FORM.: 977.612

REVISED: JAN 2001

SABB L DIESEL

OPERATORS HANDBOOK

FOR

L2.093GR

L3.139GR/HVP

L4.186GR/HVP

L4.186TGR/HVP

SABB MOTOR A.S

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GENERAL PRECAUTIONS

- Ensure that the engine is securely mounted.
- Ensure that the ventilation and combustion air ducts are not obstructed.
  Keep the engine and surrounding areas clean.
- Never allow any part of the body to come into contact with high pressure fuel oil when testing injection equipment.
- Avoid contact with exhaust pipe when the engine is, or has recently been running. These parts can be very hot and can cause severe burns.
- Keep all safety guards in position.
- Keep the body and clothing clear of all moving or hot parts.
- Rectify all fuel, water and oil leaks as soon as possible.
- Isolate the battery when working on the engine.
- All drive belts must receive regular attention.
- Keep electrical contacts free from corrosion etc by smearing them with petroleum jelly.
- Batteries under charge release explosive gases, therefore the battery compartment must be well ventilated at all times. Never allow any smoking, sparks or flames near the batteries.
- Wear protective goggles when handling liquids which are harmful to the eyes, for ex. battery acid. If any of these substances are splashed in the eyes, wash out thoroughly with clean water.
- Many liquids used in engines are harmful if taken internally. In the event of accidentally swallowing oil, fuel, anti-freeze or battery acid obtain medical assistance immediately.

LIFTING PRECAUTIONS

The following points must be considered before attempting to lift the engine.

- Ensure the lifting equipment to be used has the correct capacity to lift the engine.
- Single lifting equipment must only be used when a single lifting eye is fitted.
- When two engine lifting eyes are fitted suitable lifting equipment designed to give two vertical lifts from directly above the engine lifting eyes must be used.
- Check that the engine lifting eyes are not damaged and that they are secure.
- To prevent damage to the cylinder head cover ensure that there is clearance between the lifting equipment hooks and the cover.
- The lifting eyes fitted to the engine are suitable for lifting the engine, and gearbox if fitted, and accessory assemblies originally fitted by Lister-Petter.

INTRODUCTION

The SABB-L-DIESEL, type L2.093, L3.139, L.4.186 and l4.186-T are based upon the LISTER PETTER engine types LPW2, LPW3 and LPWT4, and are adapted to requirements for marine use.

It is essential that the operators read carefully the main points in this manual before the engine is put into service.
Reference is made to:

"CHECKS BEFORE STARTING", "STARTING", "OPERATION" and "STOP".

The information, specifications, illustrations, instructions and statements contained within this publication are given with our best intentions and are believed to be correct at the time going to press. Our policy is one of continued development and we reserve the right to amend any technical information with or without prior notice.

Whilst every effort is made to ensure the accuracy of the particulars contained within this publication neither the Manufacturer, Distributor or Dealer shall in any circumstances be held liable for any inaccuracy or the consequences thereof.

Users of this book are advised that the specification details apply to a range of engines and not to any one particular engine. In cases of difficulty consult SABB MOTOR A.S, BERGEN, NORWAY or a local SABB MOTOR or Lister-Petter Distributor for further advice and technical assistance.

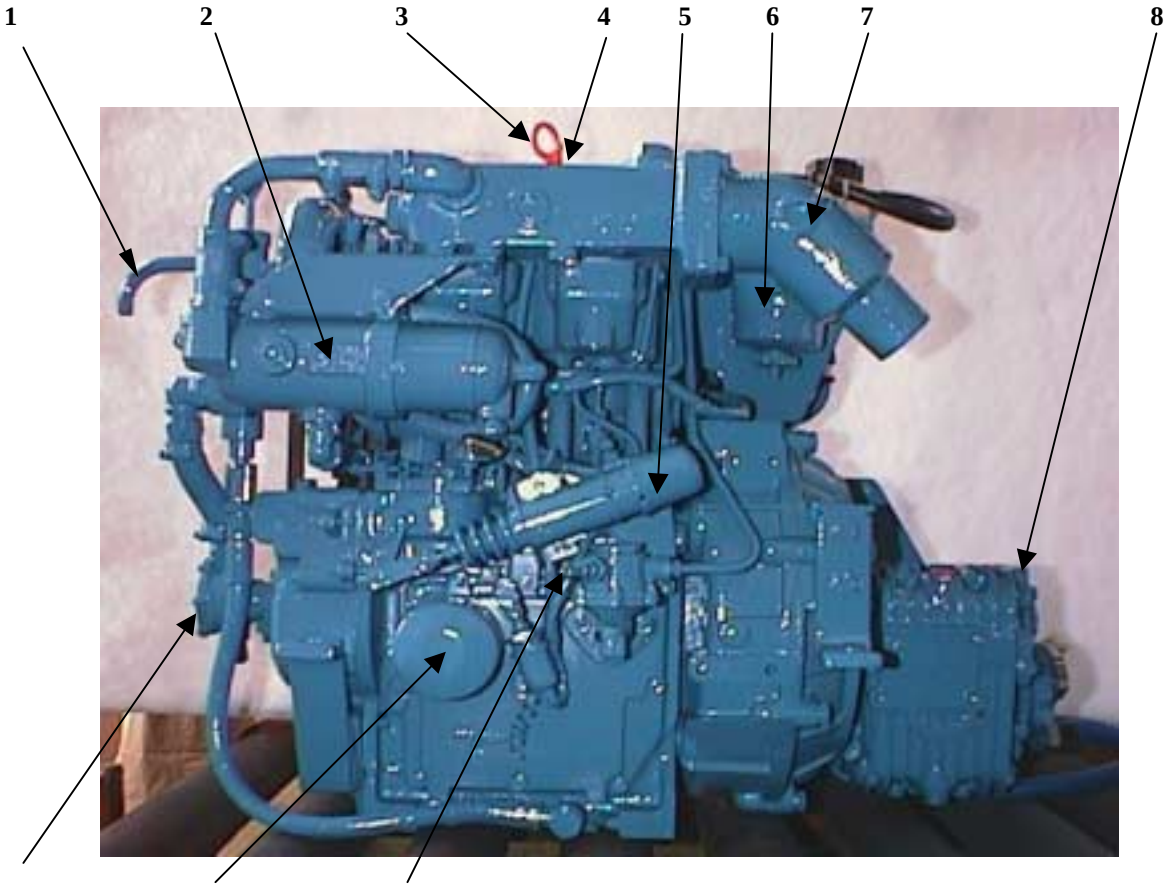
The information given is subject to the Company's current Conditions of Tender and Sale, and is for the assistance of users and is based upon results obtained from tests carried out at the place of manufacture. This company does not guarantee that the same results will be obtained elsewhere under different conditions.

When purchasing parts or giving instructions for repairs customers should, in their own interests, always specify **GENUINE SABB MOTOR A.S PARTS.**

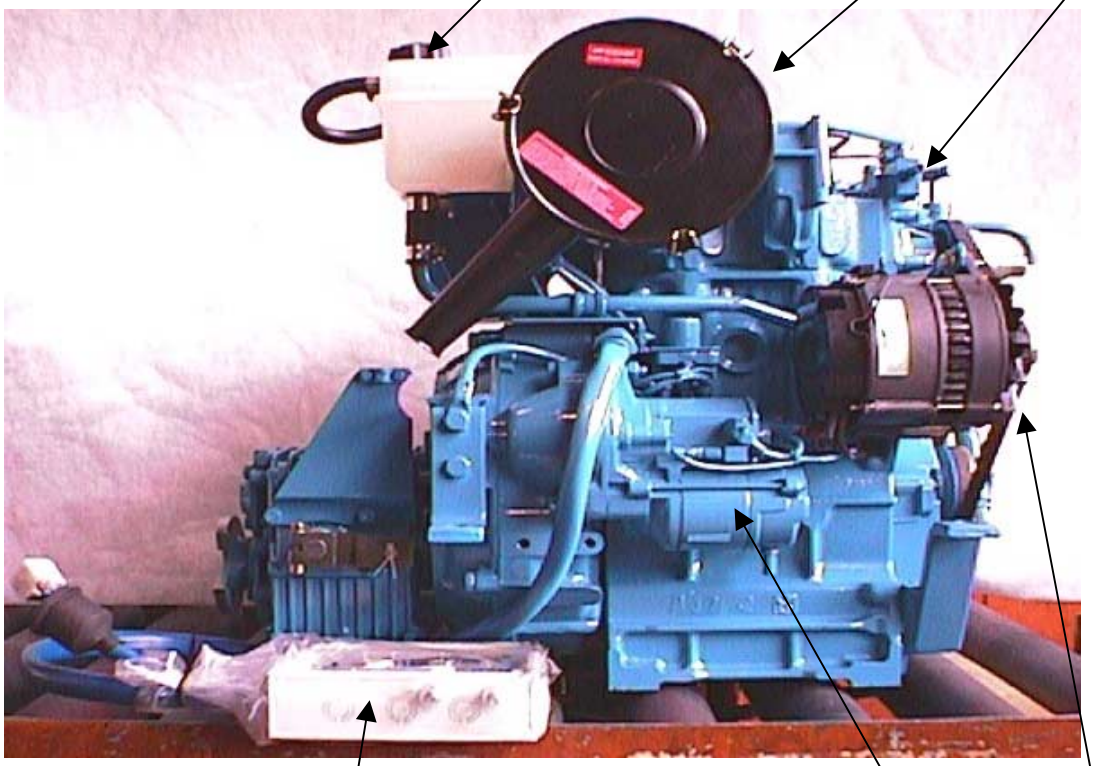
Parts that have not been supplied by the SABB MOTOR A.S cannot be relied upon for correct material, dimensions or finish.

This Company cannot therefore be responsible for any damage arising from the use of such parts and the guarantee will be invalidated.

ENGINE STARBOARD / PORTSIDE VIEW



PORT SIDE



STARBORDSIDE

DESCRIPTION OF ENGINE VIEWS

1. Sump oil drain pump
2. Heat exchanger
3. Dipstick
4. Oil filler cap, valve cover
5. Stop solenoid
6. Fuel filter
7. Sea water cooled exhaust outlet
8. Gearbox
9. Sea water pump
10. Lubricating oil filter
11. Fuel supply
12. Header tank w/coolant filler cap
13. Air inlet damper
14. Fuel return to tank
15. Relay box with connections
16. Starter motor
17. Alternator

GENERAL ENGINE DATA

Type	L2.093	L3.139	L4.186	L4.186-T
Basic Engine Make	Lister Petter Ltd.			
Rotationning	Clockw.looking on gearbox			
Injection system	Direct			
Aspiration	Normal asp.			Turbo ch.
No of cyl.	2	3	4	4
Bore mm	86			
Stroke mm	80			
Cyl. capacity litre	0,930	1.395	1.860	1.860
Firing Order	1-2	1-2-3	1-3-4-2	1-3-4-2
Compression Ratio	18,5:1			16,2:1
Output at 3000 RPM, kW/bhp	14,2/19	22/30	29/40	40,2/55
Output Reference	ISO 3046,related to flywheel			
Fuel Oil Consumption l/h	3,9	5,9	7,8	11,45
Max.Lub.Oil Consumpt.l/24 h	0,70	1,06	1,41	2,06
Idling Speed	900 o/m			
Min. Full Load Speed	1500 o/m			
Fuel Pump maximum Lift	3,05 m			
Max.Exhaust Temp. Norm.Asp.	560°C			
Max. Exhaust Temp. after Turbo				400°C
Max. Exhaust Temp. before Turbo				500°C
Boost Pressure, bar				0,8
Max. Intake Restriction mm				254 H_2O
Max.Exhaust Backpressure mm	1016 H_2O			510 H_2O
Engine Dimensions				
Length with HVP-gearbox mm	842	942	1025	1025
" " Hurth gearbox mm	697	809	909	950
Width mm	495	495	495	565
Heigth mm	607	607	607	607
Weight with HVP-gearbox kg	210	230	260	280
" " Hurth gearbox kg	180	210	240	200
Max. Inclination, Running	20° Astern/Ahead/Lateral			

ENGINE RATING AND PROPELLER

The engine ratings given are the ratings measured on propeller shaft and with reference to ISO 3046 (DIN 6271). Deduction due to alternators, extra water pumps and similar auxiliaries which are not necessary for the engine function, may be done.
The ratings are also a DIN 6270 B rating, i.e. the engine can run on this power for one hour every 6th hour.

Choice of propeller.

When selecting the correct fixed propeller for the boat, choose the propeller which permits the engine to run at full speed 3000 rpm with the lever (throttle) in full speed position. When slowing down (appr. 100 rpm) for continuous running the engine rating is reduced by appr. 10%, but the speed of the boat is nearly the same. This will save fuel and extend the engine’s life.

With controllable pitch propeller (CPP) the full speed at 3000 rpm should be marked on the control lever (operator). For continuous operation the speed control lever (throttle) is pulled back for 100 rpm, but the pitch control is kept in its full speed position. This full speed position is dependant on the boat, and is not the same as maximum pitch.

On a lower rpm (manoeuvring, trolling etc.) the pitch may be increased above the full speed mark. Do not overload the engine with too heavy pitch. Overload is noticed by the exhaust getting dark.

FUEL SYSTEM

Injector Settings.....	New:/Used 240 bars
Fuel Specification.....	Gas oil conforming BS2869:1988 Class A1 or A2 or to USA Specification ASTM D-975-77 Grades No. 1-D and 2-D or BSMA 100 class M1 for marine use.

The fuel must be a distillate, and not a residual oil or blend. Vaporising oils are not suitable as fuels for Lister-Petter series engines.
The user is cautioned that although the engines may operate on fuels outside the above specifications, such operation may well result in excessive wear and damage.

If the engine has to work in areas with extremely low ambient temperatures, use fuel with good clog characteristic. Clog point (CFPP) -25E C

EXCESS FUEL DEVICE.

This device is fitted as standard, being automatically selected when the engine is intentionally stopped.
Should the engine run out of fuel and stop, the device will not select excess fuel until the engine mounted stop lever is moved to the stop position by pressing the stop button and releasing it.
The engine will automatically disengage the excess fuel position when the engine runs up to speed.

LUBRICATION SYSTEM

Lub.Oil Pressure at idle RPM: 0,7 bar
" at 3000 RPM: 2,0 bar

Oil Sump Capacity:

Oil Symp Cap. incl. Filter:	L2.093: .....3,3 l
" " "	L3.139: .....4,5 l
" " "	L4.186: .....5,6 l
Oil Sump Cap. incl. Filter and cooler:	L.186-T:.....6,5 l.

Gearbox Sump Cap.	HURTH HBW 125:.....0,55 l
"	HURTH HBW 250:.....0,75 l
Gearbox Cap. excl. Oil Cooler	SABB HVP15:.....2,6 l.
" "	SABB HVP25:.....2,6 l.

The oil level marks on the dipstick are correct only for engines in horizontal position. Check the oil level after installation and readjust the marks if necessary.

COOLING SYSTEM

Cooling system Cap.(with Keel Cooler)	L2.093:	3,0 ltr.
	L3.139:	4,6 ltr.
	L4.186:	8,0 ltr.
	L4.186-T:	8,0 ltr.

Basic engine cooling system cap. (with no heatexchanger or pipes)

	L2.093:	2,1 ltr.
	L3.139:	2,5 ltr.
	L4.186:	3,0 ltr.
	L4.186-T:	3,0 ltr.

Thermostat setting: 74°C

The specification of the coolant concentrate should comply with one of the following:
BS6580 : 1985
MIL-A-11755D
MIL-A-46153/B
To determine the amount of coolant concentrate to be added it will be necessary to calculate the total coolant capacity by adding together the engine, heat exchanger/keel cooler, expansion tank and associated pipework capacities.

WARNING

Anti-freeze contains Monoethylene Glycol and other constituents which are toxic if taken internally, and can be absorbed in toxic amounts under prolonged skin contact.
If clothing is splashed with anti-freeze, it should be washed before being worn again.
If anti-freeze is swallowed accidentally, medical advice should be sought immediately.

An anti-freeze concentration of 40% should be used as an all year round coolant. This concentration will give low temperature protection down to -25E C.
Additionally, a 40% concentration will protect the cooling system from corrosion.

ELECTRIC SYSTEM

Voltage	12 V, isolated return
Starter Motor.....	2 cyl. engine: 1,2 kW
Starter Motor	3 and 4 cyl.engine: 1,7 kW
Alternator	55 A Lucas, radio suppressed
Engine Heater.....	42 V, 300 W (extra equipm.)
Inlet Manifold Heater.Plug	2 and 3 cyl. engine: 1x345 W
" " " "	4 cyl. engine: 2x345 W

GEARBOX

Engine type	L2.093, L3.139, L4.186	L4.186-T
Gearbox Type	Hurth HBW 125	HBW 250
Gearbox ratio,forward/reverse	3,63/1,95	2,74/2,72

Rotation of propeller:..... Right (RH)

SABB HYDRAULIC OPERATED ADJUSTABLE PITCH PROPELLER

Engine Type	L3.139 HVP	L4.186, L4.186-T
Gearbox Type	HVP15	HVP25
Ratio	1,7/2/3	1,7/2/3

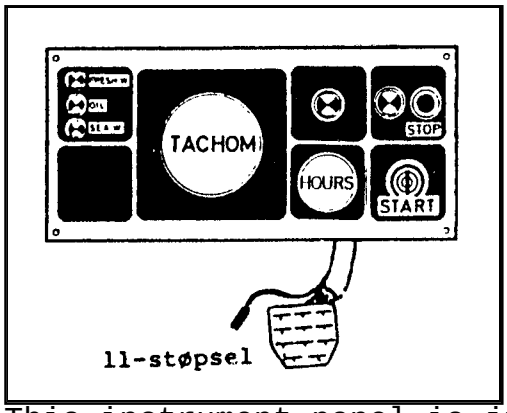
Rotation of propeller: . . . Right (RH)

The SABB HVP-gearbox has hydraulic operated clutch and pitch adjustment. Operating of the gearbox is not possible when the engine is at standstill.
To move the propeller shaft or propeller pitch rod it is necessary to start the engine.

INSTRUMENT PANEL AND OPERATING CONTROLS

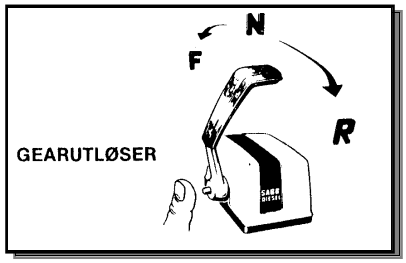
The engine is normally fitted with following instruments:

1. Tachometer
2. Charge Control Lamp. The light will glow when the battery switch is on, but must go out when the engine has started.
3. Alarms (light and acoustic) warns:
   1. at too high cooling water temperature
   2. at too low oil pressure
4. Glow/Starter Switch
5. Stop Button
6. Running hour recorder (optional)

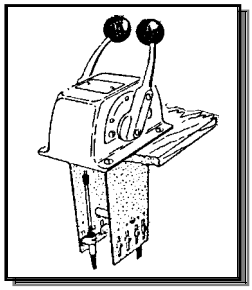


(This instrument panel is just an example)

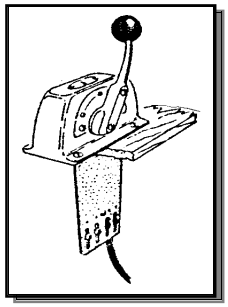
A. Single lever control for gearbox/speed control



B. Double lever control for HVP gearbox/ speed control



C. Separate lever control for clutch, HVP gearbox



PRELIMINARY INSTRUCTIONS

CAUTION
ETHER BASED COLD START AIDS MUST NOT BE USED UNDER ANY CICUMSTRANCES

WARNING
EXHAUST GASSES CONTAIN CARBON MONOXIDE WHICH IS A COLOURLESS, ODOURLESS AND POISONOUS GAS THAT CAN CAUSE UNCONSCIOUSNESS AND DEATH

STARTING PRECAUTIONS

Starting any engine can be dangerous in the hands of inexperienced people. Before attempting to start any engine, the operator should be fully conversant with starting procedure and controls.

- Ensure that the batteries are in serviceable condition and correctly connected.
- Check that the oil levels in the engine and the gearbox are correct.
- Check that the fuel tank is full and that the system is primed.
- Check that all water drain plugs and cocks are closed. Check that water inlet valves, if fitted, are opened.
- Check that the water level in the header tank is filled up with mixture of water/anti-freeze (40%).
  Under no circumstances must the engine be started without liquid in the cooling system.
- Ensure that the gearbox is in neutral.

CHECKS BEFORE STARTING

- Oil level in engine and gearbox.
- Coolant level in header tank.
- Battery main switch is ON. The charge control and oil pressure lights will now be on and the buzzer will sound.

STARTING

1. Before attempting to start the engine, the operator Should be familiar with the safety precautions as described earlier.
2. Move the speed/gearbox lever into max.speed position by means of the control lever, with gearbox disengaged.
2. Dependent on temperature, turn the starter switch into the preheat position (position 1) and hold it for 10-20 seconds. Then turn the switch further into position 2 to energise the starter. Release immediately the engine starts, and it will return to position 0. The alarm light, audible alarm and the changing light should now be off.
4. If the engine fails to start within 15 seconds, despite

good battery condition, release the switch and investigate the cause (see **FAULT FINDING**). The starter motor should be allowed to cool for at least 15 seconds before attempting to restart.

5. In very cold weather (below appr. - 10EC), it could be necessary to increase the glowing time to appr. 30 seconds and run the starter motor for up to 1 minute.

OPERATION

If one or more alarm lamps do not go out, or lights up when the engine runs, the engine should be stopped at once to trace the reason.
When all functions are normal:
Engine with forward/reverse gearbox:
engage the gearbox by pushing the control lever forward or backward.
Engine with SABB HVP gearbox:
engage the clutch. Increase the engine speed and pitch simultaneously until desired level.
Allow the engine to warm up before going full speed.
Run engine moderately to save engine and fuel. Full speed at maximum rpm only for intervals. For continuous running the speed should be reduced by approx. 100 rpm.
See "Engine Rating and Propeller".

CAUTION
On L4.186-T engines serious damage to the turbocharger bearing can result if for any reason the turbocharger housing is not full of oil.
It is recommended that these engines run on 'no load' after starting for 30 seconds, to ensure an adequate oil supply to the turbocharger, and 30 seconds before stopping to allow the heat from the bearing to dissipate.

STOP

Move control lever into neutral position or if SABB HVP-gearbox, pitch control lever in neutral and clutch disengaged.
Allow the engine to idle for appr. 2 minutes to cool.
Stop the engine by pressing the stop button, (max. 10 seconds).
Switch off the battery main switch.

ROUTINE MAINTENANCE

- The engine should receive regular attention during the first 50 hours of its life from new and after a major overhaul.
- Long periods of light or 'no load' running early in the engine's life may lead to cylinder bore glazing and high oil consumption.
- The instructions given in "Maintenance Schedule" are based on average operating conditions and cover the minimum requirements to keep an engine running at peak performance with trouble free operation.
- Decarbonising may be required more often if the engine has been running on light loads for long periods.
- Before carrying out any maintenance work on an engine it is advisable to remove the battery.
  The battery and alternator must be disconnected before commencing any electric welding when a pole strap is directly or indirectly connected to the engine.
- It is essential to ensure that nuts and bolts are tightened to the torques specified.
- When re-assembling an engine lubricate all moving parts with engine oil.
- Renew nuts and bolts that have been taken from high stress locations. In particular nuts and/or bolts from the connecting rods should be renewed.
- The fuel injector can only be checked and set off the engine using suitable specialist test equipment.

WARNING

On no account allow any unprotected skin to come into contact with the injector spray as the fuel may enter the blood stream with fatal results.

Some engines may be fitted with seals or 'O' rings manufactured from 'Viton' or a similar material.
When exposed to abnormally high temperatures, in excess of 400°C (752°F), an extremely corrosive acid is produced which cannot be removed from the skin.
If signs of decomposition are evident, or if in doubt, always wear disposable heavy duty gloves.

Fuel and new or used lubricating oil may cause skin irritation.

The materials used in the manufacture and treatment of some filters and elements may cause irritation or discomfort if they come into contact with the eyes or mouth and they may give off toxic gasses if they are burnt.

Care must be taken to ensure that all fuel, used oil, filters and filter elements are disposed of in accordance with all the relevant regulations of the country concerned.

The engine has passed Test Programme before delivery. Still however the engine is not completely run in. It is recommended to operate the engine moderately during the first hours after it has been put into service. Full speed only for short periods during the first 15-20 hours.

INITIAL ATTENTION.

(AFTER THE FIRST 15 HOURS OF OPERATION)

- Check and tighten all hose clamps and unions, paying particular attention to the fuel system
- Check and tighten all external nuts and bolts, particularly mounting bolts, shaft coupling bolts and exhaust manifold bolts and nuts.
- Check belt tension, see **ALTERNATOR BELT TENSION**.
- Check lubrication oil and coolant level.
- Change the lubrication oil and filter for the first time after 100 hours and then as specified below.

ROUTINE MAINTENANCE PERIODS

PERIOD	ATTENTION
After the First 15 Hours or after the First 3 Months	See INITIAL ATTENTION
Before Start or Weekly	Check engine oil level. Check coolant level. Check fuel level in tank. Drain water and contaminants from water separator. Grease stern gland
Every 3 months or 25 hours	Check gearbox oil level Check battery condition
Every year or 200 hours	Change engine oil and filter element. Change gearbox oil. Grease remote control parts. Change fuel oil filter. Check belt tension. Check block heater if fitted and manifold heater plug. Check electrical connections for tightness and corrosion. Tighten nuts, bolts unions and hose clamps. Change pressure oil filter in HVP-gearbox.

LUBRICATION OIL SPECIFICATION

The engines must be run on heavy duty lubricating oils, meeting the requirements of API CC, DEF2101D, MIL-L-2104B or MIL-L-46152A/B. Straight mineral oils are not suitable, neither are oils of less detergency than specified.

API CD, Series 3, or MIL-L-2104C/D oils can inhibit the running-in process in new or reconditioned engines but can be recommended for engines running at high load factor, particularly in conjunction with high ambient temperatures.

Turbo charged engines type L4.186-T must be run on heavy duty lubricating oils, meeting the requirements of API CD, Series 3, or MIL-L-2104C/D.

The following tables show the correct oil viscosities at various ambient temperature ranges for cold start to maximum running. Before selecting a viscosity grade refer to Notes:

Monograde Oils

Grade	**Ambient Temperature Range °C**
10W	Between -15**°C** and 10**°C**
20W-20	Between 5**°C** and 30**°C**
30	Between 20**°C** and 52**°C** For temperatures above 40**°C** refer to Note 3

°F = (1,8 x °**C**) + 32

Multigrade Oils

Grade	**Ambient Temperature °C**
5W-20	Between -32**°C** and 25**°C** Refer to Note 1
10W-30	Between -15**°C** and 52**°C** For temperatures above 40**°C** refer to Note 3
10W-40	Between -15**°C** and 52**°C**
15W-40	Between -5**°C** and 52**°C**
20W-40	Between 5**°C** and 52**°C**

°F = (1,8 x °**C**) + 32

Notes

1. SAE 5W-20 oils are recommended on the basis that they are fully synthetic, and are technically suitable for use up to 25**°C** (77**°F**). Non synthetic oils at very low temperatures will suffer from wax crystallisation.
   Monograde SAE 5W is not normally available as a synthetic oil and therefore is not quoted.

2. In order to maintain the cold starting characteristics of any recommended grade it is essential that oil changes are made within the specified recommendations.
   An oil change is recommended immediately if the engine fails to reach its normal cold start cranking speed due to excessive oil viscosity.
   Fuel dilution of the lubricating oil will adversely affect cold starting and oil consumption.

3. SAE 30 and 10W-30 oils may be used at up to 52**°C** (126**°F**) but oil consumption may be affected.
   10W-40, 15W-40 and 20W-40 multigrades are recommended for continuous full load operation at this temperature.

4. Monograde SAE40 oils are not recommended.

The temperatures mentioned in the table are the ambient temperatures at the time when the engine is started.
However, if the running temperatures are much higher than the starting temperatures, a compromise must be struck and a higher viscosity oil used, provided starting is satisfactory. Multigrade oils overcome the problem, provided they have a suitable specification.

GEARBOX OIL SPECIFICATION

Gearbox, type Hurth:	Automatic Transmission Fluid, ATF: Ford Specification M2C-33G GGM Specification ATF DEXRON II D
HVP-gearbox, type SABB:	Engine oil SAE 15W-40

STERNGLAND AND REMOTE CONTROL GREASE

Following types of universal grease may be used:

BP Energrease LS-EP	Fina Marson EPL
Norol Universalfett EP2	Gulfpride SF
Castrol Spheerol AP2	Mobilux 2 or Mobilplex 47
Chevron Dura-Lith Grease No. 2	Shell Alvania Grease EP2
Esso MP Grease Beacon EP2	Texaco Multifak EP2

GREASING OF ADJUSTABLE PITCH PROPELLER

Following types of water resistant grease may be used:
Esso Cazae K2
Shell Strombus Oil L 320
Texando FO 20
Norol Smørefett VF-EP2
Castrol CL-grease
Fina Merkan 3

CHECK OF LUBRICATION OIL LEVEL

The lubrication oil level should always be checked before starting.
The level should never be allowed to fall below lower mark.
Note that the marks indicate correct level when the engine has appr. horizontal position. The marks should be corrected according to installation angle.

LUBRICATION OIL CHANGE

The oil change should be done when the engine is warm.
Operate the pump handle of the engine mounted pump, see fig. 1, until the sump has been emptied.
Remove the filler cap on the top of the valve cover. Fill up new oil.
If the filler hole in the crankcase cover, fig. 2, is accessible, the filling may be done there.
Run the engine after oil and filter change and check for any leaks from oil filter.
Stop the engine, allow the oil to settle and top up if necessary.

CAUTION
Do not overfill with oil. If a cylinder head oil filler is fitted the oil must only be poured into the filler at a rate which enables it to drain into the crankcase. If the oil is poured in too quick it can flood the crankcase breather holes and escape into the inlet manifold and cylinders.

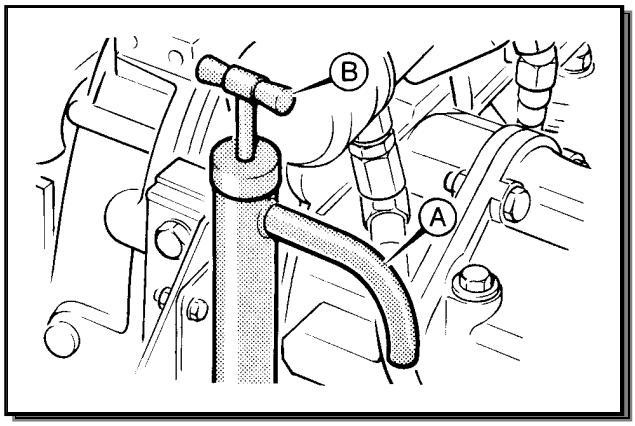


Fig. 1

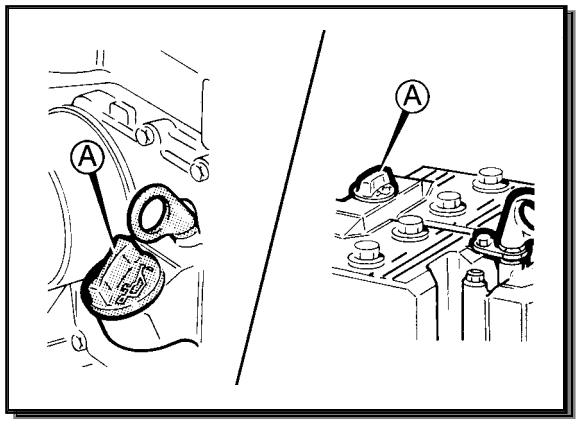


Fig. 2

CHANGE OF OIL FILTER ELEMENT

Precautions for Filters and Elements

- Used liquid filters and elements contain some of the filtered liquid and should be handled and disposed of with care.
- After handling new or used elements the users hands should be thoroughly washed, particularly before eating.

Use a suitable strap wrench, unscrew and remove filter canister. Thoroughly clean the crankcase oil filter housing face. Apply a thin film of clean oil to the oil filter sealing gasket. Screw on the new oil filter canister until the sealing gasket abuts the filter head and tighten a further half turn.
Only approved filters should be used as these have high temperature joints, adequate filter paper characteristics and a rigid case.
Other filters may have the same external dimensions and thread as the genuine one but may fail in service.

HURTH GEARBOX OIL CHECK AND CHANGE.

Unscrew the dipstick A, see Fig. 3, from the gearbox. Check the oil level by reinserting through hole. Fill up if the oil level is below the mark.
Refill new ATF oil to correct level.
If the oil is to be changed, pump out the oil by means of a sump drain pump through the dipstick hole.

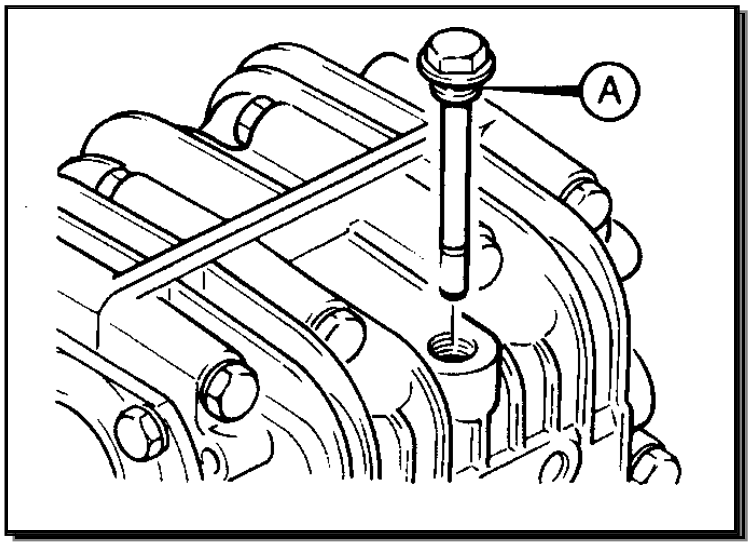


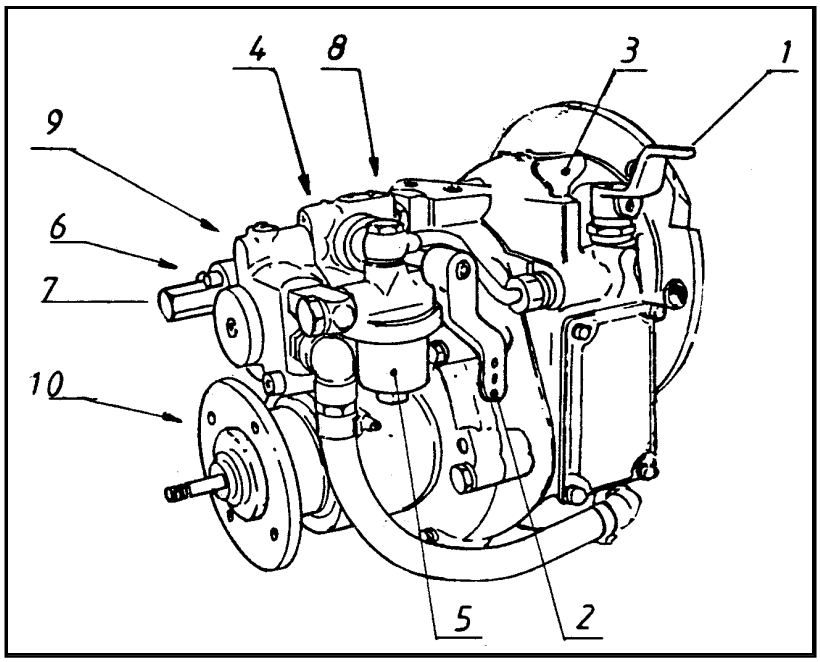
Fig. 3

SABB HVP GEARBOX OIL CHECK AND CHANGE

Unscrew the dipstick 3, see fig. below. Check the oil level by reinserting through the hole. Fill up if the oil level is below the mark.
If the oil is to be changed, unscrew the vent plug 4, on port side of the gearbox, and pump out with a sump drain pump with hose extension. Ensure that the hose reaches the bottom in order to drain all contaminants.
Refill new engine oil, appr. 2,6 litres, to correct level. Run the engine some minutes and top up.

SABB HVP GEARBOX CHANGE OF PRESSURE OIL FILTER

The pressure oil filter should be changed at the same time as oil change.
Unscrew the two bolts, securing the lower filter housing to the cover and pull down.
Remove the filter element and the O-rings. Clean the filter housing and fit new element and O-rings.
Ensure that the spring in the bottom of the housing is properly located and tighten the two bolts.
Start the engine and check the filter for leakage.



1. Pitch control lever
2. Clutch lever
3. Dipstick
4. Oil filler
5. High pressure filter
6. Pressure gauge connection
7. Oil pressure valve
8. Oil from cooler
9. Oil to cooler
10. Grease nipple (invisible)

CHANGING FUEL CARTRIDGE AGGLOMERATOR

If the fuel oil tank is installed at a level above the engine, the cock must be closed before fuel filter change.
Water is drained from the agglomerator by unscrewing the drain tap (C) sufficiently to allow the water to drain. See fig. 4.

1. Using a suitable strap wrench unscrew the cartridge (A) from the head (B).
2. Screw a new cartridge onto the head and hand tighten it.

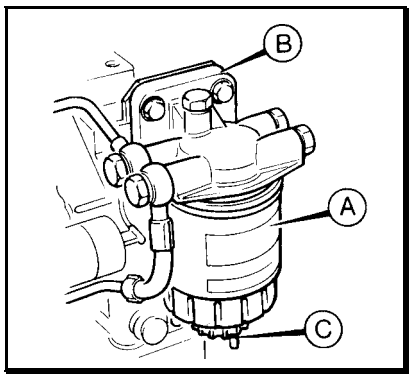


Fig. 4 Cartridge Agglomerator

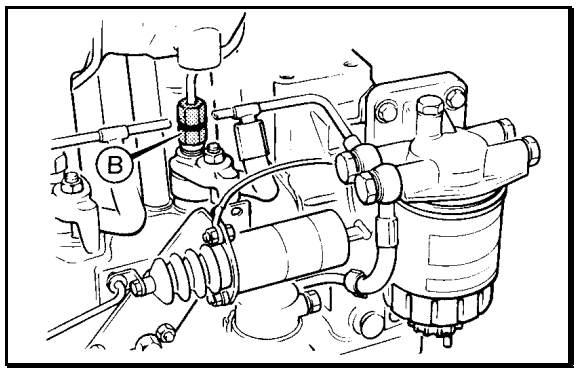


Fig. 5 Delivery Valve Holder

Prime the fuel system after filter change, see below.

REPLACING AN INJECTOR

1. Pull off the injector leak-off pipe from the injector body stub pipe.
2. Remove the cylinder head cover nut retaining the fuel pump to injector pipe clip and release the clip.
3. Hold the fuel pump delivery valve holder (B) with a spanner and slacken the pump to injector pipe nuts.
4. Slacken the injector clamp bolt.
5. Remove the pump to injector pipe.
6. Remove the injector clamp and lift out the injector.
7. Remove the injector sealing washer from the cylinder head taking care not to damage the seating area.
8. Ensure the seating in the cylinder head is clean and smooth.
9. Lightly smear a very small amount of high melting point grease to one side of a new injector sealing washer and place it over the injector nozzle, greased side first.
10. Replace the injector and clamp. Hand tighten the clamp bolt.
11. Replace the pump to injector pipe hand tightening the nuts.
12. Fit new rubber 'O'rings into the recesses on the cylinder head cover.
13. Replace the pipe clip and torque the nut to 9,0 Nm (6,5 lbf ft).
14. Torque the injector clamp bolt to 21,0 Nm (15,5 lbf ft).

15. Hold the fuel pump delivery valve holder with a spanner and torque the fuel pipe nuts to 29,0 Nm (21,0 lbf ft).
16. Replace the injector leak-off pipe.
17. Fuel injector setting: 240 bar.

WATER SEPARATOR (IF MOUNTED)

A water separator/fuel filter should always be mounted between the fuel tank and the engine.
Drain the separator by loosening the bottom tap.

PRIMING THE FUEL SYSTEM

The fuel system has to be primed before initial starting, after fuel filter change, if it has been disconnected, or if the engine has run out of fuel and stops.

Start the priming at the water separator, (if mounted).

1. Loosen the vent plug on top of the separator and let the fuel flow until no air is left. Re-tighten the vent plug.

2. Release the bleed screws, (A) see Figure 6, on the filter and re-tighten when no further air bubbles are expelled.

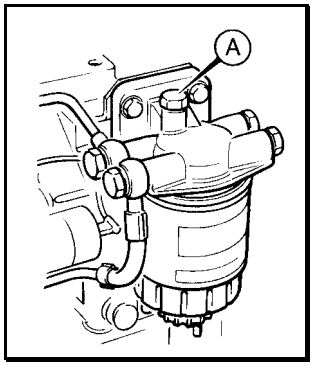


Fig. 6 Priming the Fuel Filter

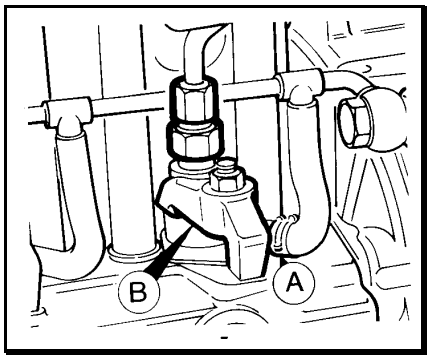


Fig. 7 Priming a Fuel Pump

3. Move the speed control to the fast position.
4. Operate the fuel lift pump by hand.

The remaining procedure must be carried out with the engine running and to each pump in turn starting with the pump nearest the filter.

5. Refer to Fig. 7 and hold the delivery valve holder (B) with a spanner and slacken the injector pipe nut (A) until no air bubbles are expelled.
6. Hold the delivery valve holder and torque the injector pipe nut to 29,0 Nm (21,0 lbf.ft)

NOTE. It is of the greatest importance for trouble-free performance that no air has access to the fuel system.

Make therefore sure that all connections, particularly on the suction side, are properly tightened

REFUELING

The fuel to be used is: GAS OIL.
The fuel injection equipment is made to very accurate limits and therefore even the smallest particle of dirt entering the system will destroy its efficiency by causing scoring or premature wear on the highly finished parts.
Ensure that scrupulous cleanliness is observed when handling the fuel system components and also the fuel.
Take care that water is not allowed to contaminate the fuel oil.
Always install a pre-filter (water collector/sedimentor) in the line between the tank and the engine. The pre-filter must be easily accessible for inspection and draining.

When refueling always apply a fine gauze filter and a clean, dry funnel in the tank filler neck. Before moving the fuel filler cap, clean well near it, and replace the cap after the refueling.

COOLANT LEVEL CHECK

The engine should be allowed to cool down for some time before coolant level check.
Be careful when removing the coolant filler cap when the engine is warm.
Use a rag to protect against scalding.
If necessary, fill up with clean fresh water/anti freeze mixture.
If the engine has extra header tank, the coolant level is always checked in the upper tank.
The coolant should be changed every two years.

TO DRAIN THE COOLANT.

Remove the filler cap on header tank.
Drain the coolant through tap or plug hole in front of the crankcase.
Close the tap securely after draining.
Refill the system with correct water/anti freeze mixture.
Let the engine idle for 20-30 minutes with the filler cap off and top up.

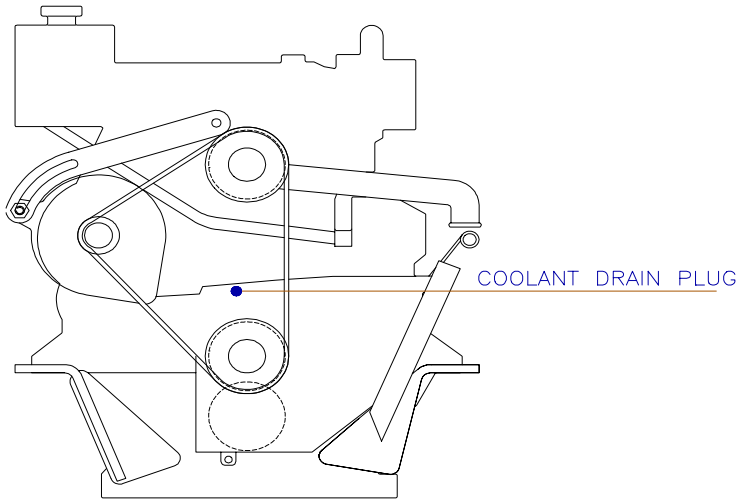


FIG.10

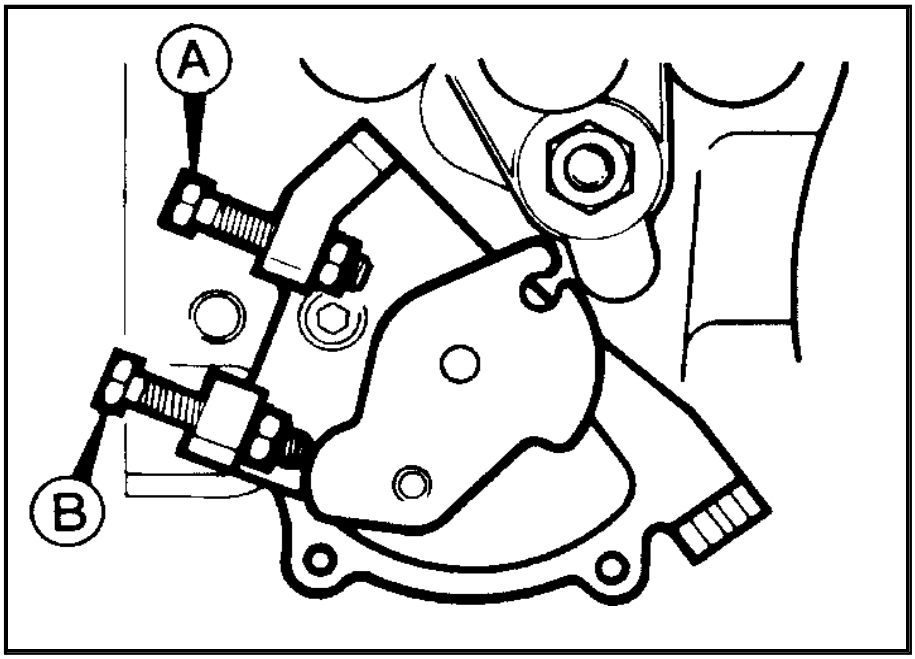
CAUTION
Under some circumstances an airlock can occur when filling the system causing a false level indication.

CHECK OR REPLACE THERMOSTAT

Loosen the rubber bend between the thermostat housing and the water cooled exhaust manifold.
Unscrew the thermostat housing bolts and remove the housing with thermostat.
To check the thermostat function, put it into hot water. The thermostat is set to open at 73EC. It should close again when put into cold water.
If the thermostat is defect, it must be replaced.
The gasket should also be replaced before assembling the thermo-stat housing.
Ensure that all hose clamps are properly fixed and drain tap closed, before refilling with water/anti-freeze mixture.

IDLING SPEED ADJUSTMENT

The factory should be consulted before any idling speed adjustment.
Start the engine and run until normal operating temperature is reached.
Correct idling speed is 900 RPM and is factory set before despatch.
Adjustment should only be carried out after consulting SABB MOTOR A.S
The idling speed is adjusted with the adjusting screw "A". see Fig. below.



VALVE CLEARANCE ADJUSTMENT

The engine is fitted with hydraulic tappets and therefore no adjustment is necessary or possible.
NOTE. If the cylinder head and the valve gear for any reason have been removed, the assembling sequence must be according to the Service Manual which may be obtained from the factory.

ALTERNATOR BELT TENSION.

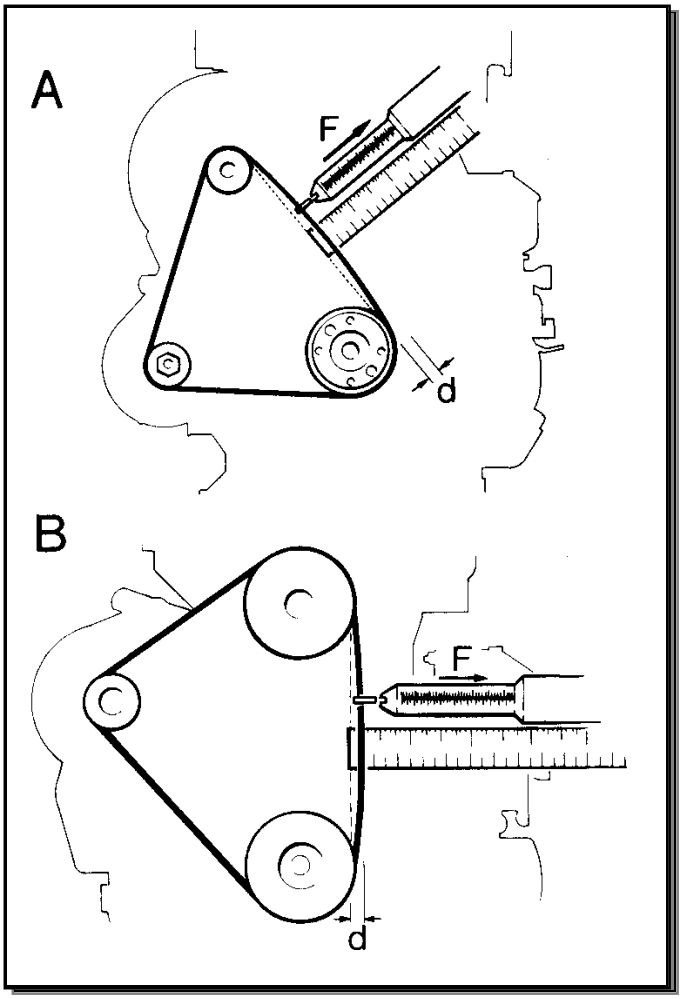
It is important that the belt tension is checked after an overhaul or when new belt is fitted.

New belt tension:
A force of 3-3,5 kg to deflect belt 3,5 mm

Checking and adjustment at service intervals:
A force of 2,2-2,4 kg to deflect belt 3,5 mm

The deflection should be measured on the belt section between crank shaft pulley and the water pump pulley.

See fig. below.



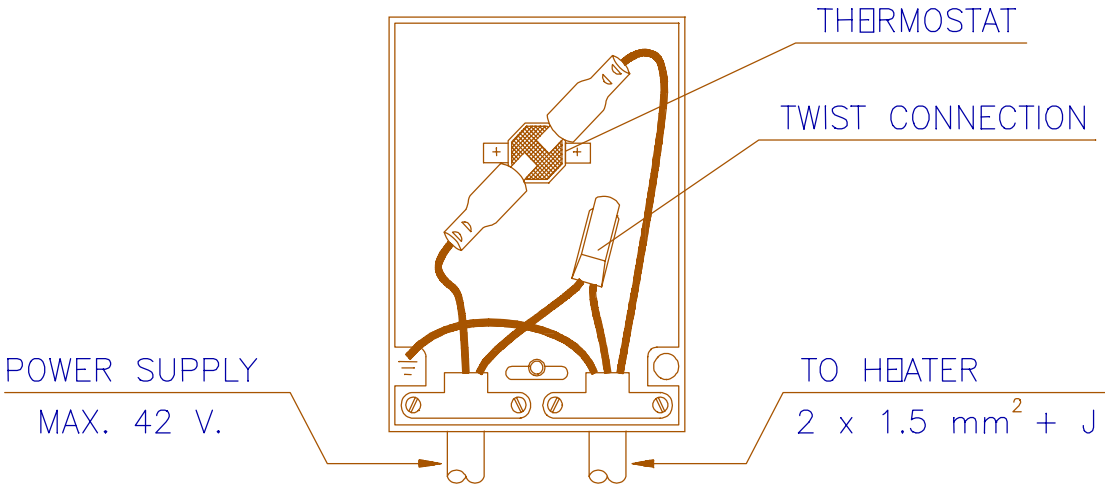
CHECK AND CHANGE OF ENGINE HEATER (IF MOUNTED)

The engine heater is mounted in the port side of the engine block.

If the heater is being continuously used, the heater element is subject to burning and should be checked yearly or if the heating does not work.

- Drain the coolant through the drain plug.
- Disconnect the leads and unscrew the heater, using a 26 mm wrench.
- If the inner reducer should loosen, reglue with epoxy glue or Loctite.
- If the element is badly burnt or corroded, replace it by a new one.
- If the new heater element does not work, check the thermostat and replace if defective. See wiring diagram inside the thermostat box, see below.

Note: The engine heater should not be tested in open air as it will be overheated and damaged.



CHECK OF BATTERY

The condition of the battery should be checked every third month. The specific gravity of a fully charged battery depends on the ambient temperature.

The table below indicates the relationship between the specific gravity and the temperature.

Temperature	Spec.Gravity	Temperature	Spec. Gravity
0°C	1,287	-10°C	1,259
10°C	1,280	-20°C	1,248
20°C	1,273	-30°C	1,241
25°C	1,270		
30°C	1,267		
35°C	1,263		

The electrolyte level should be 6-9 mm above the separators. Top up with distilled water if necessary.

NOTE: In cold weather distilled water should be added only before charging the battery.
Keep the battery terminals clean and coat with petroleum jelly.

CAUTION

The electrolyte is sulphuric acid and should be handled with great care. Always wear goggles when servicing the battery.
If battery acid accidentally is splashed in the eyes, wash with clean water and obtain qualified medical assistance immediately.

GENERAL PRECAUTIONS REGARDING ELECTRIC SYSTEM

The following points must be strictly observed when working on the electric system, otherwise serious damage can occur.

- Never remove any electrical cable without first disconnecting the batteries.
- Never disconnect the alternator cables while the engine is running.
- Only disconnect the batteries with engine stopped and all switches in the OFF position.
- Always ensure that cables are connected to their correct terminals before reconnecting the batteries. A reversal of polarity or short circuit will destroy diodes and transistors in the alternator and regulator.
- Never flash any connections to check the current flow.
- Always keep the electrical connections properly tightened.

- The battery and alternator must be disconnected before commencing any electrical welding when a pole strap is directly or indirectly connected to the engine.

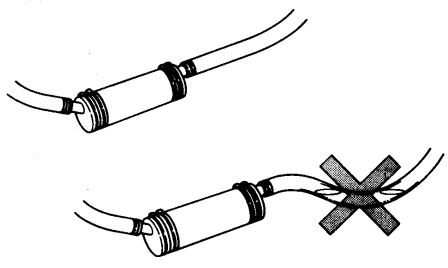
POWER TAKE OFF LIMITS (PTO)

Auxiliary hydraulic Drive.....	5 kW max
Gear End Axial	12 kW max
Gear End Axial	12 kW subject to a maximum crankshaft bending moment, for drives in any direction. The maximum radial force F (kg) which can be applied to the crankshaft is given as: $F = \frac{41182}{(102+L)}$ where L (mm) is the distance from the center of the radial force to the crankshaft pulley face.

WET EXHAUST SYSTEM FOR SAILING BOATS AND MOTOR BOATS

SUITABLE EXHAUST PIPING IS IMPORTANT FOR SAFE OPERATION OF THE ENGINE.
Damage caused by incorrect exhaust piping is not covered by the engine's warranty or insurance.

MOUNTING THE EXHAUST HOSE



The exhaust hose must be installed in such a way that no sea water can enter the hose from rear outlet. A "swan neck" close to the skin fitting is sufficient for most boats. For deep sailing yachts, however, a full-way valve is recommended at the exhaust outlet. This valve should be closed when the engine is stopped. Starting from the outlet bend from exhaust manifold the hose should run down and to its lowest point which must lay minimum 250 mm below the outlet bend.

1.
Further the hose should run as far as possible, and then rising to the "swan neck" at the outlet. This will permit adequate cooling of the hose and enough volume to take all water which is trapped in the hose when the engine is being stopped.

2.
If the outlet is not well above the deepest water level, it is necessary to extend discharge hose upwards, forming a loop as shown on next page The loop must be provided with a vent pipe at its crown 300 mm above the water line. This vent pipe is necessary to prevent siphoning, because the impeller pump (sea water pump) is not completely tight.

IMPORTANT:

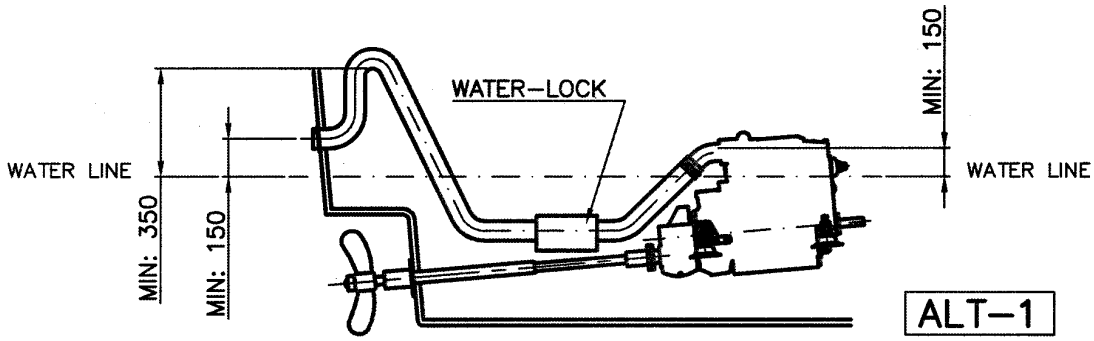
The swan neck at the end of the exhaust line (hown on next page) is normally higher than standard exhaust bend fitted to the engine. Thus, in case the engine does not start normally (after 10 sec.), the main valve at the sea water inlet (sea cock) must be closed to prevent the engine being filled up with sea water through the exhaust line. The valve must be opened again immediately after the engine has started.
Check the function of the wet exhaust system by letting engine idle for 5 minutes, and then stop. Undo the exhaust hose from the exhaust bend, and check that the trapped water in the line is well below the exhaust manifold, minimum 250 mm.

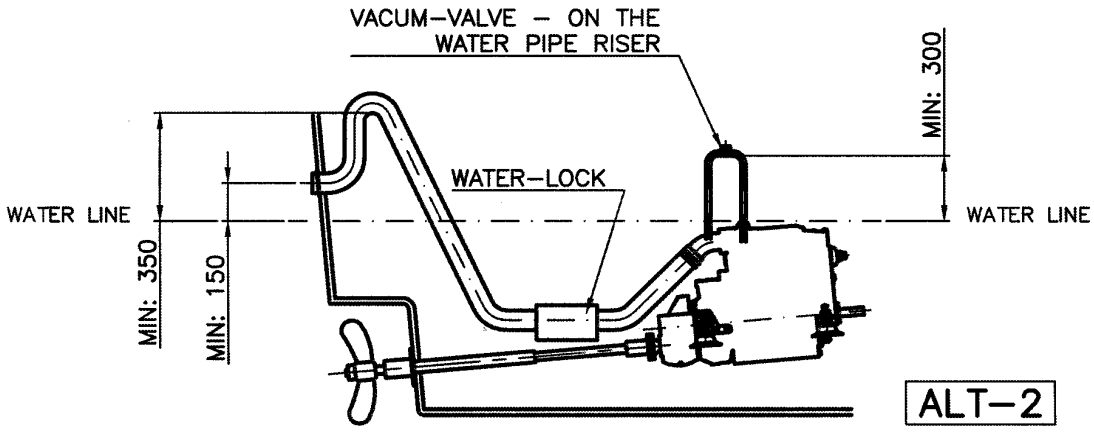
All exhaust hose connections should have two hose clamps each. Use only stainless steel clamps.

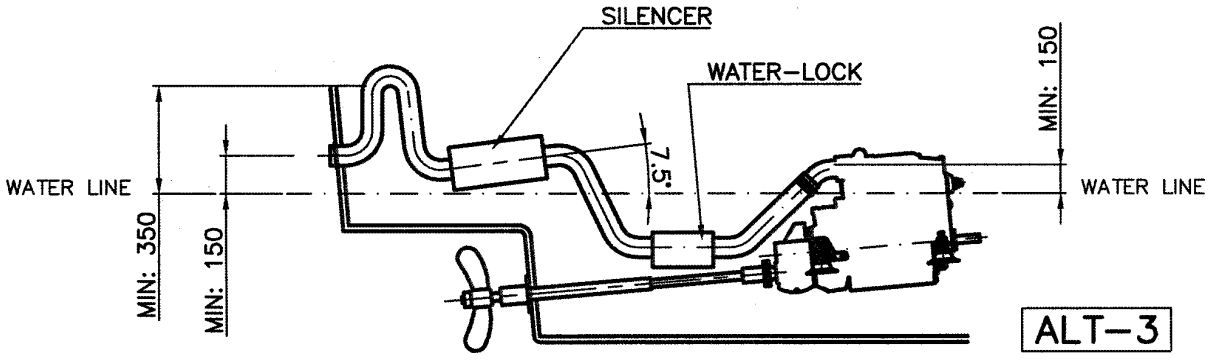
If water lock is fitted, it should have enough capacity to collect the water which is trapped in the hose when the engine is stopped, and it should be provided with a drain valve to prevent frost damage. Normally, the hose without water lock is drained by closing the sea cock and permitting engine to idle for max. 10 seconds.

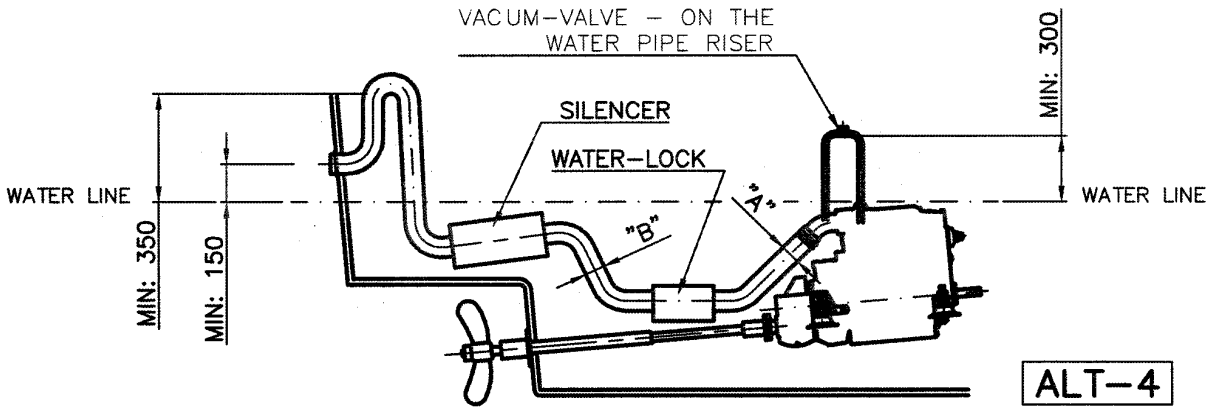
3.
Never use hose smaller then engine exhaust outlet & and use a (B=A+1″)lager hose after the water-lock to prevent back pressure rising in the exhaust line.(Shown in ALT-4)

4.
Avoid sharp bends in the exhaust piping hose, so that water dose not get traped befor the water-lock


WATER-LOCK
MIN: 150
WATER LINE
WATER LINE
MIN: 350
MIN: 150
ALT-1


VACUM-VALVE - ON THE
WATER PIPE RISER
MIN: 300
WATER-LOCK
WATER LINE
WATER LINE
MIN: 350
MIN: 150
ALT-2

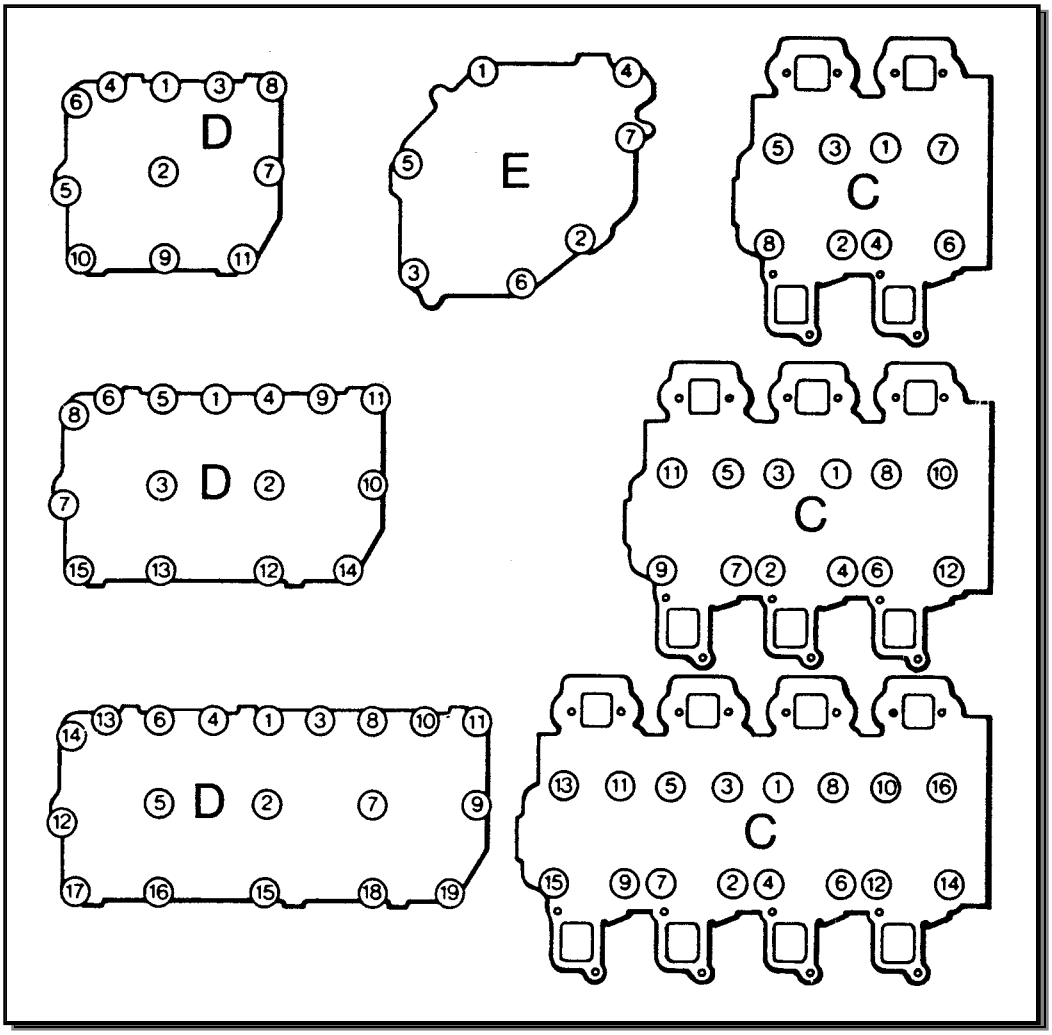

SILENCER
WATER-LOCK
MIN: 150
7,5°
WATER LINE
WATER LINE
MIN: 350
MIN: 150
ALT-3


VACUM-VALVE - ON THE
WATER PIPE RISER
MIN: 300
SILENCER
WATER-LOCK
WATER LINE
WATER LINE
"B"
MIN: 350
MIN: 150
ALT-4

SPANNER TORQUE SETTINGS

DESCRIPTION	Nm	lbf ft
Crankcase Door Bolt (see D in Fig.7) End Cover Nut (see E in Fig. 8) Fuel Filter Bracket Screw Manifold Bolts Rocker Cover Nut	8,8	6,5
Fuel lift pump Injector Clamp Nut Alternator Bolt Water Pump Bolt	21	15,5
Injector Pipe Nuts	28,5	21
Fuel Pump Clamp	33,9	25
Starter Motor Screw	40,7	30
Fuel Pump Delivery Valve Holder	47,5	35
Flywheel Bolt	67,8	50
Flywheel Housing Screw	78,6	58
Injector Nozzle Nut	81,3	60
Cylinder Head Nut (see C Fig.6)	88,1	65
Crankshaft Pulley (left hand thread)	300	221
Prop.Shaft Coupling Bolts (acid proof)	86,3	63
Crankshaft Main Bearing	21	15,5
Conn. Rod Big End Bearing	24,5	18,1

TIGHTENING SEQUENCES FOR CYLINDER HEAD BOLTS, CRANKCASE DOOR BOLTS AND END COVER NUTS.



FAULT FINDING SCHEME

This section is intended as a guide only. If in difficulty consult SABB MOTOR A.S or a SABB Agent.

DIFFICULT STARTING

a. Stop lever not in start position
b. Unsuitable lubrication oil
c. Incorrect fuel
d. No fuel in tank
e. Choked fuel filter
f. Air lock in
g. Discharged battery
h. Poor battery connections
i. Defect heater plug or engine heater (In cold weather)

EXCESSIVE CARBON DEPOSITS

a. Choked exhaust system
b. Unsuitable fuel oil
c. Unsuitable lubricating oil
d. Continuous idling

EXHAUST SMOKE

a. White smoke - generally as a result of water entering the cylinder
b. Faint blue smoke - generally the result of high load
c. Heavy blue smoke - caused by lubricating oil passing the piston rings due to:
   Stuck, worn or broken rings
   Worn cylinder blore
   Overfull oil sump
d. Black smoke due to incomplete combustion can be caused by:
   Overload
   Choked air filter
   Inlet temperature too high
   Unsuitable fuel or water in it

ENGINE STOPS

a. Lack of fuel
b. Air or water in fuel system
c. Choked fuel filter
d. Overload
e. Overheating
f. Loss of compression
g. Lack of lubricating oil

LOSS OF POWER

a. Loss of compression
b. Choked exhaust system
c. Fuel injector dirty
d. Choked fuel filter
e. Worn engine

OVERHEATING

a. Thermostat faulty
b. Low coolant level
c. Water pump belt to slack
d. Overload
e. Lubricating oil level too low
f. Obstructed cooling water system

ENGINE FAILS TO BE STOPPED

a. Automatic fuse is out. Press the fuse button.
b. Stop solenoid linkage is loose.
c. Defect stop solenoid.

DESCRIPTION OF THE ELECTRICAL OPERATED STOP/START SYSTEM.

The lever "A" has two functions:

1. To stop the engine. The engine is stopped when the lever "A" is moved fully anticlockwise until it is against the stop screw "C".

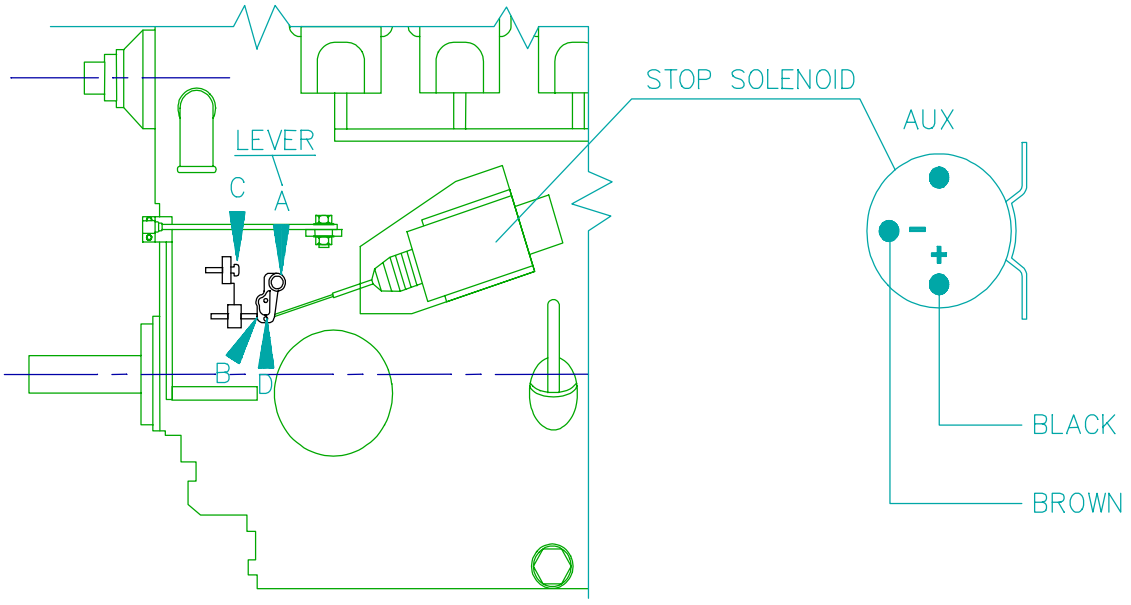
2. The lever is reset to start position (excess fuel) when it is moved fully clockwise until it is against the screw "B".

The electrical stop solenoid takes care of those two functions. When pressing the stop button on the instrument table, the stop solenoid is energised, and the lever "A" is pulled to its stop position.
As soon as the stop button is released, the return spring inside the rubber boot moves the lever back to its start position.

STOP SOLENOID DESCRIPTION.

The stop solenoid has two coils, one for pull and one for hold. When the stop button is pressed, both the pull and hold coil are energised and the plunger retracts. As soon as it "BOTTOMS", the internal switch disconnects the high current winding, and the plunger is kept retracted by the hold coil.

The stop solenoid is secured by an automatic fuse (circuit breaker), located in the relay box.
If the stop function fails, the reason is likely a blown fuse. It should be reset by pressing the upper fuse button.



IMPORTANT!

If the stop solenoid for any reason has been dismantled, it should be refitted in following way:

Move the lever "A" by hand until it rests against the screw "C". Press the stop solenoid plunger fully until it "BOTTOMS". Secure the screw "D" in this position.

Check the function by pressing the stop button. It is very important that the stop solenoid plunger is completely home, otherwise the pull coil fails to be unswitched, and the fuse may blow.

If the stop solenoid fails to work, although the fuse is reset, the reason may be loose or defect wire connections or a faulty internal switch in stop solenoid.

Check the connections. If the connections are in good order, the internal switch may be sticking or corroded.

It may be a good remedy to remove the stop solenoid plunger and spray some contact cleaner (f.inst. CRC 2-26) against the bottom. The nylon switch pin should be loose in its bore.

If the stop solenoid still does not work, try to interconnect the + terminal and the aux. terminal by means of a piece of wire. See fig. When doing so, the pull coil is always energised as long as the stop button is pressed. If the stop button is pressed for more than 4 seconds, the fuse may blow, but usually 4 seconds should be adequate to stop the engine.

If the fuse should blow , the stop solenoid should be allowed to cool down for some time before resetting the fuse.

If everything fails, the engine is stopped manually by moving the lever "A" fully anticlockwise until the engine stops, and so fully clockwise again to reset in start position.

A new stop solenoid should be ordered for replacement.

WINTER LAYING UP

Before laying up the boat for the winter, protect the engine as follows:

Change the oil in engine and gearbox.

If the boat is laid up for more than one year, the HURTH gearbox should be filled completely with ATF-oil. Remember to drain to normal lever before starting.

Grease the nipple for oil seals SABB HVP Gearbox. Close the sea cock and allow the engine to idle for approx. 20 seconds to expel any water from the exhaust hose.

For keel water cooled system there is no need to drain if antifreeze has been added. If the system is drained, the keel cooler must be blown through or drained.

See that the sea water is self-drained from the tubestack in heat exchanger. (Does not refer to engines with keel cooler).

Open impeller pump cover, remove impeller and replace cover drain gearbox oil cooler (HVP-gearbox).

Clean engine externally, and touch up with engine paint.

Drain off water from fuel tank and top up with fuel.

The battery should be recharged and stored in a dry frost-proof place.

RETURN TO SERVICE

When the boat is launched and before taking it into service, again the engine/prop. shaft should be checked for alignment.
Tighten rubber mounts carefully after this check.

Wear protective goggles when handling liquids which are harmful to the eyes; for ex. battery acid. If any of these substances are splashed in the eyes, wash out thoroughly with clean water and OBTAIN QUALIFIED MEDICAL ASSISTANCE IMMEDIATELY.

ORDERING SPARE PARTS

For ordering spare parts, see the separate SPARE PARTS CATALOGUE for correct part name and part number.

When ordering, always state full details:

1. Engine type and Serial no. (Identification plate, Fig. 15)

2. Part name and part No. (See page No. 5 and 6)

3. Quantity

4. Full address, name of ship, port of call, marking and forwarding instructions (air freight, air mail, by ship, by mail).