ratio 14.5:1
Capacity for Liquids — L (U.S. gal)
Cooling System (engine only) 45.4 (12.0)
Lube Oil System (refill) 34.0 (9.0)
Oil Change Interval . . . . . 9500 L (2,500 gal) Fuel
Engine Weight, Net Dry (approx) — kg(lb)
Turbocharged-Aftercooled (TA) 1,470 (3,240)

CATERPILLAR ENGINE FACILITIES ISO 9001 CERTIFIED

PERFORMANCE DATA*

Turbocharged-Aftercooled

Rating Level	E			D			C			B			B			A		
Rated rpm	2100			2100			2100			2100			1800			1800		
Engine Power @ rpm	433 bkW (580 bhp) 588mhp			399 bkW (535 bhp) 542mhp			358 bkW (480 bhp) 542mhp			328 bkW (440 bhp) 446mhp			298 bkW (400 bhp) 406mhp			272 bkW (365 bhp) 370mhp		
rpm	2100	1800	1400	2100	1800	1400	2100	1800	1400	2100	1800	1400	1800	1600	1200	1800	1600	1200
bkW	433	272	128	399	251	118	358	225	106	328	207	97	298	209	88	272	191	81
g/bkW-hr	218	209	223	220	211	225	218	213	228	218	215	230	207	213	224	207	214	227
L/hr	112.6	67.9	34.0	104.8	63.1	31.8	93.0	57.2	28.8	85.2	52.9	26.7	73.6	53.1	23.6	67.2	48.8	21.8
bhp	580	365	172	535	337	159	480	302	142	440	277	130	400	281	118	365	256	108
lb/bhp-hr	.358	.344	.367	.362	.347	.370	.358	.350	.375	.358	.353	.378	.340	.350	.368	.340	.352	.373
gal/hr	29.7	17.9	9.0	27.7	16.7	8.4	24.6	15.1	7.6	22.5	14.0	7.1	19.4	14.0	6.2	17.8	12.9	5.8

*Represents performance along a typical fixed pitch propeller curve.

RATING LEVEL DEFINITIONS

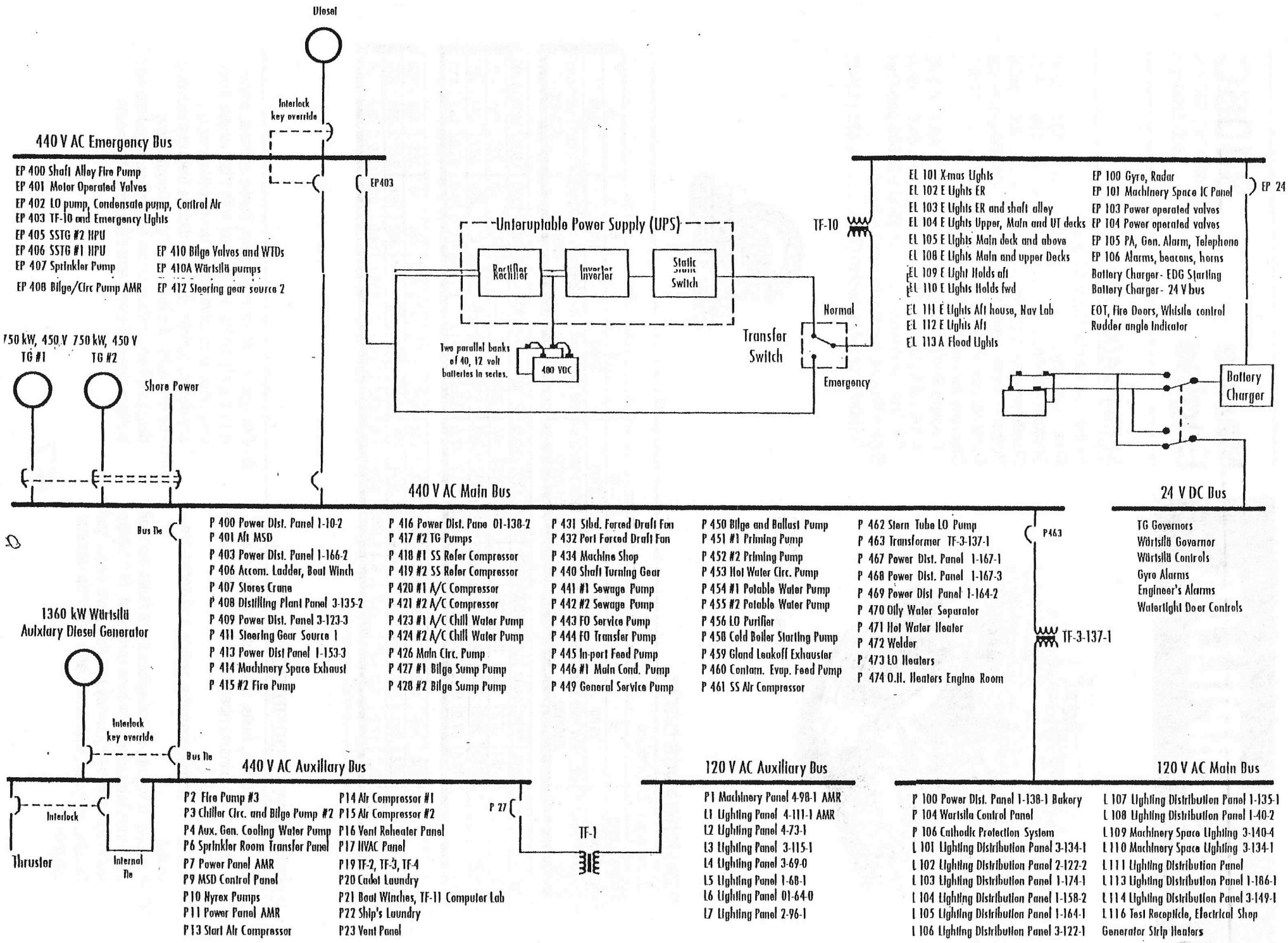
E –For use in planing hulls, such as pleasure craft, where the maximum operating time at rated speed and load is 5%.

D –For use in patrol, customs, police and some fire boats.

C –For use in yachts with displacement hulls, as well as ferries with trips less than one hour, fish boats with higher speed journey out and back (e.g., some lobster, crayfish, and tuna), and short trip coastal freighters.

B –For use in midwater trawlers, purse seiners, crew and supply boats, ferry boats with trips longer than one hour, and towboats in rivers where locks, sandbars, curves, or traffic dictate frequent slowing.

A –For use with little load cycling in oceangoing displacement hulls such as freighters, tugboats and bottom-drag trawlers, and deep river towboats.


Diesel
Interlock key override
440 V AC Emergency Bus
EP 400 Shaft Alley Fire Pump
EP 401 Motor Operated Valves
EP 402 LO pump, Condensate pump, Control Air
EP 403 TF-10 and Emergency Lights
EP 405 SSTG #2 HPU
EP 406 SSTG #1 HPU
EP 407 Sprinkler Pump
EP 408 Bilge/Circ Pump AMR
EP 410 Bilge Valves and WTDs
EP 410A Wärtsilä pumps
EP 412 Steering gear source 2
EP403
Uninterruptable Power Supply (UPS)
Rectifier Rectifier
Inverter Inverter
Static Switch
Two parallel banks of 40, 12 volt batteries in series.
400 VDC
TF-10
Normal
Transfer Switch
Emergency
EL 101 X-mas Lights
EL 102 E Lights ER
EL 103 E Lights ER and shaft alley
EL 104 E Lights Upper, Main and UT decks
EL 105 E Lights Main deck and above
EL 108 E Lights Main and upper Decks
EL 109 E Light Holds aft
EL 110 E Lights Holds fwd
EL 111 E Lights Aft house, Nav Lab
EL 112 E Lights Aft
EL 113 A Flood Lights
EP 100 Gyro, Radar
EP 101 Machinery Space IC Panel
EP 103 Power operated valves
EP 104 Power operated valves
EP 105 PA, Gen. Alarm, Telephone
EP 106 Alarms, beacons, horns
Battery Charger - EDG Starting
Battery Charger - 24 V bus
EOT, Fire Doors, Wärtsilä control
Rudder angle Indicator
EP 24
Battery Charger
750 kW, 450 V TG #1
750 kW, 450 V TG #2
Shore Power
440 V AC Main Bus
24 V DC Bus
Bus Tie
P 400 Power Dist. Panel 1-10-2
P 401 Aft MSD
P 403 Power Dist. Panel 1-166-2
P 406 Accom. Ladder, Boat Winch
P 407 Stores Crane
P 408 Distilling Plant Panel 3-135-2
P 409 Power Dist. Panel 3-123-3
P 411 Steering Gear Source 1
P 413 Power Dist Panel 1-153-3
P 414 Machinery Space Exhaust
P 415 #2 Fire Pump
P 416 Power Dist. Pane 01-138-2
P 417 #2 TG Pumps
P 418 #1 SS Refer Compressor
P 419 #2 SS Refer Compressor
P 420 #1 A/C Compressor
P 421 #2 A/C Compressor
P 423 #1 A/C Chill Water Pump
P 424 #2 A/C Chill Water Pump
P 426 Main Circ. Pump
P 427 #1 Bilge Sump Pump
P 428 #2 Bilge Sump Pump
P 431 Stbd. Forced Draft Fan
P 432 Port Forced Draft Fan
P 434 Machine Shop
P 440 Shaft Turning Gear
P 441 #1 Sewage Pump
P 442 #2 Sewage Pump
P 443 FO Service Pump
P 444 FO Transfer Pump
P 445 In-port Feed Pump
P 446 #1 Main Cond. Pump
P 449 General Service Pump
P 450 Bilge and Ballast Pump
P 451 #1 Priming Pump
P 452 #2 Priming Pump
P 453 Hot Water Circ. Pump
P 454 #1 Potable Water Pump
P 455 #2 Potable Water Pump
P 456 LO Purifier
P 458 Cold Boiler Starting Pump
P 459 Gland Leakoff Exhauster
P 460 Contam. Evap. Feed Pump
P 461 SS Air Compressor
P 462 Stern Tube LO Pump
P 463 Transformer TF-3-137-1
P 467 Power Dist. Panel 1-167-1
P 468 Power Dist. Panel 1-167-3
P 469 Power Dist Panel 1-164-2
P 470 Oily Water Separator
P 471 Hot Water Heater
P 472 Welder
P 473 LO Heaters
P 474 O.H. Heaters Engine Room
P463
TF-3-137-1
TG Governors
Wärtsilä Governor
Wärtsilä Controls
Gyro Alarms
Engineer's Alarms
Watertight Door Controls
1360 kW Wärtsilä Auxiliary Diesel Generator
Interlock key override
Bus Tie
440 V AC Auxiliary Bus
Interlock
Thruster
Internal Tie
P2 Fire Pump #3
P3 Chiller Circ. and Bilge Pump #2
P4 Aux. Gen. Cooling Water Pump
P6 Sprinkler Room Transfer Panel
P7 Power Panel AMR
P9 MSD Control Panel
P10 Nyrex Pumps
P11 Power Panel AMR
P13 Start Air Compressor
P14 Air Compressor #1
P15 Air Compressor #2
P16 Vent Reheater Panel
P17 HVAC Panel
P19 TF-2, TF-3, TF-4
P20 Cadet Laundry
P21 Boat Winches, TF-11 Computer Lab
P22 Ship's Laundry
P23 Vent Panel
P 27
TF-1
120 V AC Auxiliary Bus
P1 Machinery Panel 4-98-1 AMR
L1 Lighting Panel 4-111-1 AMR
L2 Lighting Panel 4-73-1
L3 Lighting Panel 3-115-1
L4 Lighting Panel 3-69-0
L5 Lighting Panel 1-68-1
L6 Lighting Panel 01-64-0
L7 Lighting Panel 2-96-1
120 V AC Main Bus
P 100 Power Dist. Panel 1-138-1 Bakery
P 104 Wartsila Control Panel
P 106 Cathodic Protection System
L 101 Lighting Distribution Panel 3-134-1
L 102 Lighting Distribution Panel 2-122-2
L 103 Lighting Distribution Panel 1-174-1
L 104 Lighting Distribution Panel 1-158-2
L 105 Lighting Distribution Panel 1-164-1
L 106 Lighting Distribution Panel 3-122-1
L 107 Lighting Distribution Panel 1-135-1
L 108 Lighting Distribution Panel 1-40-2
L 109 Machinery Space Lighting 3-140-4
L 110 Machinery Space Lighting 3-134-1
L 111 Lighting Distribution Panel
L 113 Lighting Distribution Panel 1-186-1
L 114 Lighting Distribution Panel 3-149-1
L 116 Test Receptacle, Electrical Shop
Generator Strip Heaters

Questions for emergency diesel lab

1. According to the U. S. C. G. regulations CFR Title 46, how long should the emergency diesel generator be tested under load each month?

2. What are two dangerous conditions that should shut down an emergency generator?

3. What are the two types of alarms that are required if the diesel over heats?

5. What type of oil is used with this diesel engine? Where is it kept?

6. What does the over-speed trip shut off to shut down the diesel engine?

7. What will shut down or close if the CO2 is released?

8. What are the ways to release the CO2?

9. Explain the steps to "feed-back" the emergency generator to the main bus in the engine room?

10. What are two motors needed to light off a boiler under dead ship conditions?

Massachusetts Maritime Academy
TABLE A-III/1 Specification of Minimum Standard of Competence
OFFICER IN CHARGE OF AN ENGINEERING WATCH

Control Sheet

ASSESSMENT NO. OICEW-7-1A, MMA# 31B102A

FUNCTION: Electrical, Electronic and Control Engineering at the Operational Level

COMPETENCE: Operate alternators, generators and control systems

KNOWLEDGE, UNDERSTANDING & PROFICIENCY: Preparing, starting, coupling and changing over alternators or generators.

TASK: Start emergency generator

PERFORMANCE CONDITION: Aboard ship or in an approved simulator, given access to generator and proper tools.

PERFORMANCE BEHAVIOR: Plan and manually start the emergency generator, describing actions as they are being performed.

PERFORMANCE STANDARD:

1. Plan reflects proper sequence of actions, is complete, and conforms to the requirements of manufacturer's instructions and ship's procedures;
2. Start up of the emergency generator is successful and conducted according to plan;
3. Actions taken are correctly and completely described;
4. Required steps taken are verified by assessor utilizing sample checklist as a guide;
5. No safety violations are observed.

COURSE: EN 4131 Internal Combustion Engines II

Candidate	SSN
Assessor	Position
Vessel or Course	License No. / Date

Internal Combustion Engines II

EN – 4131L

Lab #6

Lab #6

STCW

Westerbekes unassisted

Trace Fuel System & Describe Components

Bleed Fuel System

Set Valve Lash

Run Engine

Massachusetts Maritime Academy
TABLE A-III/1 Specification of Minimum Standard of Competence
OFFICER IN CHARGE OF AN ENGINEERING WATCH

Control Sheet

ASSESSMENT NO. OICEW-7-1B, MMA# 31B102B

FUNCTION: Electrical, Electronic and Control Engineering at the Operational Level

COMPETENCE: Operate alternators, generators and control systems

KNOWLEDGE, UNDERSTANDING & PROFICIENCY: Preparing, starting, coupling and changing over alternators or generators.

TASK: Pre-start inspection of diesel generator

PERFORMANCE CONDITION: Aboard ship, in the laboratory, or in an approved simulator given access to proper equipment and manufacturer's technical manual.

PERFORMANCE BEHAVIOR: Plan and conduct a pre-start-up inspection of a diesel generator, describing actions as they are being performed.

PERFORMANCE STANDARD:

1. Plan reflects proper sequence of actions, is complete, and conforms to the requirements of manufacturer's instructions and ship's procedures;
2. Pre- start up inspection of the prime mover and alternator is successful and conducted according to plan;
3. Actions taken are correctly and completely described;
4. Required steps taken are verified by assessor utilizing sample checklist as a guide;
5. No safety violations are observed.

COURSE: EN 4131 Internal Combustion Engines II

Candidate	SSN
Assessor	Position
Vessel or Course	License No. / Date

Massachusetts Maritime Academy
TABLE A-III/1 Specification of Minimum Standard of Competence
OFFICER IN CHARGE OF AN ENGINEERING WATCH

Control Sheet

ASSESSMENT NO. OICEW-5-1J, MMA# 31A601J

FUNCTION: Marine Engineering at the Operational Level

COMPETENCE: Operate main and auxiliary machinery and associated control systems

KNOWLEDGE, UNDERSTANDING & PROFICIENCY: Preparation of main machinery and preparation of auxiliary machinery for operations.

TASK: Prepare main propulsion diesel engine for operation

PERFORMANCE CONDITION: In an approved simulator, in the laboratory, or aboard a ship and given access a main propulsion diesel engine.

PERFORMANCE BEHAVIOR: Plan for and prepare a main propulsion diesel engine for operation, describing actions as they are being performed.

PERFORMANCE STANDARD:

1. Plan reflects proper sequence of actions, is complete, and conforms to the requirements of manufacturer's instructions and ship's procedures;
2. Preparation of main propulsion diesel engine for operation is successful and conducted according to plan*;
3. Actions taken are correctly and completely described;
4. Required steps taken are verified by assessor utilizing sample checklist as a guide;
5. No safety violations are observed.

*NOTE: Because of the physical separations and complexity of the tasks involved in demonstration of this proficiency, the assessment may be accomplished in segments during successive operational opportunities aboard ship.

COURSE: EN 4131 Internal Combustion Engines II

Candidate	SSN
Assessor	Position
Vessel or Course	License No. / Date

Massachusetts Maritime Academy
TABLE A-III/1 Specification of Minimum Standard of Competence
OFFICER IN CHARGE OF AN ENGINEERING WATCH

Control Sheet

ASSESSMENT NO. OICEW-5-1K, MMA# 31A601K

FUNCTION: Marine Engineering at the Operational Level

COMPETENCE: Operate main and auxiliary machinery and associated control systems

KNOWLEDGE, UNDERSTANDING & PROFICIENCY: Preparation of main machinery and preparation of auxiliary machinery for operations.

TASK: Secure main propulsion diesel engine

PERFORMANCE CONDITION: In an approved simulator, in the laboratory, or aboard a ship and given access a main propulsion diesel engine.

PERFORMANCE BEHAVIOR: Plan for and secure a main propulsion diesel engine, describing actions as they are being performed.

PERFORMANCE STANDARD:

1. Plan reflects proper sequence of actions, is complete, and conforms to the requirements of manufacturer's instructions and ship's procedures;
2. Securing of main propulsion diesel engine is successful and conducted according to plan*;
3. Actions taken are correctly and completely described;
4. Required steps taken are verified by assessor utilizing sample checklist as a guide;

*NOTE: Because of the physical separations and complexity of the tasks involved in demonstration of this proficiency, the assessment may be accomplished in segments during successive operational opportunities aboard ship.

COURSE: EN 4131 Internal Combustion Engines II

Candidate	SSN
Assessor	Position
Vessel or Course	License No. / Date