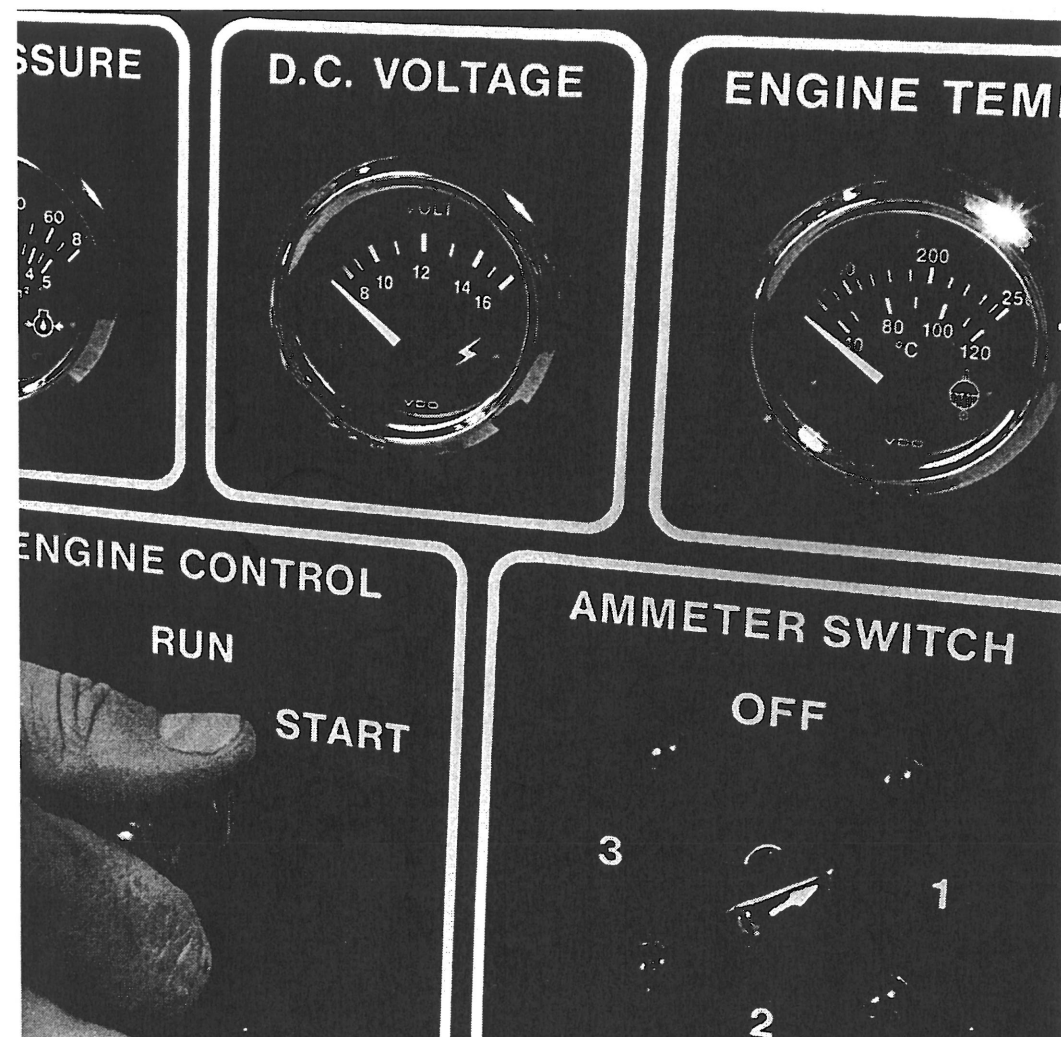


OPERATOR'S MANUAL

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OPERATOR'S MANUAL

FOREWORD

BEFORE YOU START RUNNING YOUR ENGINE, READ THROUGH THIS OPERATOR'S MANUAL. IT CONTAINS ALL THE INFORMATION YOU NEED TO RUN AND SERVICE YOUR ENGINE.

The servicing or repair of a marine engine presents its own unique problems, and cannot be compared to the servicing of automobiles, trucks, or even farm equipment. In many cases boats cannot be moved to a repair facility. Engines are usually more difficult to remove, and failures often occur in remote waters far from competent assistance. Marine engines are taxed more severely than auto-truck engines, and therefore maintenance schedules must be adhered to more rigidly. Failures usually start from minor problems that amplify in a domino effect when not found through routine maintenance or observation.

As the owner-operator of a vessel, you have the obligation to learn about your equipment and its proper maintenance. This manual does not claim to be a comprehensive technical service manual covering all kinds of repairs, nor does it claim to make the reader into an expert mechanic. Its aim is to aid you in maintaining and servicing your engine properly.

A warranty registration certificate is supplied with each engine and this entitles the original purchaser of our equipment to a guarantee covering material or assembly faults. The extent of the guarantee is described in our "Limited Warranty" statement written on the warranty form, and found in the operator's "Technical Information Manual". We recommend that you study the "Limited Warranty" carefully.

IF OUR WARRANTY IS TO APPLY, THE SERVICING INSTRUCTIONS OUT-LINED IN THIS BOOK MUST BE FOLLOWED AND, IF FURTHER INFORMATION IS NEEDED, WE REQUEST THAT YOU GET IN TOUCH WITH OUR AUTHORIZED DEALERS OR OUR FACTORY.

ALASKA DIESEL ELECTRIC, INC.

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**See special instructions for generators used in Northern Lights diesel electric sets located on page 10 of the operator's manual.*

INTRODUCTION

The LUGGER engine is built for high torque and constant loading. These heavy duty, yet light weight, compact industrial engines have swirl combustion chambers and glow plugs for fast starting in cold weather. Quiet, smooth low RPM operation, and world wide service make these engines the ideal base for the NORTHERN LIGHTS DIESEL ELECTRIC SETS and LUGGER MARINE PROPULSION ENGINES.

LUGGER engines are fresh water cooled for long life and reduced corrosion. They have a cast iron expansion tank and a cast iron exhaust manifold. All LUGGERS are available in heat exchanger or keel cooled configurations. The heat exchanger models include a Jabsco-type seawater pump, and copper tube and shell type exchanger assembly.

The fuel system has a Bosch type, inline injection pump with hand primer, feed pump and injectors with replaceable nozzle tips.

These cast-iron diesels are tunnel-bored to eliminate main bearing caps, and to give rigid crankshaft support. Natural aspiration, four cycle design, and slow piston speed lowers internal engine stresses, reduces engine wear, and gives longer engine life.

The heavy-duty components, common-sense design, and thorough testing of your LUGGER combine to give you reliable, economical power.

SAFETY RULES

Reports on accidents show that careless use of the engine causes a high percentage of accidents. You can avoid many accidents by observing the safety rules on this page. Study these rules carefully and enforce them on the job.

- Never leave engine without proper security.
- Turn the coolant tank cap slowly to relieve pressure before removing. Add coolant only when engine is idling or stopped.
- Mount a fire extinguisher accessible to the engine. Maintain extinguisher properly and be familiar with its use.
- Always disconnect battery ground strap before making adjustments on engine or electrical equipment.
- Do not operate an engine in a room not properly vented.
- Remove trash from engine and surrounding area daily.
- If a battery needs recharging, avoid sparks by turning off the charger before connecting or disconnecting the charger to the battery.
- Before using booster batteries, read the instructions on page 15.
- Escaping fluid under pressure can penetrate skin.
- Use a piece of cardboard or wood, not hands, to search for leaks.
- If escaping fluid is injected through the skin, see a doctor at once. Prolonged delay can cause serious infection.
- Avoid wearing loose clothing without a belt when working around engine.
- Do not leave engine running while making adjustments or repairs unless specifically recommended.
- Do not oil or grease engine while it is running.
- Provide a first aid kit.
- Use caution in handling fuel. Never refuel a hot or running engine. Do not smoke while filling fuel tank or servicing fuel system.
- Keep hands, feet and clothing away from power driven parts.
- Check for loose electrical connections or faulty wiring.
- Engine should be operated only by qualified persons.
- Walk completely around engine making sure everything is clear before starting an engine.
- Do not operate an engine with an unsafe condition. If one is noticed, tag the engine so other operators will also know it.

MODEL DESIGNATION

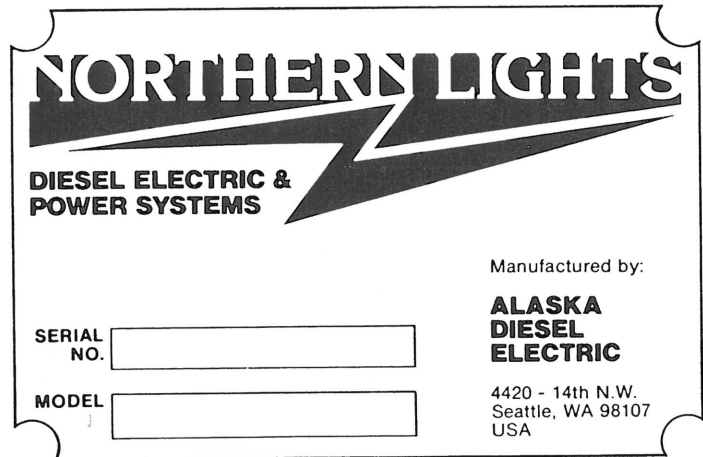
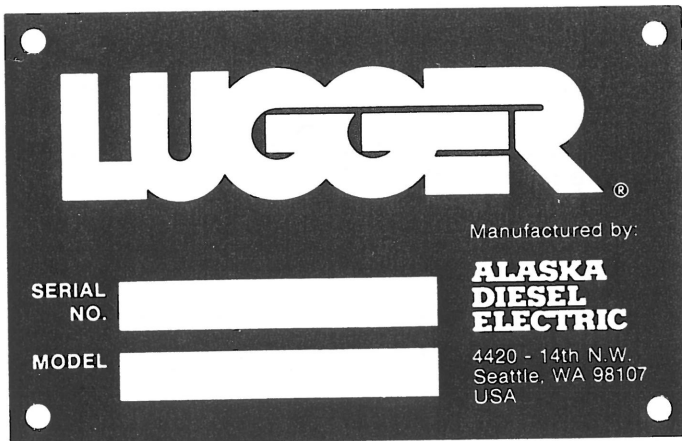
Alaska Diesel Electric uses a basic numbering system and adds letters to designate the various models and usages.

EXAMPLES:

L 854 A A **LUGGER** naturally aspirated marine propulsion engine.
M 854 A A **NORTHERN LIGHTS** naturally aspirated marine diesel electric set using the **LUGGER** marine engine as power.
M 854 Q A **NORTHERN LIGHTS** naturally aspirated 1200 RPM marine diesel electric set using the **LUGGER** marine engine as power. The "Q" designates 1200 RPM.

Other models covered in this manual include: L753, M753, M892, L843, M843, L854B and M854B.

SERIAL NUMBERS



WHEN REFERENCING ALASKA DIESEL ELECTRIC EQUIPMENT BY SERIAL NUMBER, PLEASE REFER ONLY TO THE **LUGGER** OR **NORTHERN LIGHTS SERIAL NUMBER** AS STAMPED ON THE LUGGER OR NORTHERN LIGHTS SERIAL NUMBER PLATE.

LOCATION: LUGGER serial number plates will be found on the flywheel housing.

NORTHERN LIGHTS serial number plates will be found on the flywheel housing, or on the generator.

Alaska Diesel Electric includes the serial numbers of the LUGGER and NORTHERN LIGHTS packages, as well as the major components it installs on the WARRANTY REGISTRATION found in the WARRANTY section of the TECHNICAL INFORMATION MANUAL supplied with each unit.

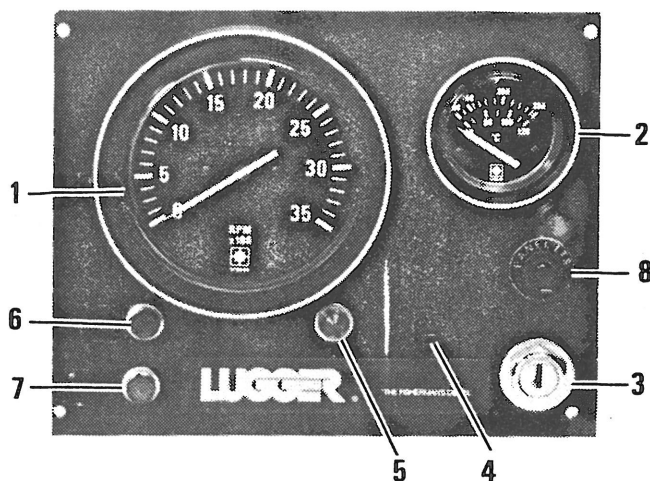


Figure 9 - Small instrument panel

INSTRUMENT PANEL - Figure 9

1. **TACHOMETER:** The tachometer shows the engine speeds in revolutions per minute (RPM). The numbers should be multiplied by 100.
2. **WATER TEMPERATURE GAUGE:** The water temperature gauge shows the temperature of the cooling water. If the gauge registers a temperature **over 200°**, **stop the engine** and investigate. If the engine temperature **drops below 140°**, **investigate** as soon as possible.
3. **KEY SWITCH:** Turning the key clockwise to the first position switches on the current. Continue turning the key clockwise until the engine starts and then immediately release to the running position. Turn the key counter clockwise all the way after the engine is stopped.
4. **COLD START SWITCH:** The cold start switch is for pre-heating the engine. The switch is held up for approximately 20 seconds before starting the engine and after the key switch has been turned to the first position. Holding the switch on too long can burn out the glow plugs.
5. **GLOW PLUG INDICATOR LIGHT:** This light will light up after the key switch is turned on to the first position and the cold start switch is held on. It indicates the pre-heating system is receiving electricity. The light will go out after the cold start switch is released.

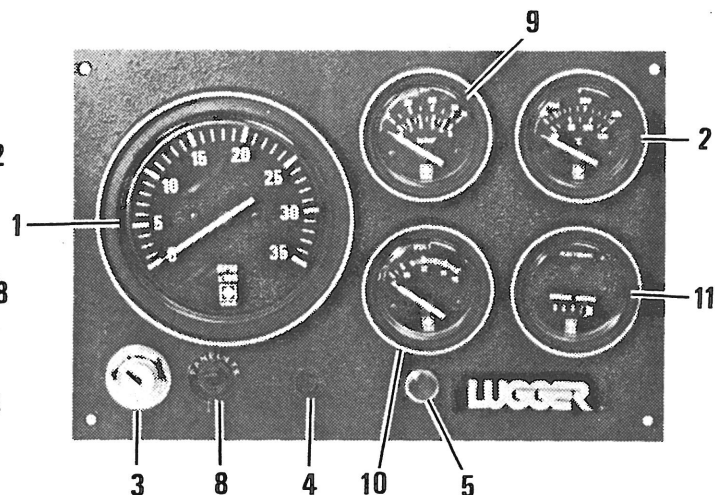


Figure 10 - Deluxe instrument panel

6. **ALTERNATOR LIGHT:** This light will light up after the key switch is turned on and will go out after the engine has started. This light indicates the electrical system is operating properly. If the light does not go on after the key switch is turned on do not try to start the engine.
7. **OIL PRESSURE LIGHT:** This light will light up after the key switch is turned on and will go out after the engine has started. If the light goes on while the engine is running, **stop the engine and investigate immediately**.
8. **SWITCH, INSTRUMENT PANEL LIGHTING:** This switch turns on the instrument panel lighting.

INSTRUMENT PANEL - Figure 10

This instrument panel includes instruments 1 through 5 and 8 as well as the following:

9. **OIL PRESSURE GAUGE:** The oil pressure gauge shows the oil pressure in the engine lubricating system. If the oil pressure **drops below 15 PSI** at a speed higher than idling, **stop the engine immediately** and investigate.
10. **VOLTMETER:** When the engine is stopped, this gauge tells you the condition of the batteries. (For starting the voltmeter should not read below 12 volts.) When the engine is running, the voltmeter tells you the voltage output of the alternator. Normal operating is between 13.8 and 14.2 volts.
11. **HOUR METER:** The hour meter keeps track of the engine running time.

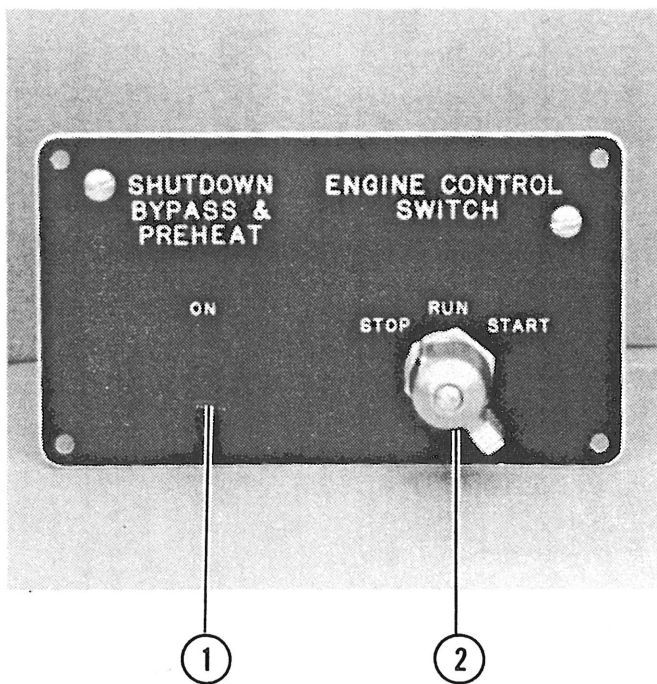


Figure 11 - SERIES 1

ENGINE CONTROL PANEL

Series 1, Figure 11

1. SHUTDOWN BYPASS - PREHEAT SWITCH: Two functions have been built into this switch: the preheating of the engine, and the bypassing of the engine safety shutdown circuit enabling a quicker start.

The switch is held up for approximately 10 - 20 seconds before starting the engine and after the key switch is turned to the run position. Holding the switch on too long can burn out the glow plugs.

2. ENGINE CONTROL SWITCH:
 - A. Rotary switch (shown): To start engine hold switch in start position until engine is running. After the engine starts, release switch; it will return to run position. To stop engine turn switch to stop position.
 - B. Toggle switch (not shown): To start engine, hold switch in start position until engine is running. After the engine starts, release switch; it will return to center position. To stop engine, momentarily move switch to stop position and release.

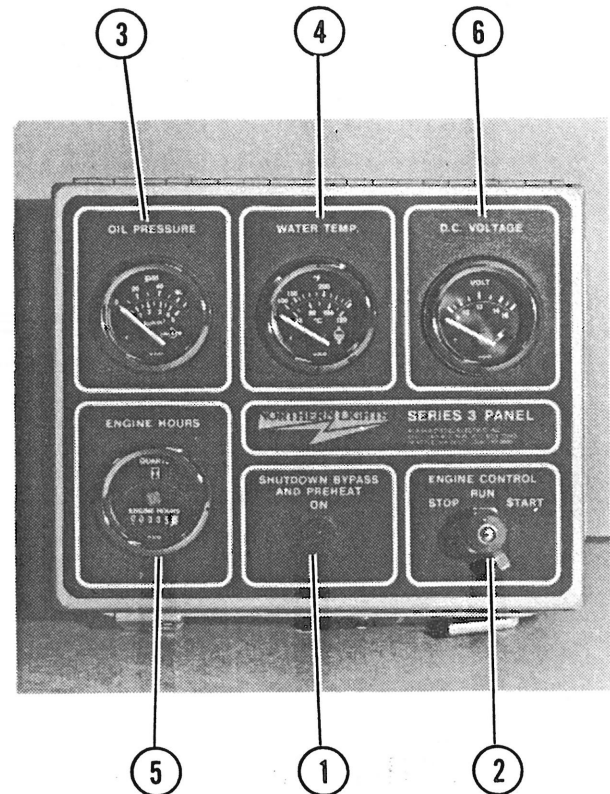


Figure 12 - SERIES 3

ENGINE CONTROL PANEL

Series 3, Figure 12

In addition to the series 1 panel features the series 3 panel includes:

3. OIL PRESSURE GAUGE: The oil pressure gauge shows the oil pressure in the engine lubricating system. If the oil **drops below 15 PSI** at a speed higher than idling, **stop the engine immediately** and investigate.
4. WATER TEMPERATURE GAUGE: The water temperature gauge shows the temperature of the cooling water. If the gauge registers a temperature **over 200**, **stop the engine** and investigate. If the engine temperature drops **below 140**, **stop the engine** and investigate.
5. HOUR METER: The hour meter keeps track of the engine running time.
6. D.C. VOLTMETER OR AMMETER: When the engine is stopped the volt meter tells you the condition of the battery. When the engine is running it tells you the voltage output of the alternator.

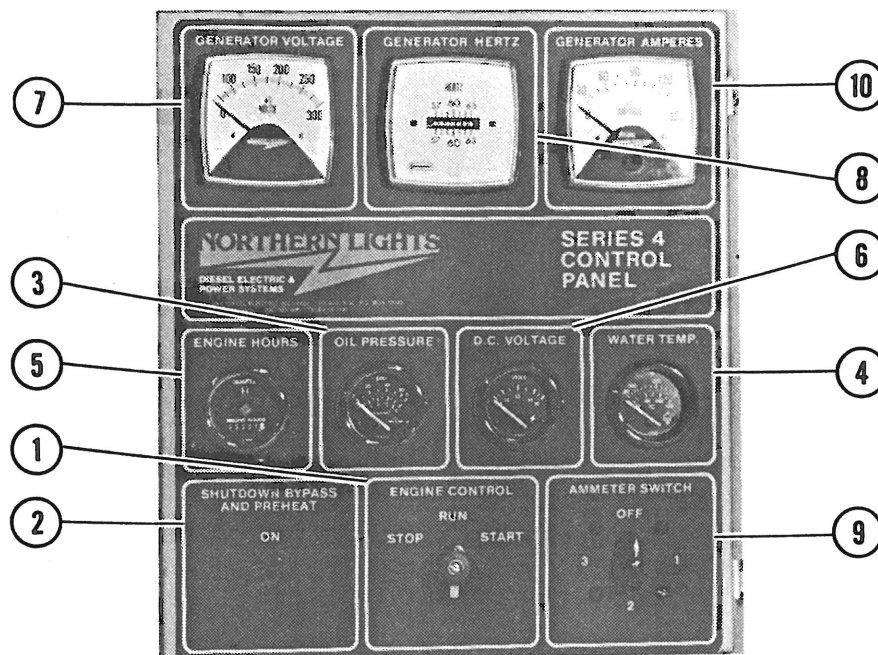


Figure 13 - Series 4 panel

ENGINE AND GENERATOR CONTROL PANEL SERIES 4

1. **ENGINE CONTROL SWITCH:** The control switch starts and stops the engine.
2. **SHUTDOWN BYPASS - PREHEAT SWITCH:** Two functions have been built into this switch: the preheating of the engine, and the bypassing of the engine safety shutdown circuit enabling a quicker start.
The switch is held up for approximately 10 - 20 seconds before starting the engine and after the key switch is turned to the run position. Holding the switch on too long can burn out the glow plugs.
3. **OIL PRESSURE GAUGE:** The oil pressure gauge shows the oil pressure in the engine lubricating system. If the **oil drops below 15 PSI** at a speed higher than idling, **stop the engine immediately** and investigate.
4. **WATER TEMPERATURE GAUGE:** The water temperature gauge shows the temperature of the cooling water. If the gauge registers a temperature **over 200°**, **stop the engine** and investigate. If the engine temperature drops **below 140°**, **stop the engine** and investigate.
5. **HOURLY METER:** The hour meter keeps track of the engine running time.
6. **D.C. VOLTMETER OR AMMETER:** When the engine is stopped, the voltmeter tells you the condition of the battery. When the engine is running it tells you the voltage output of the alternator.
7. **A.C. VOLTMETER:** This voltmeter shows the generator output voltage phase to phase. **If the voltage fluctuates greatly** from the normal reading, **shut down the unit** and investigate.
8. **FREQUENCY METER (Hertz):** The frequency meter indicates the correct engine speed. 1800 RPM or 1200 RPM (60 Hz). **If the meter does not indicate 60 Hz., shut down unit and investigate.**
9. **AMMETER SELECTOR SWITCH:** The ammeter switch is used for checking each phase for load condition. Always **leave in the "on" position while the unit is running.**
10. **A.C. AMMETER:** The ammeter shows the generator load on each phase. Each phase is selected on the ammeter selector switch (item 9).

PROCEDURE BEFORE STARTING

1. Check the water level in the fresh-water system (figures 14-16) In order to give the cooling water an opportunity to expand, the level should be about 1 $\frac{3}{4}$ " (4-5 cm) below the filler cap sealing surface (see under "Servicing" point 18).

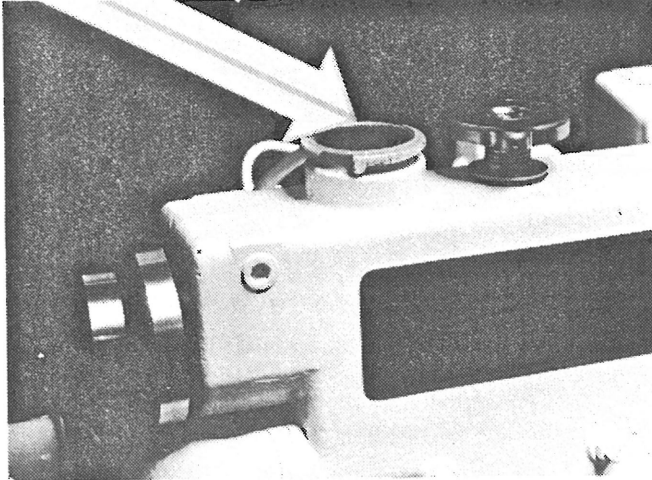


Figure 14 - Checking water level, 753 HE & KC

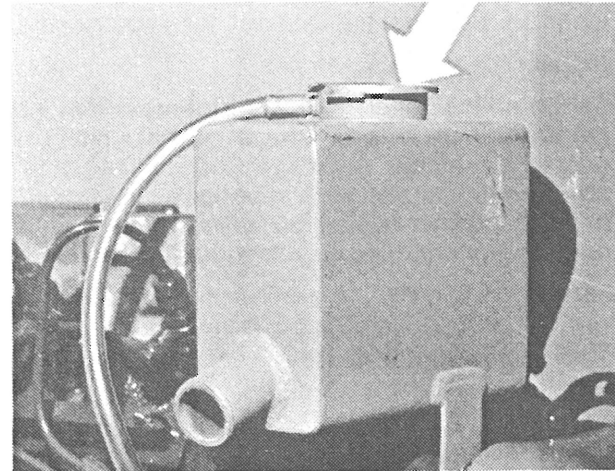


Figure 15 - Checking water level, 892 KC

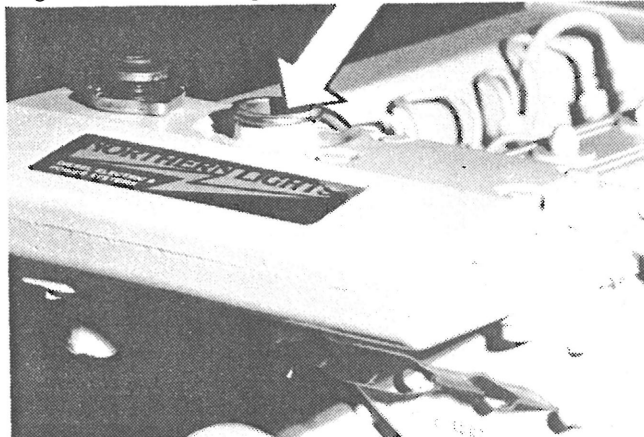


Figure 16 - Checking water level, 843 & 854

2. Check the oil level in the crankcase (figures 17 - 20, see under "Servicing", point 1). Use the oil dipstick on the side of the engine. The oil level should be in the waffled area on the dipstick and should never be allowed to go down below this area. Always use oil of the same grade and viscosity as is already in the engine.

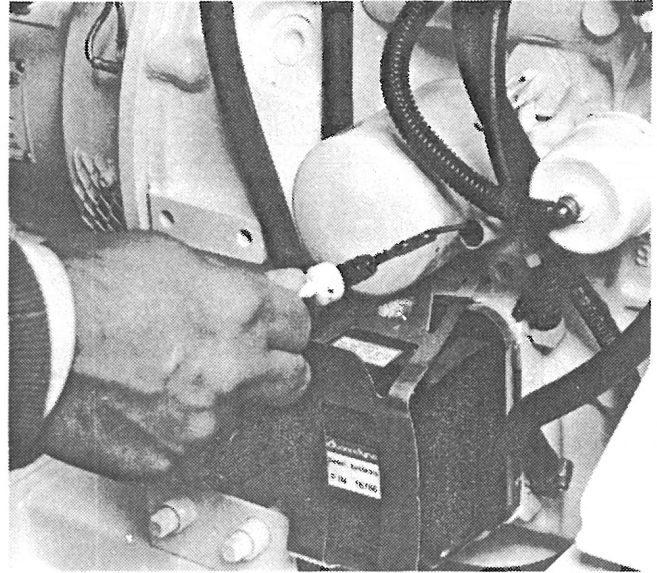


Figure 17 - Checking the oil level, 753

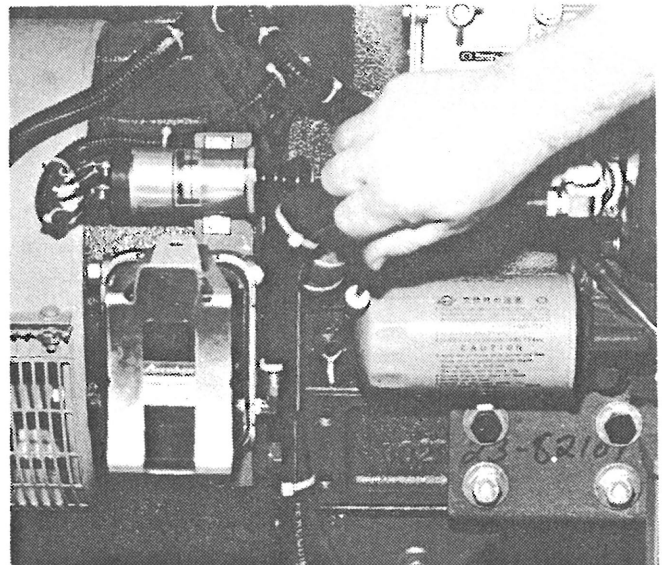


Figure 18 - Checking the oil level, 892



Figure 19 - Checking the oil level, 843

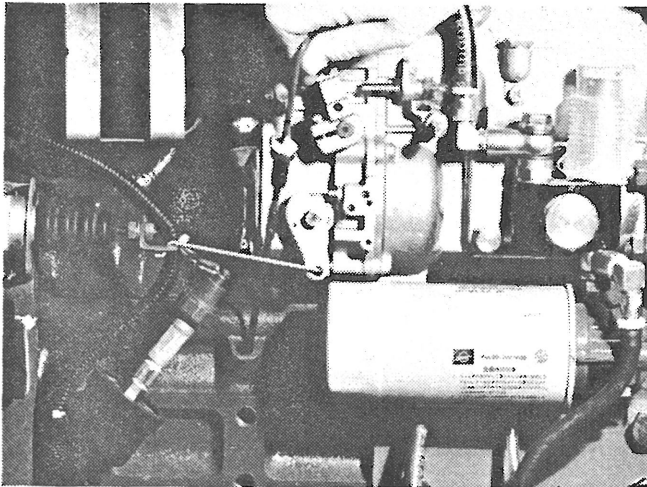


Figure 20 - Checking the oil level, 854

3. Check the oil level in the reverse gear (figures 21 and 22). Use the dipstick provided to check the oil in the reverse gear. The level in the Hurth and Borg Warner reverse gears should be checked with the engine switched off.

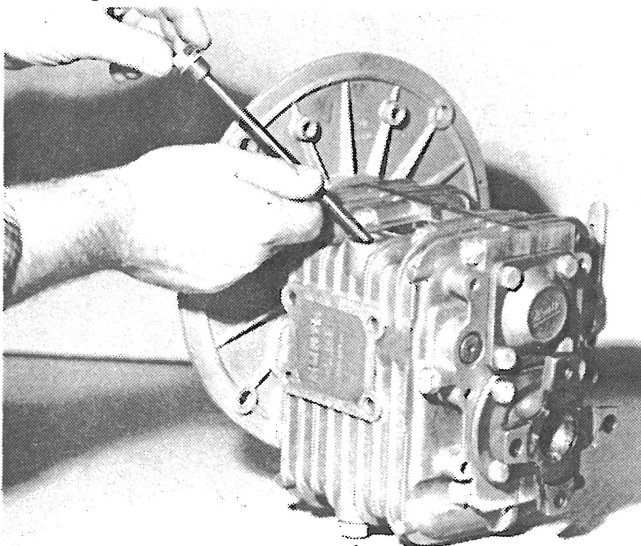


Figure 21 - Checking oil level, Hurth gear

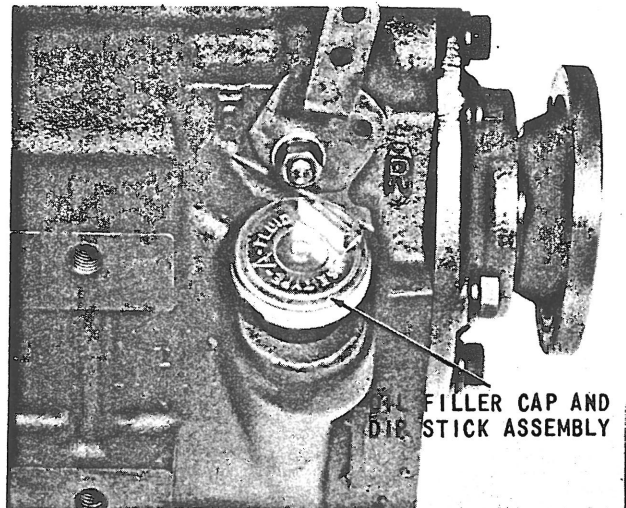


Figure 22 - Checking oil level, Borg Warner gear

4. Check the fuel in the tanks and open the cocks for fuel to the engine. If the engine has not been run for some time, the fuel system should be vented according to the instructions under "Servicing", point 14.
5. See that the sea-water cooling system drain cocks are closed. See pages 25 and 26.
6. Open the 'bottom valve' for the cooling water intake.
7. Inspect the sea-water strainer.
8. Switch on the battery switch. **Remember** that the battery switch should always be on while the engine is running. In other words, it must not be switched off until after the engine has been stopped. If this switch is turned off while the engine is running, the charging regulator can be ruined.

NORTHERN LIGHTS. In addition to those "before starting" procedures which apply to the Luger engine, Northern Lights operators should make the following checks:

Make sure you have a competent electrician install your diesel electric set.

1. Check the set for loose wiring and bare connections.
2. Check all wiring coming from and going to other machinery being run by the set making sure there are no bare connections or loose wiring.

STARTING

WITH SMALL PANEL see page 6.

1. Put the gear controls in the neutral position.
2. Switch on the key switch to the first position and make sure the alarm horn sounds.
3. Check the amp and oil pressure indicator lights to see they are lit.
4. Move the throttle control to the full speed position and return to $\frac{1}{4}$ throttle. (With MT controls, first disengage the reverse gear). In cold weather the throttle may have to be moved to $\frac{1}{2}$ throttle for starting.

5. Hold the cold start switch up for approximately 20 seconds checking to see the glow plug indicator light is on. (If the engine is warm this step need not be taken.)
6. Turn the key switch to the starting position. As soon as the engine starts, release the starter and cold start switches, and move the throttle forward until the engine is turning approximately 1000 RPM. Allow engine to warm. (The glow plug indicator light will go off as soon as the cold start switch is released.)
7. Do not crank starter for more than 20 seconds. Be sure starter has completely stopped before cranking the engine again.
8. The amp and oil pressure indicator lights will go out after starting. (If they do not, stop the engine and investigate. The amp light glowing may mean the battery is not fully charged.)

WITH DELUXE PANEL see page 6.

1. Put the gear controls in the neutral position.
2. Switch on the key switch to the first position, and make sure the alarm horn sounds.
3. Check the voltage meter. The voltage meter shows the condition of the batteries. For starting, the voltmeter should not read below 12 volts.
4. Move the throttle control to the full speed position and return to ¼ throttle. (With MT controls, first disengage the reverse gear.) In cold weather the throttle may have to be moved to ½ throttle before starting.
5. Hold the cold start switch up for approximately 20 seconds checking to see that the glow plug indicator light is on. (If the engine is warm this step need not be taken.)
6. Turn the key switch to the start position. As soon as the engine starts, release the key and cold start switches, and move the throttle until the engine is running approximately 1000 RPM. Allow the engine to warm. (The glow plug indicator light will go off after releasing the cold start switch.)

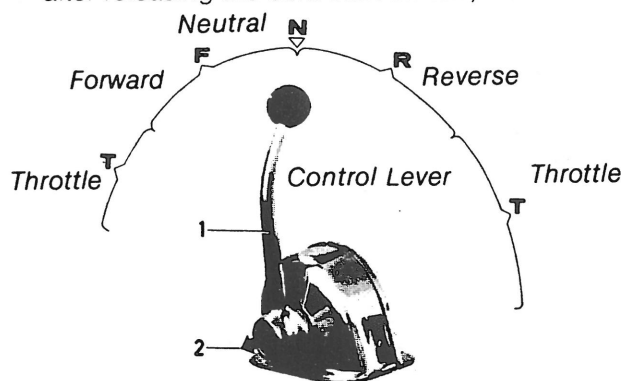


Figure 23 - Disengage: (2) pull (1) out axially while in neutral
NORTHERN LIGHTS see pages 7 and 8.

1. Turn the engine control switch to the run position.

2. Push up on the shutdown bypass-preheat switch for approximately 10 to 20 seconds before starting. Holding the switch up too long can burn out the glow plugs. (If the engine is warm this step need not be taken.)
3. Turn the engine control switch to the start position while pushing up on the shutdown bypass-preheat switch.
4. As soon as the engine starts release both switches.
5. Check all instruments.

PROCEDURE AFTER STARTING

WITH SMALL PANEL see page 6.

Never race a cold engine! Warm the engine at a rapid idle or under a light load.

1. Make sure the indicator lights on instrument panel have gone out. If any indicator light glows after the engine starts, stop the engine and investigate.
2. Check the cooling water circulation by observing the engine temperature gauge.
3. Check to see that the overboard water is flowing for heat exchanged engines.
4. If the water temperature rises over 200°, there may be an air pocket in the cooling system. Stop engine and investigate for low water level.

WITH DELUXE PANEL see page 6.

Never race a cold engine! Warm the engine at a rapid idle or under a light load.

1. Check the oil pressure as soon as the engine has started. The pressure gauge needle should be above 30 PSI. Check now and again while the engine is running to make sure the oil pressure is normal.
2. Check the voltmeter to see if the batteries are fully charging. The voltmeter should read 13.8 - 14.7 volts at 60° ambient temperature.
3. Check the cooling water circulation by observing the engine temperature.
4. Check to see that the overboard water is flowing for heat exchange engines.
5. If the water temperature rises over 200°, there may be an air pocket in the cooling system.

NORTHERN LIGHTS see pages 7 and 8.

1. Check voltage and frequency output. These outputs have been factory preset and they are not normally required to be readjusted. If there are any irregularities consult your factory representative or your local dealer before proceeding further.
2. If voltage and frequency output are normal, proceed to put a load on the unit.
3. When load is applied again check the voltage output and frequency and all engine instruments.

OPERATING

Engine RPM of 800 should not be exceeded when shifting. Repeated shifts at engine speeds higher than this can damage the reverse gear, and clutches.

MT and MT Twin single lever controls

The engine speed and reverse gear are operated by one and the same lever.

The lever has three gear positions:

1. Neutral - straight up.
2. Forward - forward one notch.
3. Reverse - back from neutral one notch.

The throttle is operated by:

1. Forward - moving through forward gear position from neutral.
2. Reverse - moving through reverse gear position from neutral.

The shift function of the control can be disengaged by pulling out on the control lever when the lever is in the neutral position. The lever then can operate the engine as a speed control. See page 11.

STOPPING

SMALL PANEL see page 6.

1. Let the engine run at 1000 RPM (no load) for two minutes, before stopping to avoid overheating
2. Set throttle at low idle.
3. Pull stop control until engine stops.
4. Turn off the key switch.
5. If the engine is not to be run and no personnel on vessel for some time, the master switch should also be switched off and all fuel and cooling water cocks closed. **NOTE: The master switch must not be switched off when the engine is running.**

DELUXE PANEL see page 6.

1. Let the engine run at 1000 RPM (no load) for two minutes before stopping it to avoid overheating.
2. Pull the throttle past low idle detent.
3. Pull stop cable.
4. Turn off key switch.
5. If the engine is not to be run and no personnel on vessel for some time, the master switch should also be switched off and all fuel and cooling water cocks closed. **NOTE: The master switch must not be switched off when the engine is running.**

NORTHERN LIGHTS see pages 7 and 8.

1. Remove all loads from the generator set before attempting to shut the unit down.
2. After the loads are removed from the unit check the engine instruments to see that they are in the normal operating range.
3. Turn the engine control switch to the off position.

ENGINE SPEED

ATTENTION: Special instructions apply with regard to the break-in period. See under "BREAK-IN".

1. Warm up engine and use tachometer to check engine speed.
2. Normal engine working range is 1800-2700 RPM depending on the engine. Low idle is 650 RPM (see pages 31 - 33, "Technical Data").
If the proper propeller is used, the speed of the engine, under full load, should be very close to those speeds (RPM'S) published for the engine in question. The engine speed can be limited by the propeller (see page 31).
Engine speed can be affected by marine growth, etc. on the bottom of the boat. For efficient and maximum speed, the hull should be clean under the water line and it should be treated with an anti-fouling paint.

BREAK-IN PERIOD

1. When an engine is new or reconditioned, it must be run with care during the first 100 hours.
2. Never run an engine at full speed for more than 5 minutes during the first 50 hours.
3. Avoid prolonged operation at either high or low engine speeds without a load on the engine.
4. For best ring seating do not idle engine for more than ¼ hour and run engine at 50 to 75% of rated RPM for first 20 hours of break-in.
5. The cruising speed should be reduced during the break-in period.
 - a. Work boats should operate between 1800 and 2200 RPM (30 - 37 r/s).
6. Constantly check the engine temperature and oil pressure gauges. (The oil pressure indicator light will go on if pressure is too low on small panel.)
7. Oil consumption is greater during break-in because piston rings, pistons and cylinder liners take a certain time to seat themselves.
8. See page 15 for special servicing instructions during break-in.

OIL CHANGES DURING BREAK-IN

The engine crank case was filled with RPM De'lo series 100/30W for break-in. Use only this oil, or service CC 30/W for the first 100 hours.

NOTE: Lugger engines are delivered filled with RPM De'lo series 100/30W oil for the break-in period. At 50 hours change oil using same oil. At 100 hours change the crankcase oil and oil filters, refilling with the proper viscosity for your conditions as listed above.

1. The oil in the engine, reverse gear and reduction gears must be changed more often during break-in.

- Change the engine oil and oil filter after 50 hours running.
- Change oil again after 100 hours running and replace the oil filters.
- Use only RPM Delo series 100/30W or service CC 30/W oil for the first 100 hours.
- Never flush out the engine with flushing oil. The bearing pressures in a diesel engine are too high for the use of this kind of oil.
- The oil in the reverse gear and reduction gears should be changed after the first 100 hours running.

NORTHERN LIGHTS

- Break-in is accomplished in the factory test cell for all generator sets and it is normally not necessary to follow any additional break-in procedures in the field.
- It is ideal to maintain at least a $\frac{3}{4}$ load on your generator set during the first 100 hours. If this is not possible, we suggest you maintain no less than $\frac{1}{2}$ load to insure proper seating of the piston rings.

FREEZING WEATHER

ANTI-FREEZE FOR ENGINE FRESH-WATER SYSTEM

During the cold season suitable anti-freeze should be mixed with the cooling water in the fresh-water system.

- Ethylene glycol with inhibitors can be used. A minimum of 40% and a maximum of 60% glycol mixture will provide protection against freezing down to about -13°F (-25°C).
- Flush out the entire cooling system before adding anti-freeze. Check hoses and connections and repair any leakage. See pages 25 and 26.

FUELS

USE ONLY CLEAN, HIGH QUALITY FUELS

- Fuel Specifications.
 - Use Grade No. 1-D or No. 2-D fuel, as defined by ASTM Designation D975 for diesel fuels.
 - Use Grade No. 2-D fuel at ambient temperatures above freezing.
 - Use Grade No. 1-D fuel at ambient temperatures below freezing and for all temperatures at altitudes above 5,000 ft. (1 500m).
 - Use fuel having less than 1.0% sulphur (preferably less than 0.5%).
 - The cetane number should be 45 minimum.
- Storing Fuels.
 - Keep dirt, scale, water and other foreign matter out of the fuel.
 - Avoid storing fuel for a long period of time.

- Fill the tank at the end of each day's operation.

DO NOT TO USE THE FOLLOWING UNSUITABLE GRADES OF OIL

- Domestic heating oils, all types.
- Engine fuels, class B.
- Domestic fuels, class D.
- Industrial and marine fuels, class E, F, G and H.
- ASTM - D975 - 60T No. 4 - D and high numbers.

LUBRICANTS

USE ONLY CLEAN, HIGH QUALITY LUBRICANTS STORED IN CLEAN CONTAINERS IN A PROTECTED AREA.

- Engine lubricating oils.
 - SINGLE VISCOSITY OILS
API Service CC/CD
 - MULTI - VISCOSITY OILS
API Service CC/SD
MIL - L - 46152
 - Depending on average temperature use oil as follows:

Air Temp.	Single Viscosity	Multi-Viscosity
Above 32°F (0°C)	SAE 30W	Don't Use
-10°F - 32°F (-23°C - 0°C)	SAE 10W	SAE 10W - 30
Below -10°F (-23°C)*	SAE 5W	SAE 5W - 20

* Some increase in oil consumption may be expected when SAE 5W - 20 or SAE 5W oils are used. Check oil level more frequently.

- NEVER PUT ADDITIVES IN THE CRANKCASE.
- Oil for reverse gears.
 - For Hurth and Borg Warner reverse gears, use ATF lubricating oil or engine lubricating oil.

ELECTRICAL SYSTEM

As standard, the engine is equipped with a 12 volt electrical system with alternator.

WARNING-THE FOLLOWING INSTRUCTIONS APPLY:

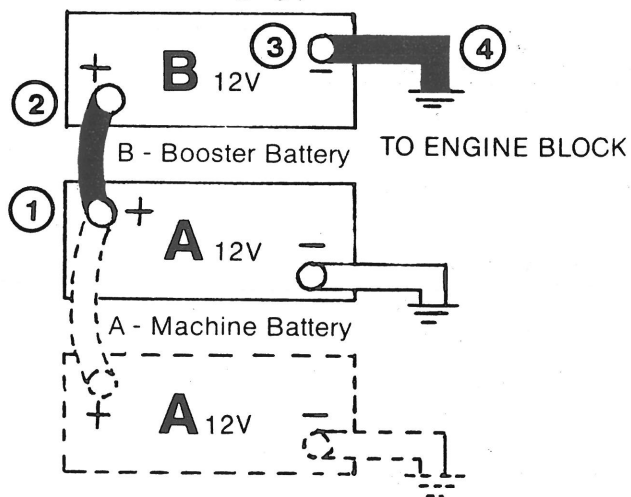
- Never break the circuit between the alternator and the batteries while the engine is running.
- The battery switch must not be switched off until the engine has completely stopped.
- No cable can be disconnected while the engine is running.
- Batteries, battery cables and cable terminals should be checked regularly.
- Tops of batteries can be kept clean by washing and flushing with fresh water.

OPERATING INSTRUCTIONS - ENGINE SERVICING

- The battery poles should be well cleaned and the cable terminals firmly tightened and greased so that no breakage occurs.
- All cables should be well-tightened. There should be no loose connections.
- Do not reverse the polarity of the battery leads when installing the battery.
- Check regularly the drive belt tension, see under "Servicing", point 5.
- When performing electrical welding work, disconnect the charging regulator and isolate the leads. Also, disconnect both the battery cable terminals.
- If any repair work is done on the alternator, first disconnect the battery leads. This also applies if the batteries are to be rapidly charged.
- Never test with a screwdriver, etc., against any terminal to see if it emits sparks.
- Do not attempt to polarize the alternator or regulator.
- Do not crank the engine for more than 20 seconds at a time. Be sure the starter has stopped completely before cranking engine again.
- Do not hold the pre-heat (switch) on over 30 seconds as you may cause the glowplugs to burn out.

BOOSTER BATTERIES

- Before charging or using booster batteries, check battery electrolyte level. Add water if necessary.
- Make sure the booster battery has the same rated voltage as the standard one.
- Connect the spare battery to the standard one, plus to plus and minus to minus.
- If using for starting remove the booster battery when the engine has started.
- If the battery is a sealed type, check battery manufacturer's charging procedure.



- Make the connections in the order shown below always making the last connection (4) to the engine block.

ATTENTION: The cables to the standard battery must never be broken.

CAUTION: Battery gas can explode. Keep flames and sparks away from batteries.

ENGINE

1. CHECKING THE OIL LEVEL

Check the oil level daily (with the engine switched off). See page 9 and 10.

- Wipe the dipstick with a clean cloth.
- The level should be between the waffled area on the dipstick, and should never be below this area. If needed add oil through the oil filler opening.
- The fresh-water pump and sea-water pump are lubricated at the factory and further lubrication is not required.

2. OIL CHANGE

Change the oil after every 100 hours.

NOTE: Luger engines are delivered filled with RPM Delo series 100/30W oil. At 50 hours change oil using the same oil. At 100 hours change the crankcase oil and oil filters, refilling with the proper viscosity for your conditions as listed on page 15.

- During the break-in period, the oil should be changed after 50 and changed again after 100 hours of operation.
- During intermittent cold weather operation, change oil at least every 100 hours or every six weeks, whichever occurs first.
- Change oil at any seasonal change in temperature when a new viscosity of oil is required.
- Change the oil when the engine is warm.
- Never use flushing oil.

LUGGER OIL CHANGE

- A hand pump for easy crankcase draining is shipped loose with every Luger engine. See figures 24 and 25.
- Remove the cap from the oil tube (figure 24)
- Attach the hand pump to the end of the oil tube and drain by pumping (figure 25).

SERVICING CHARTS

SERVICING

PLEASE NOTE: If you have purchased a **NORTHERN LIGHTS** marine diesel electric set, an additional instruction or service manual for maintaining and servicing the generator is supplied under separate cover.

DAILY

- Check oil level in engine.
- Check oil level in reverse gear.
- Check primary fuel filter.
- Check secondary fuel filter.
- Check cooling water level.

50 HOURS

- Check V-belts.
- Change engine oil and filter after first 50 hours.
- Retighten cylinder head bolts after first 50 hours.
- Check electrolyte in batteries.
- Check valve clearance after first 50 hours.

100 HOURS

- Change engine oil.
- Check air cleaner.

200 HOURS

- Change lubricating oil filters.
- Change primary fuel filter element.
- Add oil to fuel injection pump (except LM 753).
- Check zinc electrodes.

600 HOURS

- Change secondary fuel filter.
- Check valve clearance.
- Check injectors.
- Check and clean cooling system.
- Check state of charge of batteries.

1200 HOURS

- Check oil in reverse gear.

2400 HOURS

- Check fuel injection pump.
- Check and clean heat exchanger.
- Check and clean oil cooler on reverse gear.

The chart below shows the service schedule required for maintenance of your marine diesel after break-in period. Each service point and description for carrying out each function are shown on the following pages.

POINT	HOURS OF OPERATION	1)	Daily	50 hours	100 hours	200 hours	600 hours	1200 hours	2400 hours
ENGINE									
1	Check oil level		•						
2	Change engine oil	3)			•				
3	Change lubricating oil filters	7),3)			•				
4	Check air cleaner				• 4)				
5	Check V - belts			•					
6	Retighten cylinder head bolts	3)							
7	Check valve clearances	3)					•		
REVERSE GEAR									
8	Check oil level		•						
9	Change oil							• 2)	
FUEL SYSTEM									
10	Check primary filter (Racor)		•						
11	Change primary filter element					• 5)			
12	Check secondary filter		•						
13	Change secondary filter						• 5)		
14	Bleeding the fuel system								
15	Change injection pump lubricating oil					• 6)			
16	Check injectors						•		
17	Check fuel injection pump								•
COOLING SYSTEM									
18	Check cooling water level		•						
19	Check zinc electrodes					•			
20	Check and clean cooling system						•		
21	Check and clean heat exchanger								•
22	Check and clean oil cooler on reverse gear								•
23	Change impeller in sea-water pump	4)							
ELECTRICAL SYSTEM									
24	Check electrolyte level in batteries			•					
25	Check state of charge of batteries						•		
26	Check glowplugs when necessary	4)							
OUT OF SERVICE									
27	Winterizing or out - of - service when necessary								

PERIODIC SERVICE CHART NOTES

1. Perform all maintenance once a year even if 50 - 1200 operating hours are not reached.
2. Gear oil should be changed every 1200 hours or once a year, whichever ever comes first.
3. After first 50 hours of service.
4. Change when necessary.
5. More often if necessary.
6. Except LM 753.
7. Change bulkhead mounted Luber-Finer oil filter every 400 hours.

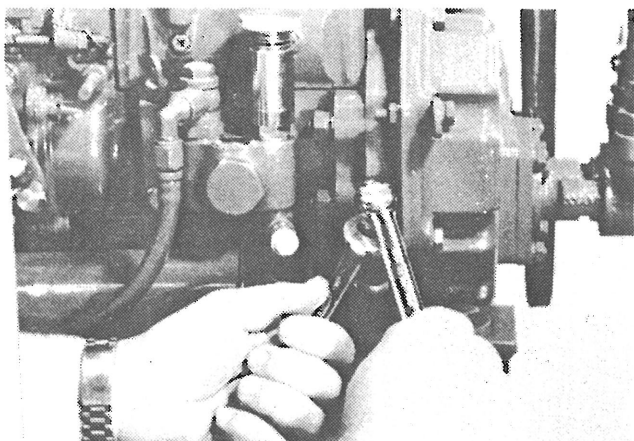


Figure 24 - Remove oil cap on oil tube

NOTE: Be sure to replace the cap on the oil tube and tighten securely after draining oil.

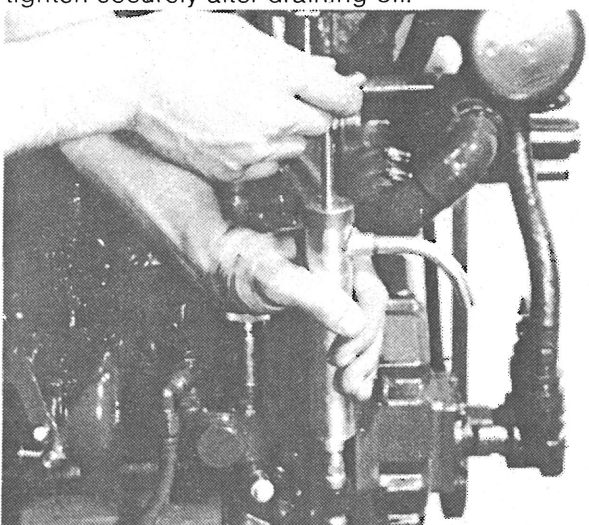


Figure 25 - Oil change hand pump, LUGGER

All engines

- e. Refill engine with recommended oil.

Air Temp.	Single Viscosity	Multi-viscosity
Above 32° F (0°C)	SAE 30W	Don't Use
-10° F-32° F (-23°C - 0°C)	SAE 10W	SAE 10W-30
Below -10° F (-23° C)	SAE 5W	SAE 5W-20

NORTHERN LIGHTS OIL CHANGE

- a. Open drain cock (figure 26).
- b. Remove drain plug and drain oil (figure 26).
- c. Refill with oil recommended above.



Figure 26 - Northern Lights oil change

3. CHANGING THE OIL FILTERS

Change the lubricating oil filters after every 100 hours of operation.

- a. During break-in change oil filters after 50 hours.
- b. Remove and scrap the oil filters (figures 27 through 30).
- c. Make sure the gasket from the old filter is removed and discarded.

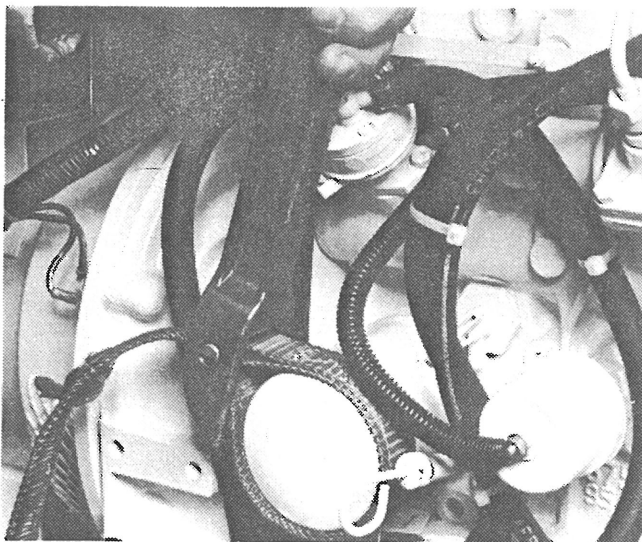


Figure 27 - Changing oil filter, 753

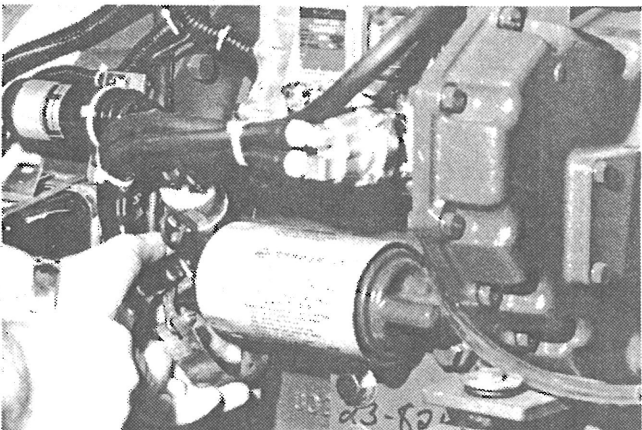


Figure 28 - Changing oil filter, 892

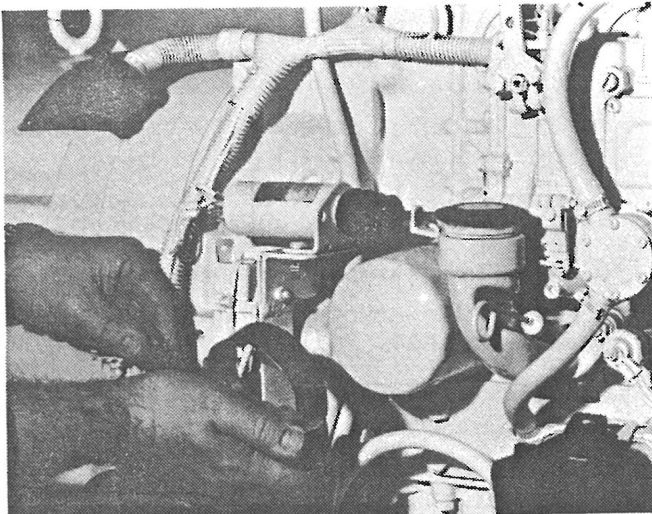


Figure 29 - Changing oil filter, 843

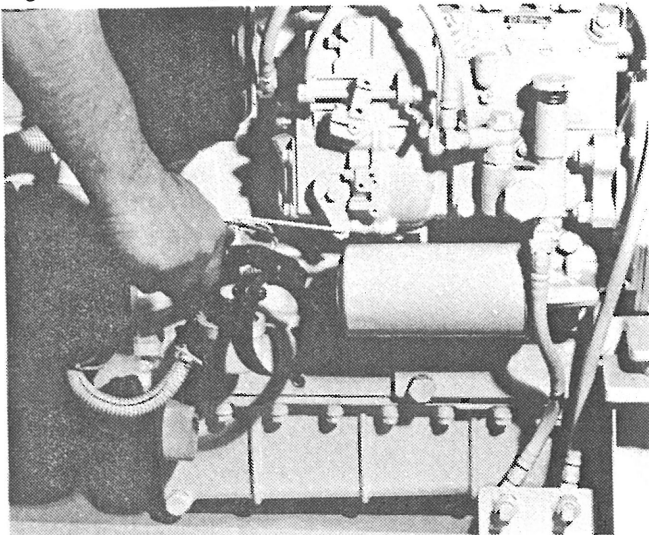


Figure 30 - Changing oil filter, 854

- d. Oil the rubber gaskets on the new filters and check their contact surfaces against the engine contact surface.
- e. Screw the new filters until the packing is firmly against the sealing surface. Then tighten a further half turn but not more.
- f. Check for leakage after starting the engine.
- g. Check the oil level in the engine.

NOTE: Oil filter contains $\frac{1}{2}$ quart of oil.

4. AIR CLEANER

Inspect the air cleaner every 100 hours and replace as necessary.

NOTE: Figures 31 through 33 show new style filters. Figures 34 and 35 show old style. The new filter element may be retro-fitted in units which currently have the pleated paper filter elements. See your local dealer.

- a. Remove cleaner by unscrewing center cap screw (figure 31).
- b. Wipe inside of filter housing.

- c. If necessary, discard old cleaner replacing with new.
- d. New style, wash in cleaning solvent or soap and water. Make sure screen is in place before reinserting. **CAUTION:** Reinstall foam filter only when completely dry.

Make absolutely sure that no impurities enter the engine.

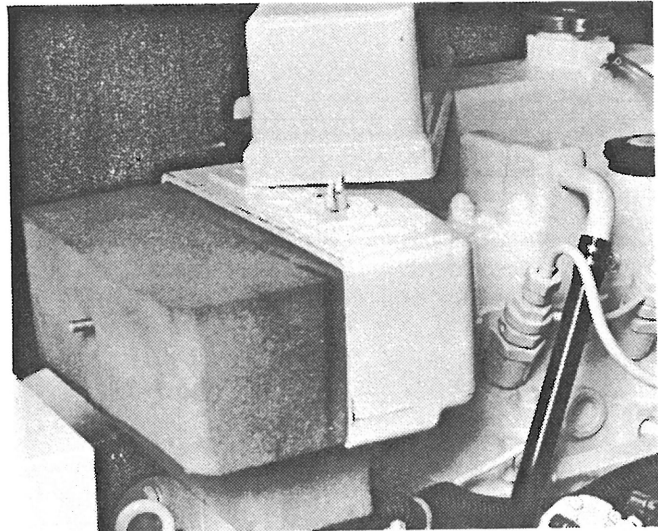


Figure 31 - Remove cap

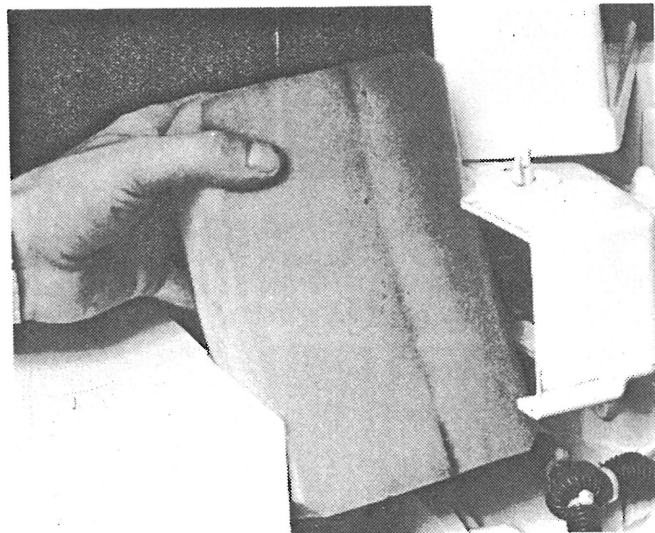


Figure 32 - Rotate 180°

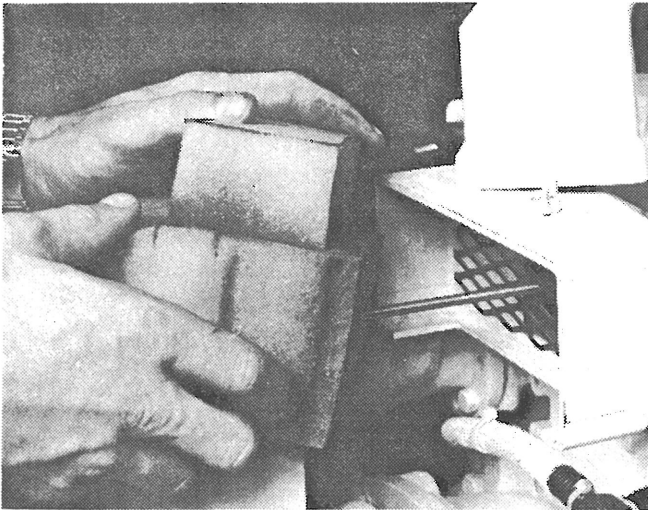


Figure 33 - Remove element. Wash in cleaning solvent or soap and water. Make sure screen is in place.

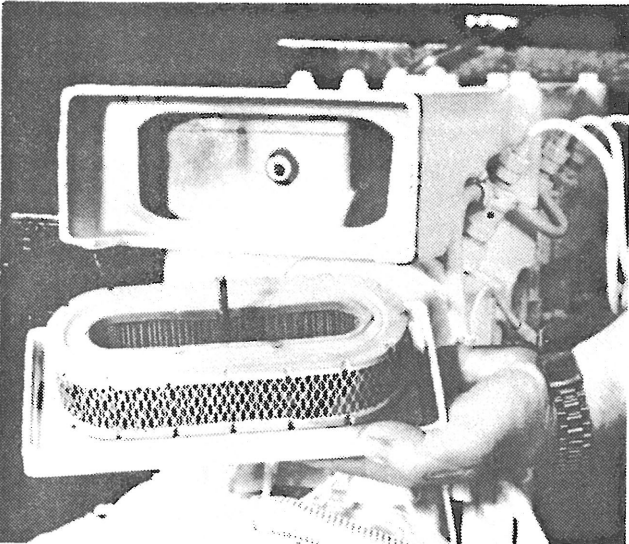


Figure 34 - Removing air filter, 892

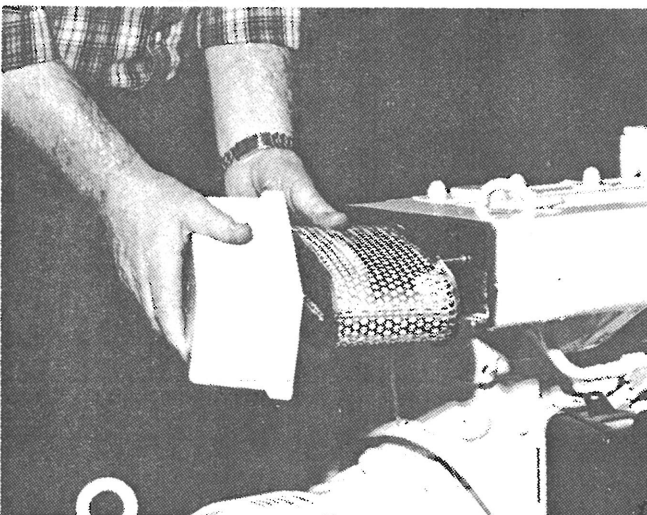


Figure 35 - Removing air filter, 843 and 854

5. CHECKING V-BELTS

Check the tension and wear on the vee-belts after every 50 hours of operation.

- The tension is correct if the belts can be depressed about $\frac{3}{4}$ " (17 mm) midway.
- Belts operating in pairs should be replaced in pairs even if only one of them is faulty.

6. RETIGHTEN CYLINDER HEAD BOLTS

After the first 50 hours of operation retighten the cylinder head bolts.

- Tighten bolts when the engine is cold.
- Loosen the nuts and remove the rocker arm cover.
- Tighten bolts sequentially in order shown. See figures 36 through 40.
- Tightening torque should be:

753

1 - 14 nuts 33 lb/ft - 36 lb/ft
(4.5 kg/m - 5.0 kg/m)

892

1 - 6 nuts 94 lb/ft - 98 lb/ft
(13.0 kg/m - 13.5 kg/m)

843

1 - 11 nuts 94 lb/ft - 98 lb/ft
(13.0 kg/m - 13.5 kg/m)
12 - 17 nuts 43 lb/ft - 47 lb/ft
(5.8 kg/m - 6.2 kg/m)

854

1 - 11 nuts 108 lb/ft - 112 lb/ft
(15.0 kg/m - 15.5 kg/m)
12 - 15 nuts 43 lb/ft - 51 lb/ft
(6.0 kg/m - 7.0 kg/m)

854A, 854B

1 - 18 nuts 94 lb/ft - 98 lb/ft
(13 kg/m - 13.5 kg/m)

NOTE: If you are tightening head bolts after replacing head gasket, etc., see service manual.

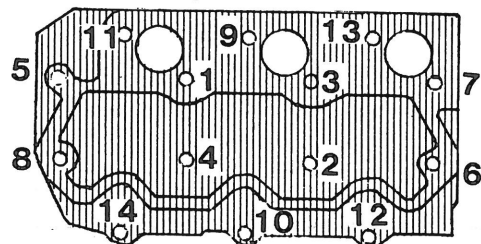


Figure 36 - Bolt tightening sequence, 753

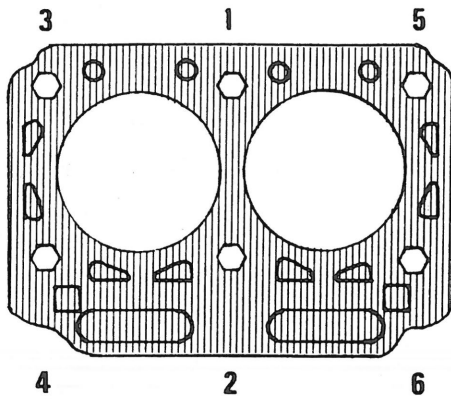


Figure 37 - Bolt tightening sequence, 892

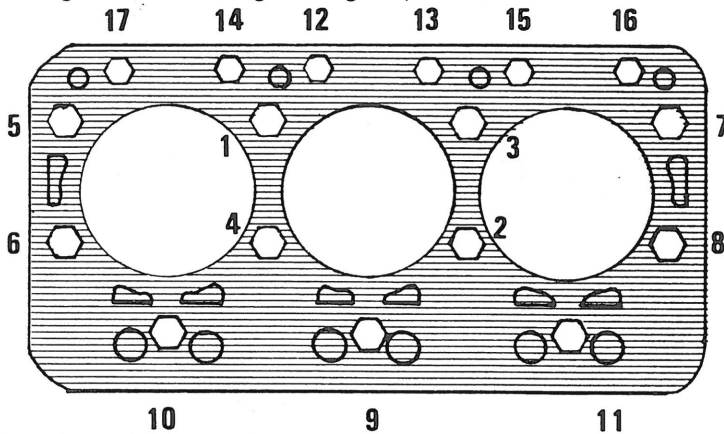


Figure 38 - Bolt tightening sequence, 843

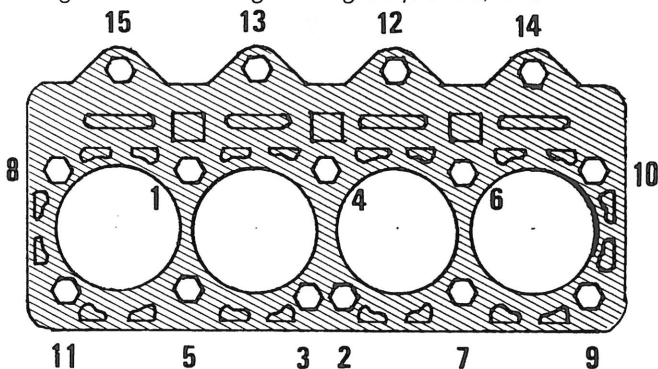


Figure 39 - Bolt tightening sequence, 854

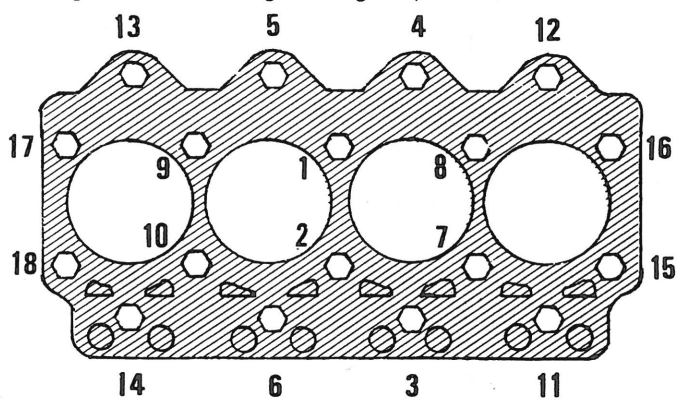


Figure 40 - Bolt tightening sequence, 854A, 854B

7. ADJUST VALVE CLEARANCE

Readjust the valve clearance after the first 50 hours of operation and every 600 hours thereafter.

- Valve clearance adjustment should be done after the cylinder head bolts have been tightened, and the engine is stopped.
- Watch the valves while turning the engine by hand. Turn until the inlet valve starts to open and the exhaust valve starts to close (the valves are "rocking"). Then turn the crankshaft one more turn and adjust the clearance for this cylinder.
- Loosen the nut and adjust the clearance of both the intake and exhaust valves with the adjust screw (figure 41).
- Each set of valves must be adjusted individually.
- Replace rocker arm cover and tighten nuts evenly.

Intake012 (0.3mm)
Exhaust012 (0.3mm)

The tightening torque should be:

43 in/lb - 68 in/lb (0.5 kg/m - 0.8 kg/m)

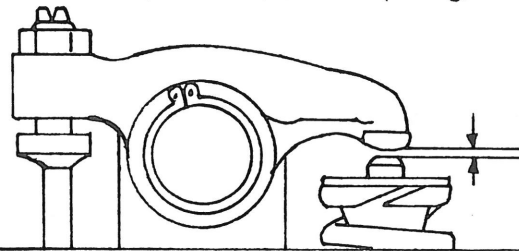


Figure 41 - Valve clearance

REVERSE GEAR

8. CHECKING THE OIL LEVEL

Check the oil level every day with the dipstick.

- If necessary, top off with the recommended oil.

HURTH GEARS

- Unscrew the hexscrew (dipstick) located on the top left side of the gear and remove dipstick.
- Insert the dipstick (do not screw in) to check oil level.
- The oil level should be up to the index mark on the dipstick.
- Reinsert and retighten hexscrew after the oil level check (do not forget sealing ring).

BORG WARNER GEARS

- Remove dipstick located on the top left side of the gear.
- The oil level should be up to the full level mark on the dipstick with the engine running.

9. CHANGING THE OIL

Change the oil at least once a year.

HURTH GEARS

ENGINE SERVICING

- Remove the oil drain plug found on the lower left side of the gear and drain oil.
- Refill with recommended oil.

BORG WARNER GEARS

- Insert a pipe down the oil dipstick hole. Attach the scavenging pump hose with the help of reduction nipple and pump out oil.
- Refill with recommended oil.

ALL GEARS

- After filling with oil, start the engine and run it at idle for a few minutes to make certain that the oil cooler (if applicable) and the various passages are full. If necessary, refill to the full mark on the dipstick.
- Recommended oil.**
ATF engine lubricating oil.

c. Capacities

Gear	US qts. (liters)
Hurth 50	.32 (.30)
100	.37 (.35)
150	.59 (.56)
Borg Warner (with oil cooler)	
1000	
AS71	2.6 (2.5)

NOTE: The quantity of oil depends upon the angle of installation.

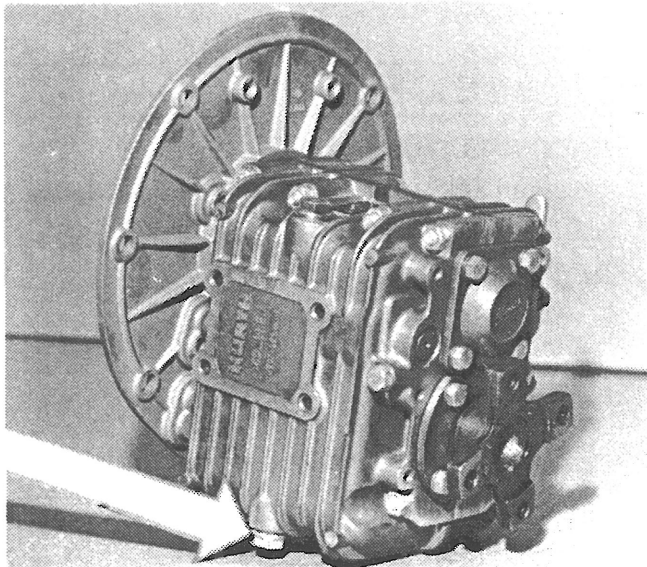


Figure 42 - Hurth 150

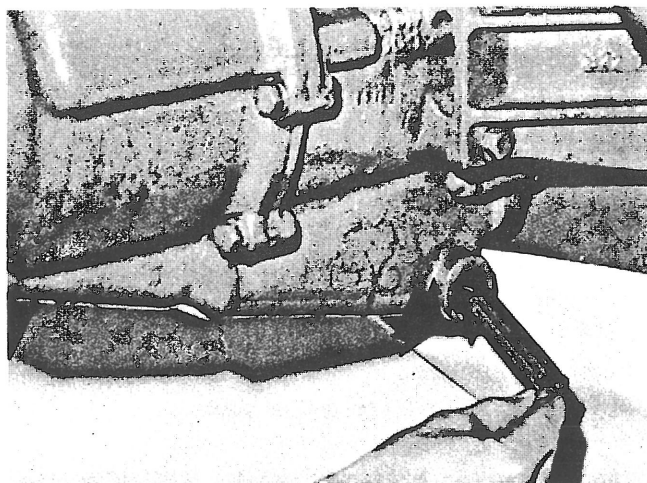


Figure 43 - Borg Warner oil change

FUEL SYSTEM

10. PRIMARY FUEL FILTER (Racor)

Check the primary fuel filter daily.

- Check the level of accumulated material in the bowl. Empty bowl as necessary.

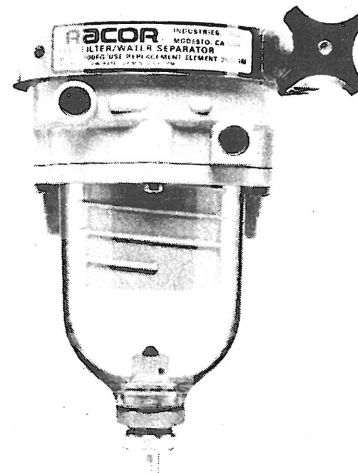


Figure 44 - Racor fuel filter, 200FG



Figure 44A - Racor fuel filter, 220

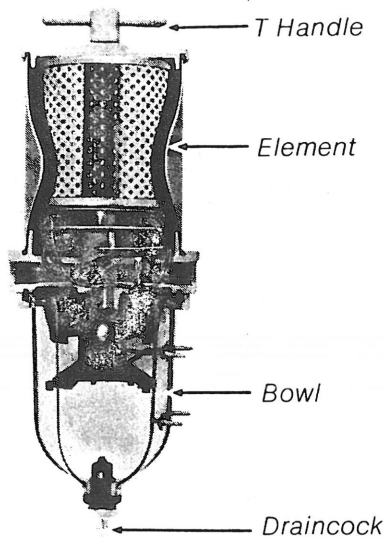


Figure 45 - Racor fuel filter, 500FG

11. CHANGE THE PRIMARY FUEL FILTER ELEMENT

- a. Change as necessary or every 200 hours running time.
- b. If bowl ever fills with water, change the element immediately.

12. SECONDARY FUEL FILTER

Check the secondary fuel filter visually every day.

- a. Drain if necessary (see figure 46).

13. CHANGE THE SECONDARY FUEL FILTER

- a. Replace fuel filter as necessary or every 600 hours of operation.
- b. If bowl fills with water, change filter immediately.

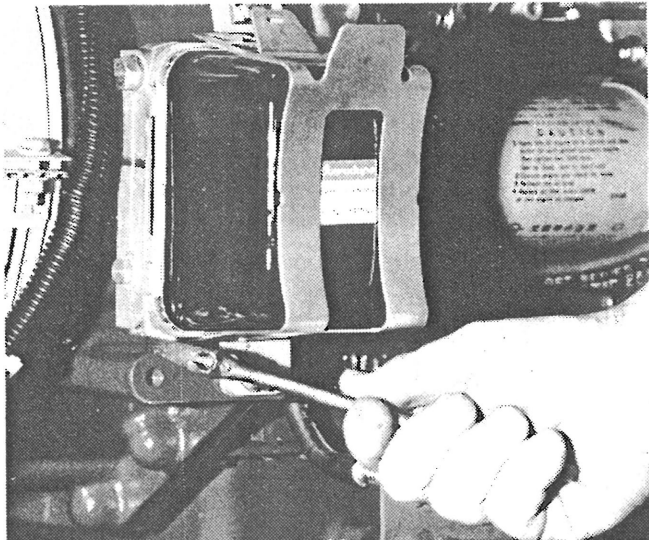


Figure 46 - Drain secondary fuel filter

14. BLEEDING THE FUEL SYSTEM

- a. The fuel system should be bled under the following circumstances:
 1. If a new filter element has been installed.
 2. If the engine has run out of fuel.

3. If the lines leading to or from the filter have been disconnected.
4. If the injection pump has been removed and reinstalled.
- b. Be sure there is adequate fuel in the fuel tank.
- c. Open the fuel shut-off valve.
- d. Open the bleed screw at the top of the fuel filter, (figure 47), and let the air bubbles escape from the screw while pumping the hand primer (figure 49). Close the bleed screw.
- e. For 753 open bleed cock (figure 48). All other units see figure 51, small pointers.
- f. Push the throttle to the full speed position (**LUGGER** engines). Turn the engine over for a few seconds to bleed the delivery lines.

NOTE: If the engine does not start after the above bleeding procedure, the fuel lines to each injector may have to be loosened while cranking the engine to complete bleeding of the system. Tighten lines at injectors after completing bleeding (figure 52).

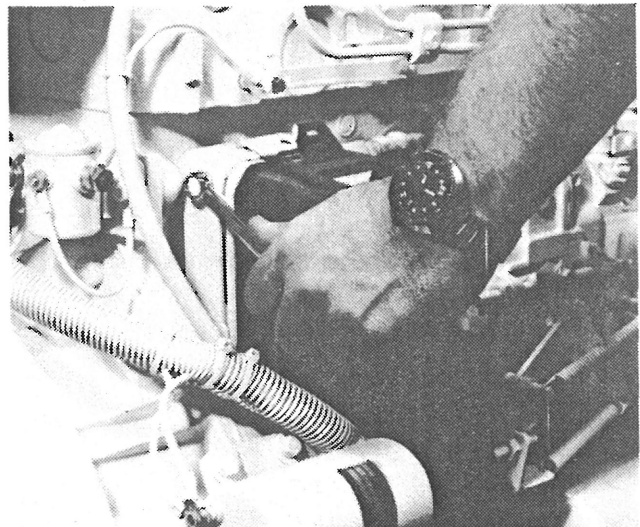


Figure 47 - Bleed screw, fuel filter.

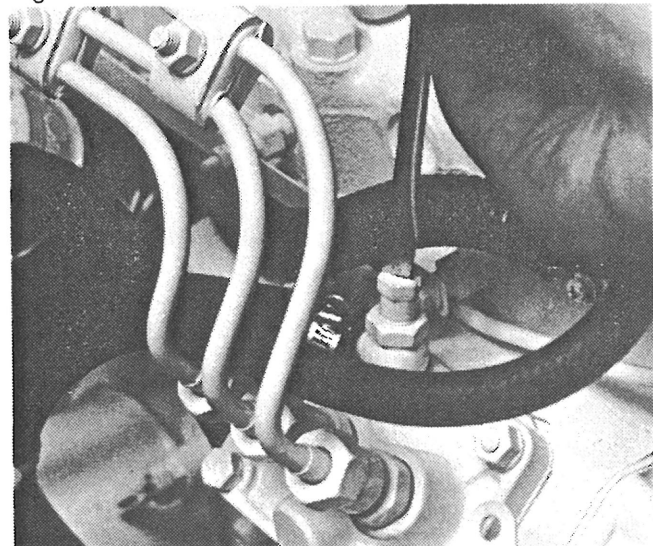


Figure 48 - Bleed cock, L - M 753

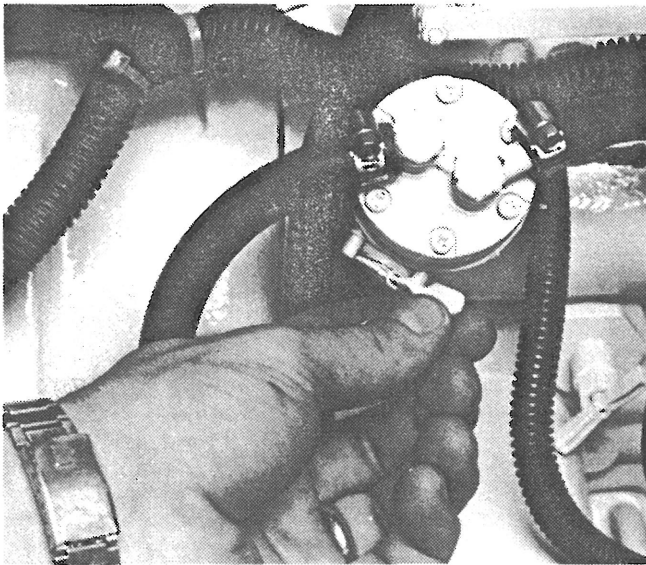


Figure 49 - Hand bled primer pump

CAUTION: Escaping fluid under pressure can penetrate skin. Use a piece of cardboard or wood, not your hands, to search for leaks. If injured by escaping fluid, see a doctor at once.

15. ADD OIL TO THE FUEL INJECTION PUMP after every 200 hours of operation (except 753).

NOTE: The fuel injection pump on the L-M 753 is lubricated automatically through the engine lubricating system.

L - M 843 & M 892

- Remove oil filler cap located on injection pump (figure 50).
- Pour in two pints of oil using the same type of oil as the engine oil. (The injection pump is self cleaning.)

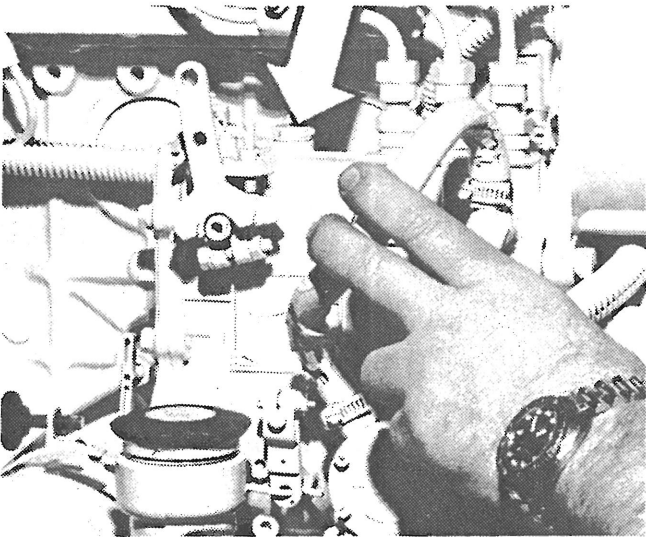


Figure 50 - Injection pump, 843 and 892

L - M 854A, 854B

- Remove the oil filler cap located on the injection pump (see figure 51, large arrow).

- Pour in two pints of oil using the same type of oil as the engine oil (the injection pump is self cleaning).

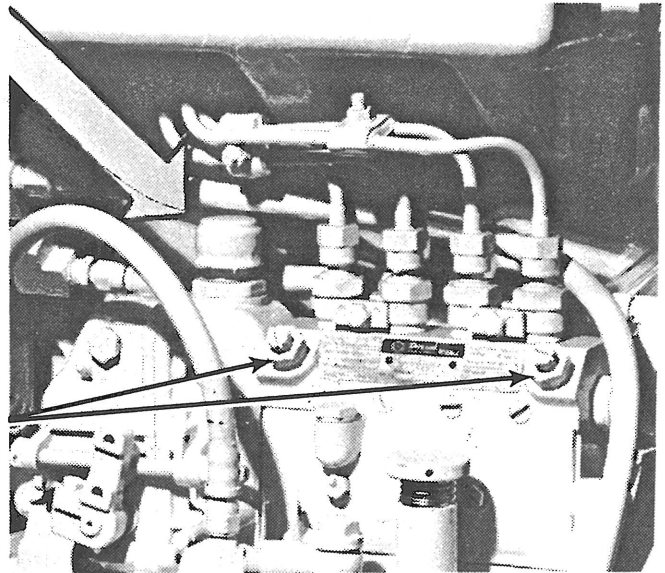


Figure 51 - Injection pump, 854A

16. CHECK INJECTORS

This check should be made by a Lugger or Northern Lights dealer or local injection repair station after every 600 hours of operation.

CAUTION: Escaping diesel fuel under pressure can have sufficient force to penetrate the skin causing serious personal injury. If injured by escaping fuel, see a doctor at once.

A. Removal

- Clean all loose dirt from around the injectors and injection lines.
- To relieve high pressure in the fuel system, slightly crack fuel injection line connectors at each injection nozzle (figure 52).
- Disconnect the delivery lines at the pump and injectors (figure 53). Cover the ends of the lines, the injector inlet and leak-off ports.
- Unscrew and remove the injectors (figure 54).

IMPORTANT: Do not use screw driver or pry bars to remove injection nozzles from cylinder head.

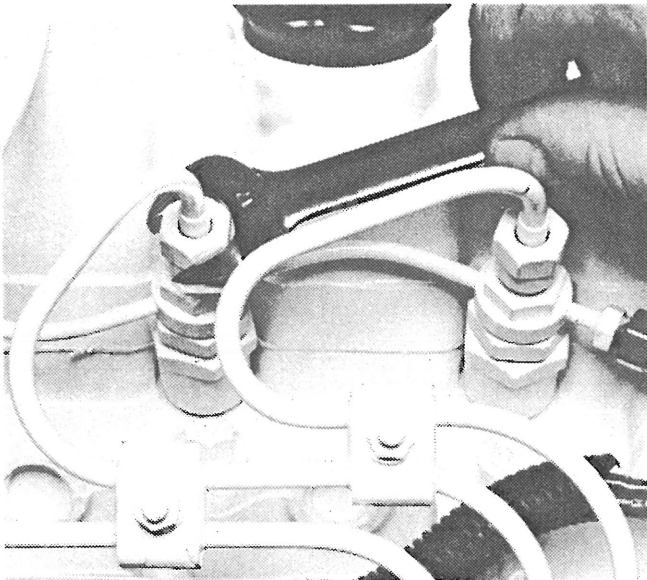


Figure 52 - Remove delivery line flare nuts.

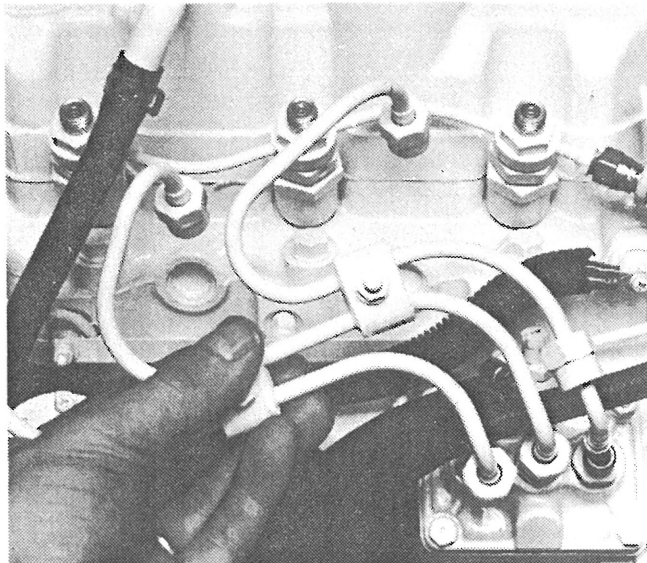


Figure 53 - Remove delivery lines.

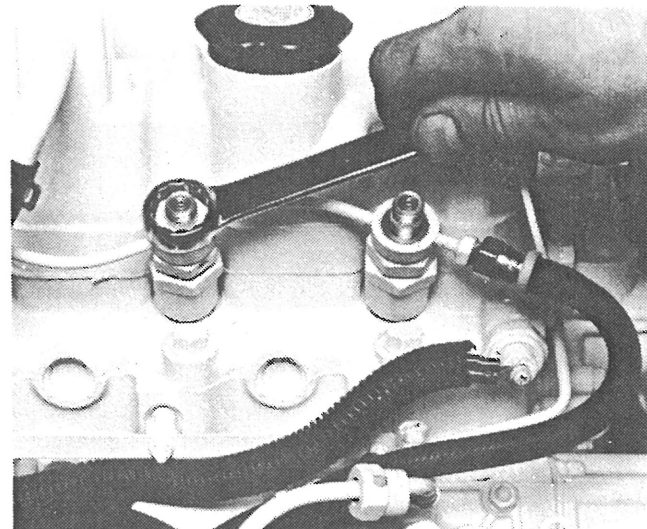


Figure 54 - Remove leak-off retaining nuts.

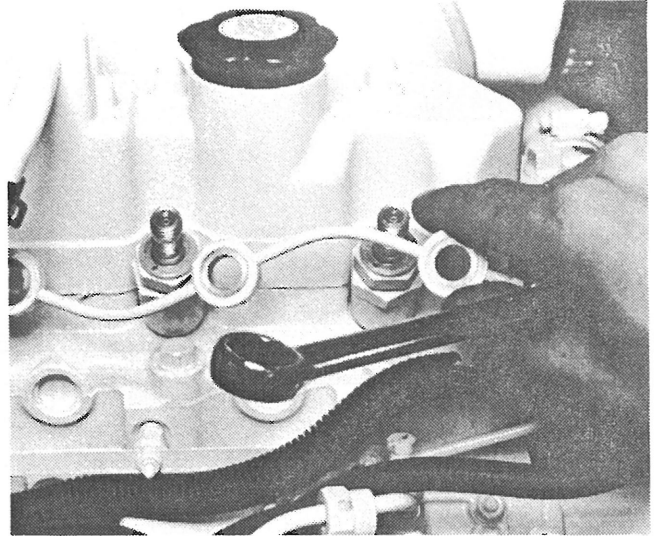


Figure 55 - Remove return line.

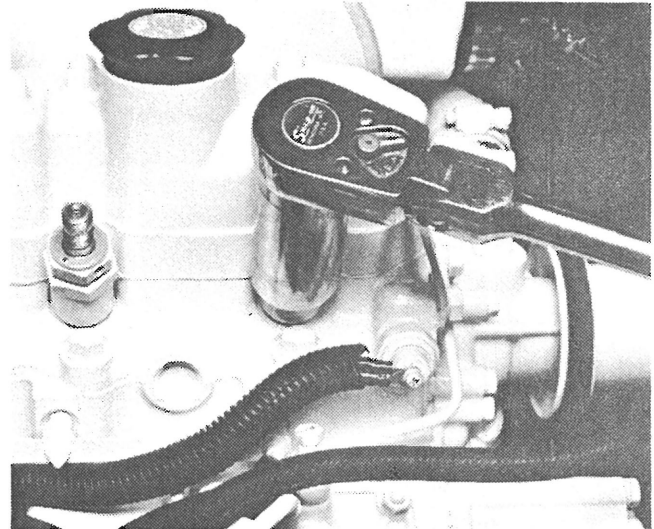


Figure 56 - Loosen injector.

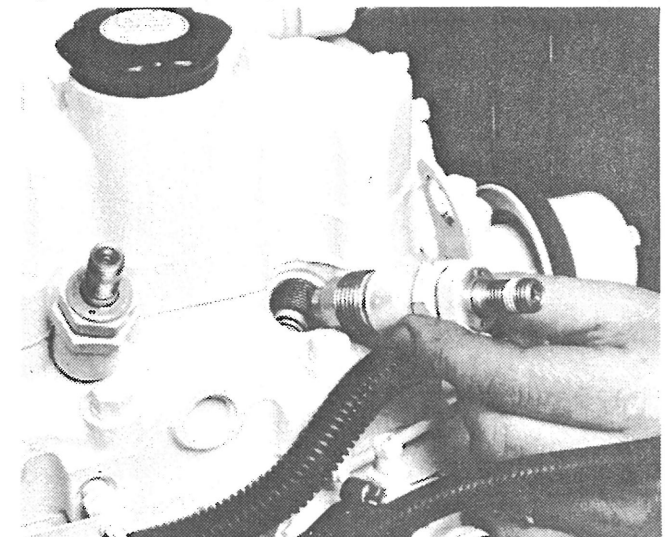


Figure 57 - Remove injector

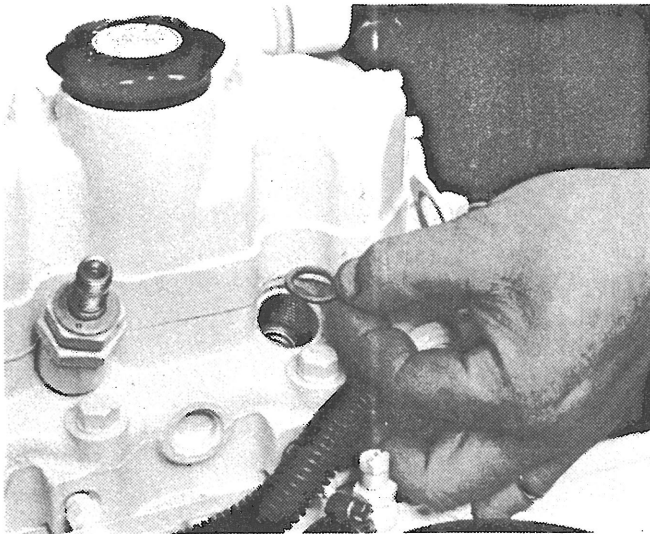


Figure 58 - Remove and replace copper sealing washer.

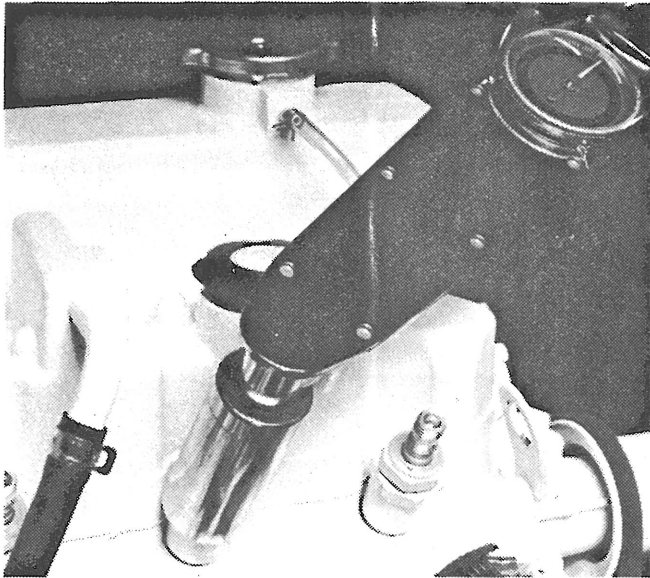


Figure 59 - Reinstall injector. Torque to proper tightness.

B. Repair and cleaning

1. After removing injectors, discard the copper sealing washers from the injector locating bores (figure 58). If a spare set of injectors is not immediately available, cover the bores to prevent the entry of dirt.
2. Take injectors to your local Lugger or Northern Lights dealer, or local injection repair station for test and service.
3. Clean the exterior of nozzle by soaking in clean solvent or diesel fuel. Then clean the spray tip with a brass wire brush.

C. Installation

1. Install a new copper sealing washer in each injector locating bore. Install the injectors and tighten the retaining nut to 43 to 51 lb/ft (58 to 69 Nm).

IMPORTANT: Do not overtighten the retaining nuts. Overtightening may distort the injector.

2. Install the injector lines. Finger tighten the fittings at the injectors until after bleeding the fuel system.
3. Install the leak-off line, using new copper sealing washers above and below each connection. Tighten the leak-off line bolts to 22 - 30 lb/ft (30 - 41 Nm).
4. Bleed the fuel system (pages 21 and 22).
5. Tighten the fitting at the injection pump to 18 - 22 lb/ft (24 - 30 Nm).

17. CHECKING THE FUEL INJECTION PUMP

This check should be made by a Lugger or Northern Lights dealer after 2400 hours of operation.

NOTES - IMPORTANT

- a. Service the fuel injection pump only if abnormal operation indicates a pump malfunction.
- b. Any repair work which involves disassembling the internal parts of the fuel injection pump must be carried out by specially trained mechanics with the proper tools and test devices at their disposal. **All guarantees on the engine become null and void if the seals are broken by unauthorized persons.**
- c. Since operating conditions vary considerably, it is difficult to give any definite interval, but as a rule the pump settings, max. and idling speeds, exhaust smoke, etc., should be checked after every 2400 hours of operation.
- d. Clean and check the injectors.
- e. The air cleaner should also be well cleaned.
- f. In order to ensure that the cylinders are evenly loaded, the fuel injection pump should be checked and, if necessary, adjusted on a test bench.

COOLING SYSTEM

Be sure to close the bottom valve and drain the cooling water before working on the cooling system.

18. CHECKING THE COOLING WATER LEVEL (see page 9).

Check this level each day before starting.

ATTENTION: OPEN THE FILLER CAP CAREFULLY WHEN THE ENGINE IS WARM.

- a. With a cold engine, the level should be about 1 3/4 (4 - 5 cm) below the sealing surface of the filler cap.
- b. A pressure radiator cap and one thermostat work to maintain proper engine operating temperature.

- c. The pressure valve in the radiator cap releases when the pressure is approximately 4 psi (27 bar).

19. CHECKING THE ZINC ELECTRODE

The zinc electrode should be checked after every 200 hours of operation.

NOTE: Model M 892 does not have zinc electrodes.

- a. Zinc electrodes are installed in the heat exchanger (see figure 60).
- b. Shut the bottom valve and drain the water before doing any work on the cooling system.
- c. Screw out the electrode and either scrape it or brush it clean with a steel brush. If more than 50% of the electrode is corroded away, replace with a new one.
- d. **Make sure there is good metal-to-metal contact between the electrode and the material when installing.**

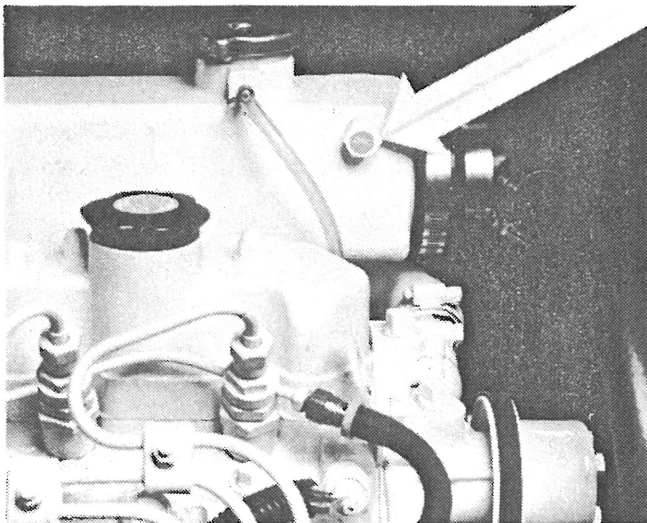


Figure 60 - 753 Zinc electrode.

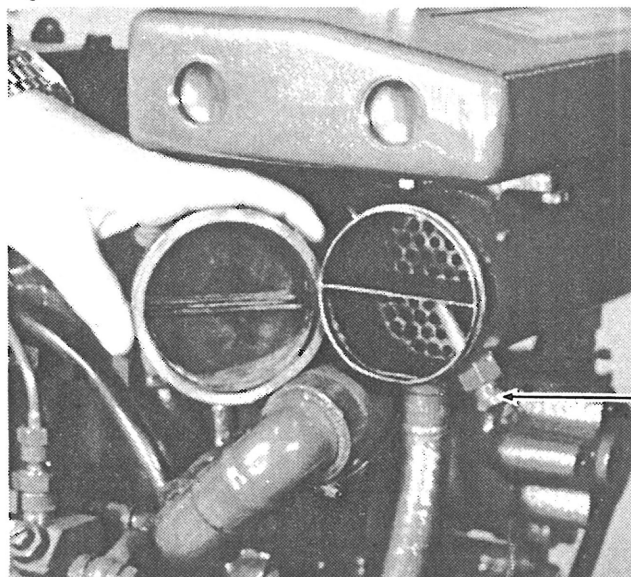


Figure 61 - 854 zinc electrode. 843 zinc electrode is in same position on opposite end of heat exchanger

20. SERVICING THE COOLING SYSTEM

Flush out the cooling system and check for leakage and blockage after every 600 hours or 12 months of operation, whichever comes first.

- a. Remove the expansion tank cap and open the drain cock at the engine block (and at exhaust manifold for L & M 843 and 854). See figures 62 through 66.

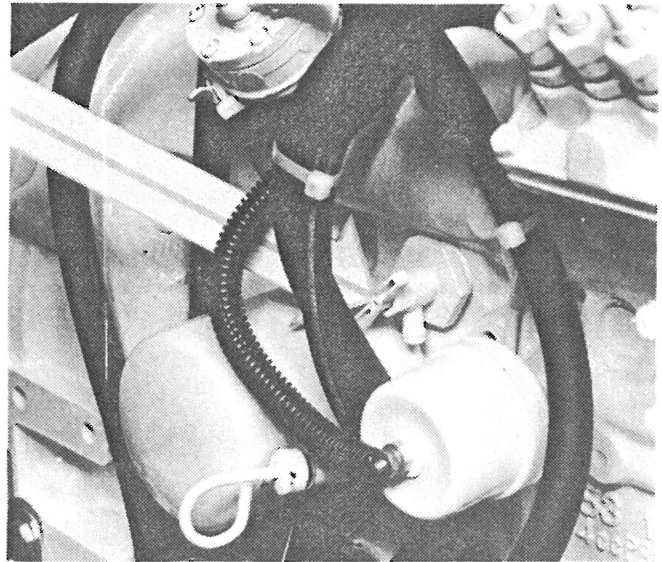


Figure 62 - Drain cock at engine block, 753

- b. Flush the cooling system with clean water until the system is free from discoloration and sediment.

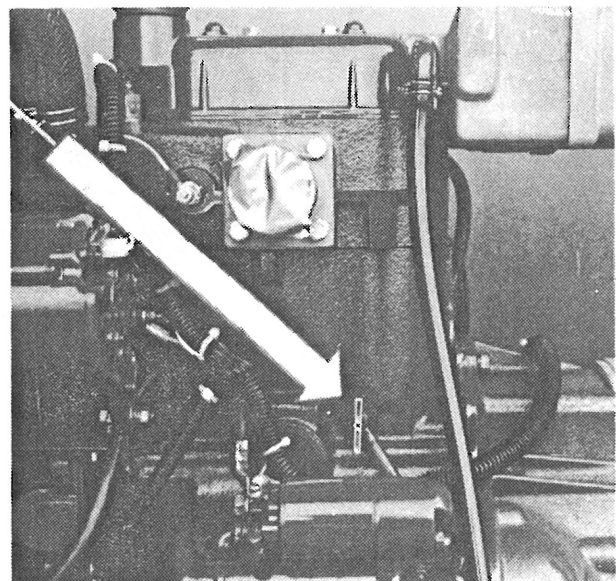


Figure 63 - Drain cock at engine block. 892

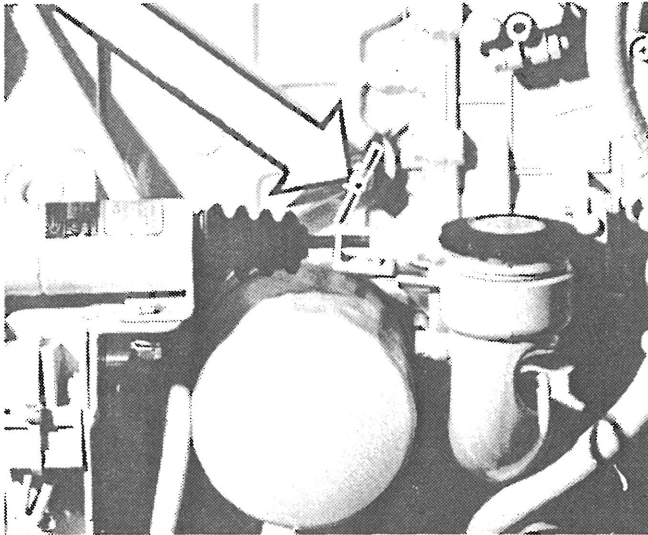


Figure 64 - Drain cock at engine block, 843

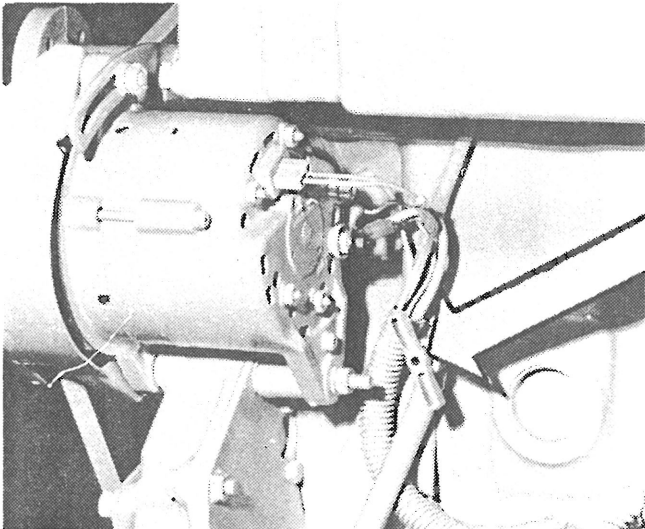


Figure 65 - Drain cock at engine block, 854A

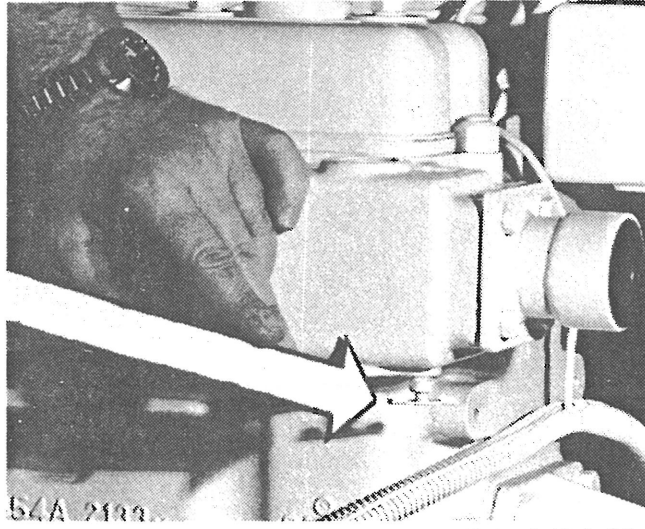


Figure 66 - Drain cock at exhaust manifold, 843 & 854

- c. If flushing is insufficient, remove and clean inserts in the heat exchanger (if applicable) and oil cooler.

- d. When cold weather is expected, fill the system with 50% anti-freeze (ethylene glycol type) and 50% water.
- e. When temperatures remain above freezing fill cooling system with water and add an engine coolant conditioner or equivalent to prevent rust and corrosion and provide lubrication to water pump.

21. CLEANING THE HEAT EXCHANGER

Clean the core once a year or after every 2400 hours of operation, whichever comes first.

- a. Loosen the clamps holding both rubber ends on to the heat exchanger housing (figure 67).
- b. Remove both rubber ends from heat exchanger housing (figures 68 and 69).
- c. Pull heat exchanger core out of housing on 753 only (figure 70). On the 843 and 854, clean the heat exchanger in place.

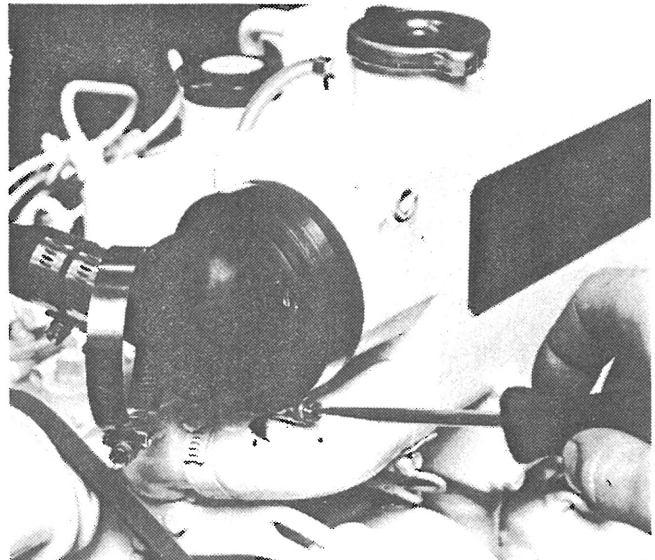


Figure 67 - Loosening clamps to heat exchanger (L-M753)

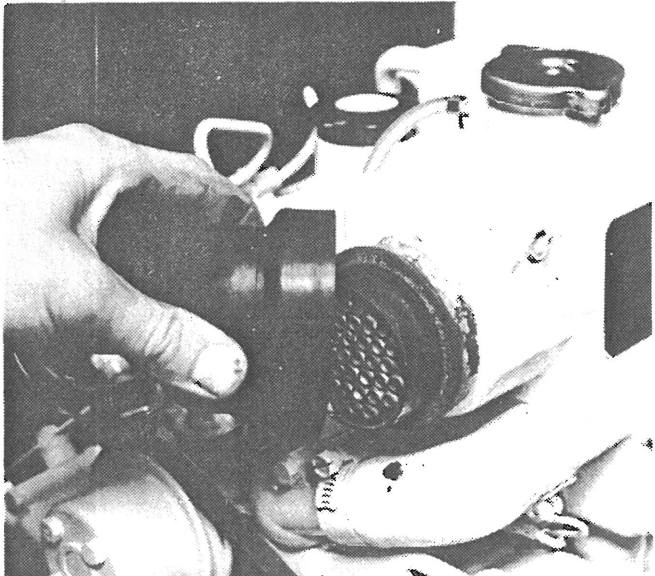


Figure 68 - Remove ends of heat exchanger (L-M753)

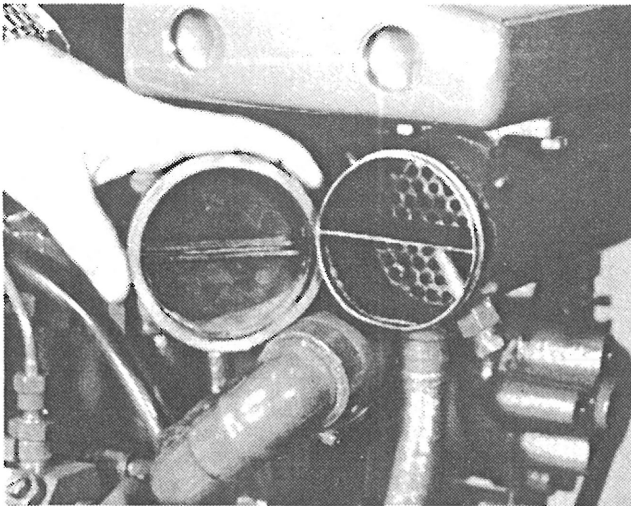


Figure 69 - End of heat exchanger, 843 and 854

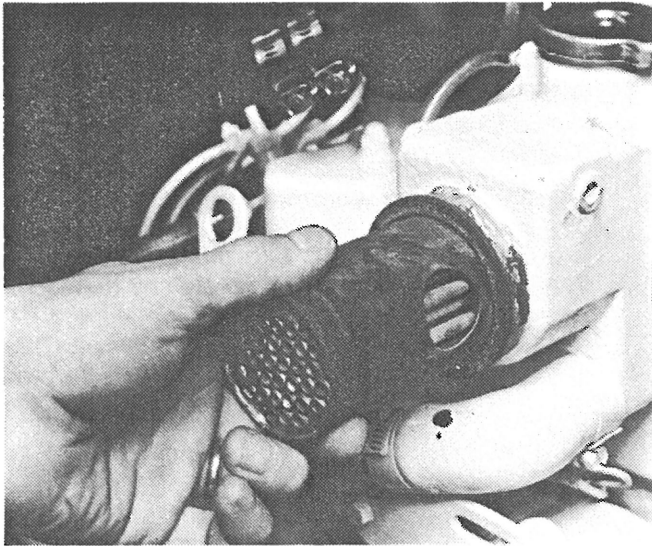


Figure 70 - Pull out core (L - M 753)

- d. Use cleaning rod to clean passages of heat exchanger element. Flush with water. Inspect and clean again if necessary.
- e. Clean accessible parts of the heat exchanger housing.
- f. Reassemble. Note: Be sure divider in 854 heat exchanger seats between the two lips in the rubber end (figure 69).

22. CLEANING OIL COOLERS

- a. **For reverse gear.** Clean the core once a year or after every 2400 hours of operation.
 1. Remove both the end covers and take out the core.
 2. Wash the core in diesel fuel and blow it dry with compressed air. Clean the end covers of the core with a steel brush and also the inside of the tubes. Clean the housing.
 3. Re-install using new sealing rings. If the oil cooler is to be pressure-tested, it should be removed from the engine.

23. CHANGING THE IMPELLER IN THE SEA-WATER PUMP

- a. Remove the pump end cover. Pry out the impeller with the help of two screwdrivers. Be sure you remove all pieces of a failed impeller.

ATTENTION: Place some kind of protection under the screwdrivers in order not to damage the housing.

- b. Clean the inside of the housing.
- c. Press in the new impeller, and place the sealing washers in the outer end of the impeller center if this has not been done already.
- d. Replace the cover using a new gasket.

Make sure that there is always an impeller and cover gasket in reserve on board vessel.

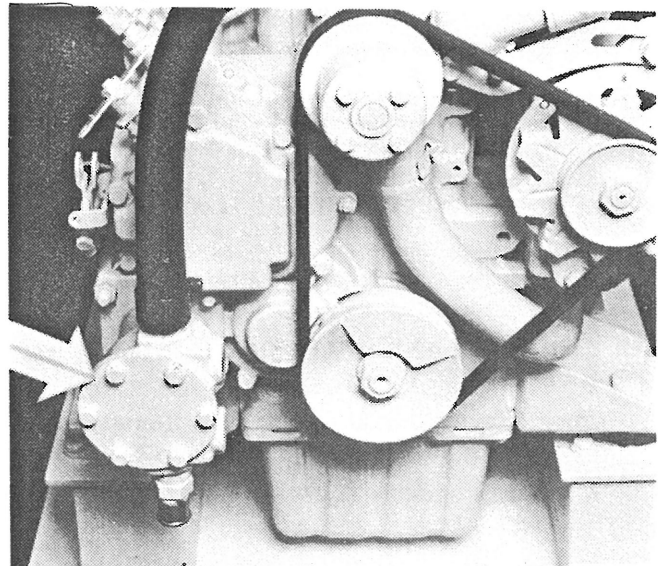


Figure 71 - Pump end cover, sea water pump

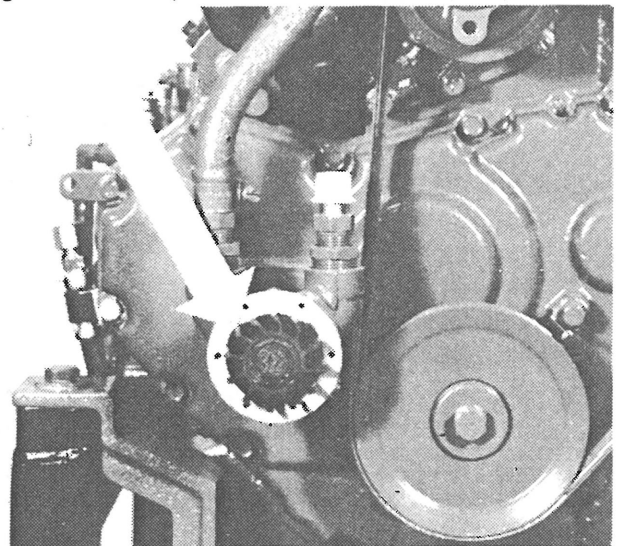


Figure 72 - Seawater pump impeller

ELECTRICAL SYSTEM

When servicing electrical system, disconnect battery.

24. CHECKING THE ELECTROLYTE LEVEL IN BATTERIES

Check this level after every 50 hours of operation.

- a. The level should be about $\frac{3}{8}$ " (10 mm) above the cell plates. Top with distilled water if necessary.

NOTE: Do not add water in freezing weather unless engine has been run two or three hours. During cold weather, keep electrolyte at proper level and keep batteries fully charged.

- b. Make sure the cable terminals are clean, properly fastened and greased.
 1. To remove corrosion around terminals, remove battery cables and wash terminals with ammonia solution or a solution consisting of $\frac{1}{4}$ pound (0.1 L) of baking soda added to 1 quart (0.9 L) of water.
 2. After cleaning, flush outside of battery, battery compartment and surrounding areas with clear water.

25. CHECKING THE STATE OF CHARGE OF THE BATTERIES

Check the state of charge of the batteries with an hydrometer after every 600 hours of operation.

- a. Check specific gravity of electrolyte in each battery cell.
- b. Hold the hydrometer vertically. Correct the reading by adding four gravity points (0.004) for every ten degrees the electrolyte temperature is above 80°F (27°C) or subtracting four gravity points for every ten degrees below 80°F (27°C).
- c. A fully charged battery will have a corrected specific gravity of 1.260. Charge battery if reading is below 1.215.

NOTE: In tropical areas, use a 1.225 full charge reading. In cold regions, use a 1.280 full charge reading.

26. CHECK OR CHANGE THE GLOWPLUGS AS NECESSARY

- a. Each cylinder is supplied with a glowplug which serves to heat the combustion chamber.
- b. To check the glowplugs, loosen the current carrying flat wire between the plug-poles of the glowplugs (figure 73). Connect a bulb between the plus-pole of the battery and the plus-pole of the glowplug. If the bulb lights up the glowplug is functioning.
- c. Check all glowplugs and replace faulty ones.

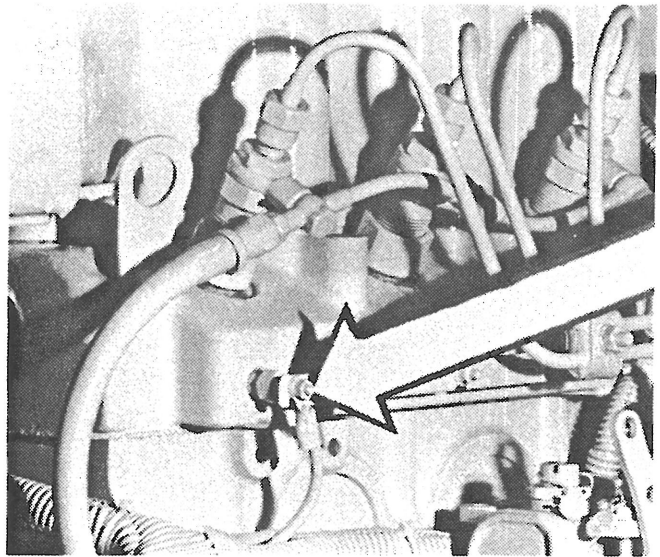


Figure 73 - Glowplug

WINTERIZING OUT-OF-SERVICE

27. PUTTING ENGINE OUT OF SERVICE

When there is risk of freezing weather, the seawater system of the cooling system should be drained to prevent cooling jackets and pipes from freezing. The fresh-water system should also be drained off or approved anti-freeze should be added. In climates where the temperature may drop to 32°F (0°C) at any time of the year it is suggested that anti-freeze be left in year round.

1. Draining

- a. Stop the engine, unscrew the filler cap and close the sea cock in the bottom of the boat.
- b. Open the drain cocks in the fresh-water and sea-water systems. There may also be cocks installed at the lowest points of the cooling water and exhaust lines.
- c. Unscrew the cover on the sea-water pump and the cover on any extra bilge pump (if installed).
- d. Make sure the cooling system is fully drained.
- e. If the cooling water lines have no drain cocks, it is advisable to remove the hoses connecting the lines so that the lines drain.

2. Anti-freeze for engine fresh-water system.

During the cold season suitable anti-freeze should be mixed with the cooling water in the fresh-water system.

- a. **Ethylene glycol with inhibitors** can be used. A minimum of 40% and a maximum of 60% glycol mixture will provide protection against freezing down to about -13 F (-25 C).
- b. Flush out the entire cooling system before adding anti-freeze. Check hoses and connections and repair any leakage.

TROUBLE SHOOTING - ENGINE

If you cannot correct engine trouble by using the following symptoms and solutions, see your **LUGGER** or **NORTHERN LIGHTS** dealer.

ENGINE HARD TO START OR WILL NOT START

Improper starting procedure (pages 10 and 11).

No fuel.

Low battery output.

Check electrolyte level and specific gravity of battery (pages 14 and 28).

Excessive resistance in starting circuit.

Clean and tighten all connections on batteries (pages 13, 14 and 28).

Crankcase oil too heavy.

Use oil of proper viscosity (pages 13).

Improper type of fuel.

Consult fuel supplier and use proper type of fuel for operating condition.

Water, dirt or air in fuel system.

Drain, flush, fill and bleed system (pages 21 and 22).

Clogged primary fuel filter element.

Clean or replace filter element (pages 20 and 21).

Clogged secondary fuel filter element.

Replace filter element (page 21).

Dirty or faulty injection nozzles.

Have your dealer check injection nozzles (pages 22 - 24).

Fuel pump primer lever left on upward end of stroke.

ENGINE RUNS IRREGULARLY OR STALLS FREQUENTLY

Below normal engine temperature.

Remove and check thermostat. See parts manual for location of thermostats.

Defective temperature gauge.

Check water temperature with thermometer and replace gauge if necessary.

Clogged primary fuel filter element.

Clean or replace filter element (pages 20 and 21).

Clogged secondary fuel filter element.

Replace secondary filter element (page 21).

Water, dirt, or air in fuel system.

Drain, flush and bleed system (pages 21 and 22).

Dirty or faulty injection nozzles.

Have your dealer check injection nozzles (pages 22 - 24).

Inspect clamps and hoses. Replace if necessary.

Use only approved parts.

Improper type of fuel.

Consult fuel supplier and use proper type of fuel for operating condition (page 13).

LACK OF ENGINE POWER

Engine overloaded.

Reduce load.

Intake air restriction.

Service air cleaner (pages 17 and 18).

Clogged primary fuel filter element.

Clean or replace filter element (pages 20 and 21).

Clogged secondary fuel filter element.

Replace filter element (page 21).

Improper type of fuel.

Consult fuel supplier and use proper type of fuel for operating conditions (page 13).

Overheated engine.

See "Engine Overheats".

Below normal engine temperature.

Remove and check thermostat. See parts manual for location of thermostats.

Improper valve clearance.

See your local dealer (page 19).

Dirty or faulty injection nozzles.

See your local dealer (pages 22 - 24).

Injection pump out of time.

See your local dealer (page 24).

Improper propeller.

Consult your dealer.

Grass, etc. on bottom of boat (page 12).

Use only approved parts.

ENGINE OVERHEATS

Engine overloaded.

Reduce load.

Check propeller size (page 31).

Low coolant level.

Fill tank to proper level (page 9).

Check hoses for loose connections and leaks.

Keel cooling tubes have been painted.

Cooling system needs flushing (pages 25 and 26).

Defective thermostat.

Remove and check thermostat. See parts manual for location of thermostats.

Defective temperature gauge.

Check water temperature with thermometer and replace gauge if necessary.

Water pump impeller worn or broken, H.E. engine (page 27).

ENGINE KNOCKS

Insufficient oil.

Call your dealer.

Injection pump out of time.

Call your dealer (page 24).

Below normal engine temperature.

Check your thermostats. See parts manual for location of thermostats.

Check water temperature with thermometer to see if temperature gauge is working properly.

Engine overheating.

See "Engine Overheating" section above.

HIGH FUEL CONSUMPTION

Improper type of fuel (page 13).

Clogged or dirty air cleaner.

Service air cleaner (pages 17 and 18).

Engine overloaded.

Reduce load.

Check propeller size (page 31).

Grass, etc. on bottom of boat (page 12).

Improper valve clearance.

See your dealer (page 19).

Injection nozzles dirty.

See your dealer (pages 22 - 24).

Injection pump out of time.

See your dealer (page 24).

Engine not at proper temperature.

Check your thermostats. See parts manual for location of thermostats.

Check water temperature with thermometer to see if temperature gauge is working properly.

BELOW NORMAL ENGINE TEMPERATURE

Thermostats not working properly.

Check thermostats. See parts manual for location of thermostats.

Temperature gauge not working properly.

Check water temperature by sticking a gauge into water.

LOW OIL PRESSURE

Low oil level (pages 9, 10 and 14).

Improper type of oil.

Drain and fill crankcase with correct oil (pages 9, 10, 13 and 14).

Partially plugged oil filter.

Replace filter (pages 20 and 21).

HIGH OIL CONSUMPTION

Break-in period (pages 12 and 13).

Crankcase oil too light.

Use proper viscosity oil (pages 13).

Oil leaks.

Check for leaks in lines around gaskets and drain plug.

Engine overheats.

See "Engine Overheats" above.

ENGINE EMITS BLACK OR GRAY EXHAUST SMOKE

Clogged or dirty air cleaner.

Service air cleaner (pages 17 and 18).

Defective muffler (back pressure too high.)

Improper fuel (page 13).

Engine overloaded.

Reduce load.

Check propeller size (page 31).

Injection nozzles dirty.

See your dealer (pages 22 - 24).

Engine out of time.

See your dealer.

ENGINE EMITS WHITE SMOKE

Improper fuel (page 13).

Cold engine.

Warm up engine to normal operating temperature (pages 11 and 12).

Defective thermostat.

Remove and check thermostat. See parts manual for location of thermostats.

Engine out of time.

See your dealer.

TROUBLE SHOOTING - ELECTRICAL SYSTEM

If you cannot correct electrical trouble by using the following symptoms and solutions, see your **LUGGER** or **NORTHERN LIGHTS** dealer. Additional generator trouble shooting is in the generator operator's manual.

BATTERY WILL NOT CHARGE

Loose or corroded connections.

Clean and tighten battery connection (pages 13, 14 and 28).

Sulfated or worn-out batteries.

Check specific gravity of each battery (page 28).

Check electrolyte level of each battery (page 28).

Defective electrical system ground wire.

Repair or replace.

STARTER CRANKS SLOWLY

Low battery output.

Batteries too small.

Battery cable too small.

Check specific gravity of each battery (page 28).

Check electrolyte level of each battery (page 28).

Crank case oil too heavy (page 13).

Loose or corroded connections.

Clean and tighten loose connections.

ENTIRE ELECTRICAL SYSTEM DOESN'T FUNCTION

Faulty battery connection.

Clean and tighten batteries.

Sulfated or worn-out batteries.

Check specific gravity and electrolyte level of each battery (page 28).

TECHNICAL DATA

TECHNICAL DATA - TRANSMISSIONS

TRANSMISSIONS	L753	L843	L854
HURTH HBW 50	●		
2:1	●		
2.7:1			
HURTH HBW 100		●	
1.5:1		●	
1.8:1		●	
2.7:1		●	
HURTH HBW 150			●
1.6:1			●
1.9:1			●
2.6:1			●
HURTH HBW 150 V-DRIVE		●	●
1.8:1		●	●
2:1		●	●
3:1		●	●
BORG WARNER 1000		●	●
1.59:1		●	●
2.13:1		●	●
2.41:1		●	●
BORG WARNER AS-71 OR AS-71 V-DRIVE		●	●
1.52:1		●	●
2.10:1		●	●
2.57:1		●	●
2.91:1		●	●

PROPELLER SIZING CHART (For approximate propeller sizes for Lugger powered boats.)

Boat Speed (knots)	15 - 18	14 - 17	13 - 15	12 - 14	10 - 13
Gear	1:1	1.5:1	2:1	2.5:1	3:1
854 - D 40 @ 2500	12 x 12 2500 RPM	15 x 15 1666 RPM	18 x 18 1250 RPM	20 x 18 1000 RPM	23 x 20 833 RPM
Boat Speed (knots)	For boats in 6 to 8 knot range.				
Gear	1:1	1.5:1	2:1	2.5:1	3:1
753 18 @ 2800	9 x 7 2B 10 x 6 3B 2800 RPM	11 x 9 2B 12 x 8 3B 1866 RPM	13 x 13 2B 14 x 10 3B 1400 RPM	16 x 12 3B 1120 RPM	17 x 15 3B 933 RPM
843 - D 24 @ 2500	11 x 11 2B 12 x 10 3B 2500 RPM	13 x 13 2B 14 x 12 3B 1666 RPM	16 x 16 2B 17 x 14 3B 1250 RPM	18 x 18 3B 1000 RPM	20 x 18 3B 833 RPM

NOTE: 2B is a 2 bladed propeller, 3B is a 3 bladed propeller.

TECHNICAL DATA

SPECIFICATIONS Model Number	753	892	843	854A	854B
Cylinders	3	2	3	4	4
Displacement	58.2 cu. in. (.95 L)	77 cu. in. (1.27 L)	85 cu. in. (1.4 L)	130 cu. in. (2.13 L)	140 cu. in. (2.27 L)
Cycle	4	4	4	4	4
Bore	2.95 in. (75 mm)	3.54 (90 mm)	3.31 in. (84 mm)	3.35 in. (85 mm)	3.35 in. (85 mm)
Stroke	2.83 in. (72 mm)	3.93 in. (100 mm)	3.31 in. (84 mm)	3.70 in. (94 mm)	3.94 in. (100 mm)
Rotation (facing flywheel)	counter- clockwise	counter- clockwise	counter- clockwise	counter- clockwise	counter- clockwise
Compression Ratio	23 to 1	23 to 1	23 to 1	22 to 1	22 to 1
Aspiration	Natural	Natural	Natural	Natural	Natural
Flywheel housing	SAE 5	SAE 5	SAE 5	SAE 5	SAE 5
Flywheel drive size	6 in. (152.4 mm)	6 in. (152.4 mm)	6 in. (152.4 mm)	6 in. (152.4 mm)	6 in. (152.4 mm)
Lugger weight w/o gear approx. keel cooled	270 lbs. (122 kg)	—	460 lbs. (209 kg)	609 lbs. (277 kg)	609 lbs. (277 kg)
Lugger weight w/o gear approx. heat exchanger	285 lbs. (129 kg)	—	350 lbs. (159 kg)	625 lbs. (284 kg)	625 lbs. (284 kg)
Northern Lights weight approx. keel cooled	475 lbs. (215 kg)	705 lbs. (319 kg)	700 lbs. (317 kg)	970 lbs. (440 kg)	970 lbs. (440 kg)
Northern Lights weight approx. heat exchanger	500 lbs. (229 kg)	730 lbs. (330 kg)	725 lbs. (328 kg)	995 lbs. (451 kg)	995 lbs. (451 kg)
INSTALLATION DATA Cooling					
Cooling capacity approx. heat exchanger	1 gal. (3 L)	2.1 gal. (8 L)	2.6 gal. (10 L)	3.1 gal. (12 L)	3.1 gal. (12 L)
Minimum through hull diameter heat exchanger cooling	¾ in. (20 mm)	¾ in. (20 mm)	¾ in. (20 mm)	¾ in. (20 mm)	¾ in. (20 mm)
Minimum seawater discharge heat exchanger cooling	¾ in. (20 mm)	¾ in. (20 mm)	¾ in. (20 mm)	¾ in. (20 mm)	¾ in. (20 mm)
Fresh water pump capacity at 2500 RPM	9.5 gpm (35.9 lpm)	—	15.8 gpm (60 lpm)	15.8 gpm (60 lpm)	15.8 gpm (60 lpm)
Fresh water pump capacity at 1800 RPM	6.1 gpm	13.2 gpm	13.3 gpm	11.4 gpm	11.4 gpm
Maximum seawater pump head	39 in. (1 m)	39 in. (1 m)	39 in. (1 m)	39 in. (1 m)	39 in. (1 m)
Keel cooler tube length (round tube)	6 ft. (1.8 m)	8 ft. (2.6 m)	8 ft. (2.6 m)	14 ft. (4.3 m)	14 ft. (4.3 m)
Keel cooler head diameter	1 in. NPT (25.4 mm)	1 in. NPT (25.4 mm)	1 in. NPT (25.4 mm)	1 in. NPT (25.4 mm)	1 in. NPT (25.4 mm)
Keel cooler water hose ID discharge and suction	1 ¼ in. (30 mm)	1 ¼ in. (30 mm)	1 ¼ in. (30 mm)	1 ¼ in. (30 mm)	1 ¼ in. (30 mm)

TECHNICAL DATA (Continued)

Electrical	753	892	843	854A	854B
Minimum battery capacity	70 amp hr.	70 amp hr.	70 amp hr.	100 amp hr.	100 amp hr.
Battery cable size	#2 up to 10 ft.	#0 up to 10 ft.	#0 up to 10 ft.	#0 up to 10 ft.	#0 up to 10 ft.
Instrument harness length (standard)	20 ft. (6.1 m)	20 ft. (6.1 m)	20 ft. (6.1 m)	20 ft. (6.1 m)	20 ft. (6.1 m)
Starting voltage DC	12 (neg. ground)	12 (neg. ground)	12 (neg. ground)	12 (neg. ground)	12 (neg. ground)
Air					
Air consumption Lugger	36 cfm @ 2800 (1.01 m ³ /min.)	30 cfm. @ 2500 (.83 m ³ /min.)	50 cfm @ 2500 (1.4 m ³ /min.)	75 cfm @ 2500 (2.1 m ³ /min.)	75 cfm @ 2500 (2.1 m ³ /min.)
Air consumption Northern Lights @ 1800 RPM	24 cfm (.67 m ³ /min.)	22 cfm (.60 m ³ /min.)	35 cfm (.97 m ³ /min.)	54 cfm (1.5 m ³ /min.)	54 cfm (1.5 m ³ /min.)
Minimum engine room vent	13 sq. in. (84.5 cm ²)	13 sq. in. (84.5 cm ²)	22 sq. in. (143 cm ²)	35 sq. in. (230 cm ²)	35 sq. in. (230 cm ²)
Maximum exhaust back pressure	30 in. H ₂ O (75 cm.)	30 in. H ₂ O (75 cm)	30 in. H ₂ O (75 cm)	30 in. H ₂ O (75 cm)	30 in. H ₂ O (75 cm)
Wet exhaust ID	2 in. (50 mm)	2 in. (50 mm)	2 in. (50 mm)	2 in. (50 mm)	2 in. (50 mm)
Dry exhaust ID	1½ in. (38.1 mm)	1½ in. (38.1 mm)	1½ in. (38.1 mm)	1½ in. (38.1 mm)	1½ in. (38.1 mm)
Maximum engine angle (front down) (rear down – underway)	0 degrees 15 degrees	15 degrees 15 degrees	15 degrees 15 degrees	15 degrees 15 degrees	15 degrees 15 degrees
Fuel					
Minimum suction line	¼ in. (6.35)	¼ in. (6.35)	¼ in. (6.35)	¼ in. (9.53)	¾ in. (9.53)
Minimum return	¼ in. (6.35)	¼ in. (6.35)	¼ in. (6.35)	¾ in. (9.53)	¾ in. (9.53)
Maximum fuel pump head – suction	39 in. (1 m)	39 in. (1 m)	39 in. (1 m)	39 in. (1 m)	39 in. (1 m)
PERFORMANCE DATA*					
Rated flywheel HP	18.2 hp (13.4 kw) @ 2800 RPM	—	26 hp (19 kw) @ 2500 RPM	41 hp (31 kw) @ 2500 RPM	41 hp (31 kw) @ 2500 RPM
Propeller shaft HP @ 2500 RPM	17.5 pshp	—	25 pshp	40 pshp	40 pshp
Generator rating @ 1800 RPM	8.0 kw (60 hz)	10 kw (60 hz)	12 kw (60 hz)	20 kw (60 hz)	20 kw (60 hz)
Generator rating @ 1200 RPM	—	—	—	12 kw (60 hz)	12 kw (60 hz)
Maximum torque @ flywheel	39 ft. lbs. 1800 RPM	55 ft. lbs. 2000 RPM	58 ft. lbs. 1600 RPM	90 ft. lbs. 2000 RPM	90 ft. lbs. 2000 RPM
Specific fuel consumption lbs/hp @ 2800 RPM - maximum load	.478	—	.451	.435	.435
Specific fuel consumption lbs/hph @ 1800 RPM – maximum load	.458	.429	.464	.444	.444
Approximate fuel rate gph @ 2800 RPM – maximum load	1.22	—	1.65	2.52	2.52
Approximate fuel rate gph @ 1800 RPM – 8.0 kw	.94	.98	1.2	1.9	1.9

*Ratings are based on SAE J270 with diesel fuel specific gravity of 0.837 at 60° F (15.5° C)

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