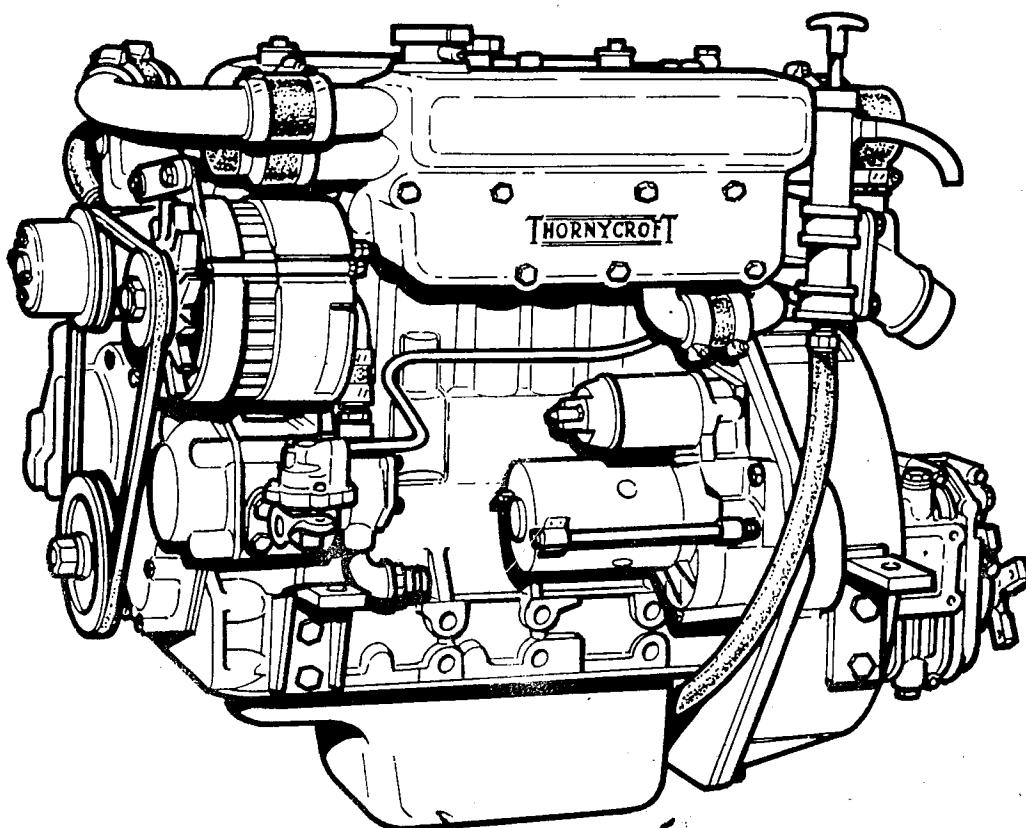


THORNYCROFT

MARINE ENGINES

OWNER'S INSTRUCTIONS



TYPE ~~60~~ & 80 ENGINES

← THIS ONE OK!

THORNYCROFT

Introduction

The purpose of this instruction book is to provide the owner with specific information so that the engine and gearbox can be maintained in a prime working condition throughout its life.

In the event of repair work becoming necessary the advice and services of your Thornycroft dealer should be sought.

For the mechanically Competent Owner Workshop and Spare Parts Manuals giving a complete overhaul procedure are available from:-

Technical Publications Department
Thornycroft Engines
P.O. Box 2
Hurst Lane
Tipton
West Midlands
DY4 9AD
England

Phone: 021-522-2757
Telex: 338205
Telefax: 021-557-2991

THORNYCROFT

MARINE ENGINES

All engines are indirect injection, four stroke naturally aspirated diesel units. The engines have a cast iron cylinder block with integral liners, light alloy pistons and main bearing supports between each cylinder supporting a cast steel dynamically balanced crankshaft. The cast iron cylinder head has precombustion chambers with electrical glow plugs.

A full pressure wet sump lubrication system is employed with a full flow detachable element type oil filter.

The cooling system is indirect and usually employs an engine mounted heat exchanger with a gear driven raw water pump. This system is known as IFWC (internal fresh water cooled.)

An optional system is EFWC (external fresh water cooled.) This system utilizes the engine fresh water pump and usually employs skin tanks attached to the hull to serve as heat exchangers.

The single belt driven alternator and fresh water pump drive include a manual belt tensioning arrangement for low maintenance completes the comprehensive engine package.

60D

3 Cylinder naturally aspirated
Power intermittent at 3000rpm = 20 BHP
 continuous at 3000rpm = 18 BHP
Maximum torque at 2000rpm = 46lbft.
Idle speed = 800rpm
Minimum full load speed = 1800rpm

60E

3 Cylinder naturally aspirated
Power intermittent at 3000rpm = 23 BHP
 continuous at 3000rpm = 20 BHP
Maximum torque at 2000rpm = 47lbft.
Idle speed = 800rpm
Minimum full load speed = 1800rpm

80D

4 Cylinder naturally aspirated
Power intermittent at 3000rpm = 30 BHP
 continuous at 3000rpm = 27 BHP
Maximum torque at 2000rpm = 64lbft.
Idle speed = 800rpm
Minimum full load speed = 1500rpm

80E

4 Cylinder naturally aspirated
Power intermittent at 3000rpm = 31 BHP
 continuous at 3000rpm = 28 BHP
Maximum torque at 2000rpm = 65lbft.
Idle speed = 800rpm
Minimum full load speed = 1500rpm

ENGINE RATINGS

The type 60 Engine may be set to develop continuous outputs from 13.8 to 20 BHP according to requirements.

The type 80 Engine may be set to develop continuous outputs from 15.5 to 35 BHP according to requirements.

For special applications where full power will not be required for periods in excess of 1 hour in any 12 hours consecutive running the engine can be supplied at an intermittent rating as shown above.

NOTE: All horsepower ratings quoted are at the engine flywheel. Due allowance must be made for transmission losses which will depend on the type of gearbox fitted. For tropical use it is necessary to derate the engine by 2% for each 5½°C (10°F) above 30°C (85°F) air temperature at sea level. In some parts of the world further derating for humidity is necessary in accordance with BS 5514/1.

INITIAL STARTING OF ENGINE

PAGE

- 1 Engine Mounting and dipstick marking.
- 2 Lubrication specification for engine and gearbox. Filling gearbox.
- 3 Coolant/corrosion inhibitor specification. Filling cooling system.
- 4 Priming the engine oil system. Bleeding the fuel system.
- 5 Initial start. Normal start. Running in.
- 6 Operating guidelines.
- 7 Operating guidelines.

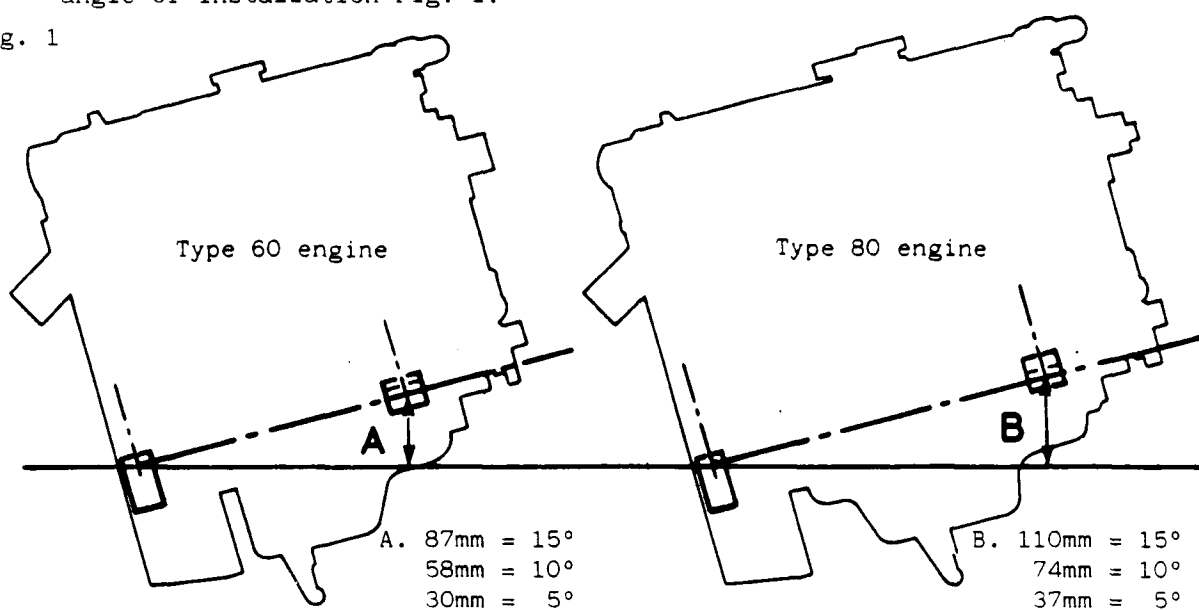
MAINTENANCE

- 8 Fault finding.
- 9 Fault finding
- 10 Maintenance schedule.
- 11 Engine oil and filter change.
- 12 Fuel filter change. Injector removal.
- 13 Gearbox oil change.
- 14 Cleaning air filter.
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- 18 Changing coolant
- 19 Drain raw water system
- 20 External fresh water cooled engines
- 21 Laying up the engine
- 22 Re-commissioning
- 23 Wiring Diagram (Basic Panel)
- 24 Wiring Diagram (Full Panel)

CHECKING ENGINE MOUNTING

The maximum installed angle of the engine is 16° . This allows for a further rise of 4° when the craft is moving. Check the angle of installation using the centreline of the mounting feet bolts as a datum. Measure vertically on the centreline of the underside of the front mounting foot bolt to find the angle of installation Fig. 1.

Fig. 1



MARKING DIPSTICK, FILLING WITH OIL

Your engine is despatched from the factory without engine or gearbox oil and with an unmarked engine dipstick. After the boat is launched, and is resting at its normal trim angle, remove the oil filler cap from the front rocker box Fig.2 and pour 3.5 litres of oil for the type 60 engine, 4.5 litres of oil for the type 80D, 6 litres of oil for the type 80E engine through the filler hole. For recommended oils see Page 2. Allow 5 minutes for the oil to drain into the sump, withdraw the dipstick and mark it for high oil level Fig.3. Use a centre punch for marking as filing a notch can cause fatigue and eventual breakage while the engine is running. Measure 12mm ($\frac{1}{2}$ ") below high oil level mark and centre punch dipstick this will be low level oil mark.

Fig. 2

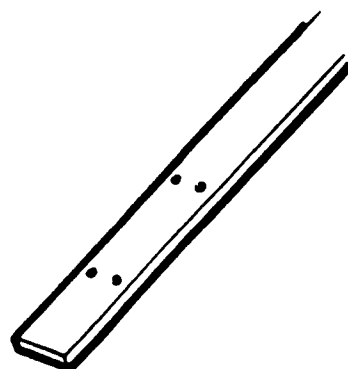
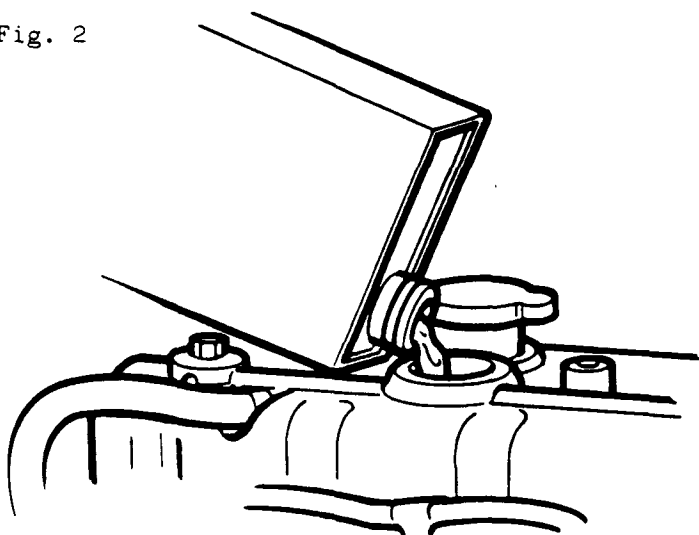


Fig. 3

ENGINE OILRUNNING IN OILS

Do NOT use special running-in lubricating oils for new or rebuilt engines. Use the lubricating oils specified for normal engine operation.

ENGINE OIL VISCOSITY RECOMMENDATIONS

The use of a multi-graded lubricating oil has been found to improve oil consumption and improve engine cranking in cold temperatures while maintaining lubrication at high operating temperatures. A multi-grade oil conforming to MIL-L-20104B or APICC is recommended with the viscosity grades shown in Fig. 4. The use of single grade lubricating oil is not recommended except for synthetic oils used in arctic conditions. It is recommended to use SAE 10W-30 oil at all seasons because of its minimum viscosity change under variations of temperature.

Atmospheric Temperature	Viscosity
20°C (68°F) or above	SAE 10W - 30
5°C (41°F) to 20°C (68°F)	SAE 10W - 30
5°C (41°F) or below	SAE 10W - 30

Fig. 4.

GEARBOX OIL

Hurth	Automatic Transmission Fluid (Type A)	
Newage P.R.M.	SAE 20 Engine Oil	Minus 18°C to 0°C
	SAE 30 Engine Oil	Above 0°C

FILLING THE GEARBOX

Remove the oil filler plug combined dipstick from the top of the gearbox. This is in approximately the same position on Hurth and Newage P.R.M.

Using a plastic bottle or funnel, fill the gearbox up to the maximum mark on the dipstick. There is one level mark on the Hurth dipstick, the P.R.M. has high and low marks.

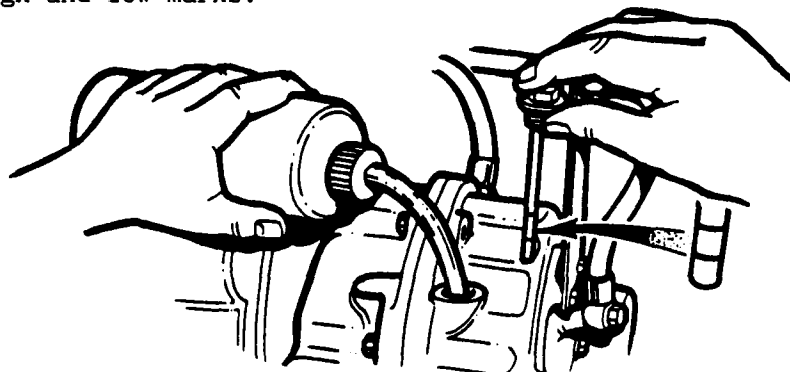


Fig. 5

COOLANT

Use anti-freeze during all seasons to protect the engine cooling system from corrosion as well as freeze damage.

Anti-freeze solution	25 % solution	33 1/2 % solution	50 % solution
Complete protection	10°F (-12°C)	3°F (-16°C)	- 4°F (-20°C)
Safe limit	1°F (-17°C)	-8°F (-22°C)	-18°F (-28°C)

In tropical climates where anti-freeze availability may be limited, use a corrosion inhibitor to protect the engine cooling system.

COOLANT QUANTITIES REQUIRED

Type 60 ENGINE

8 ltrs

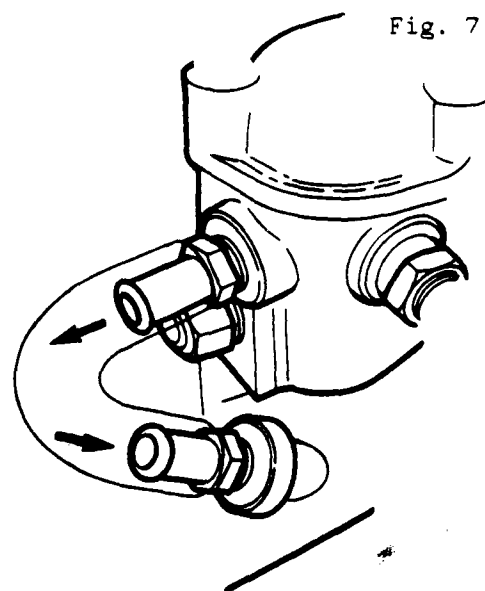
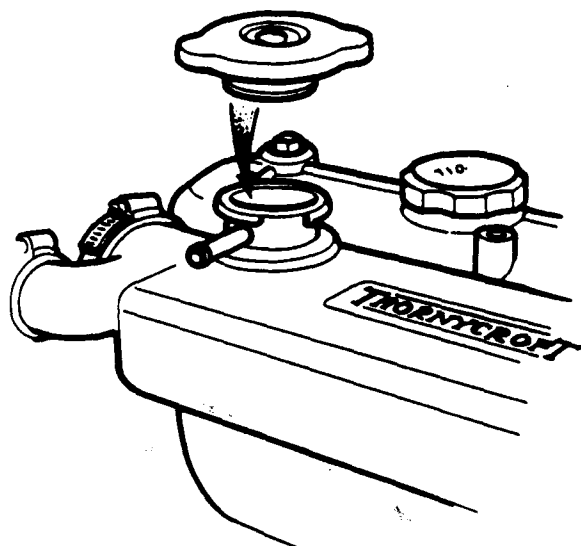
Type 80 ENGINE

8.5 ltrs

FILLING THE COOLING SYSTEM

Remove the filler cap from the header tank. Fig 6. Pour the coolant into the heat exchanger. This will take approximately 5 minutes as the system self bleeds. Fill to 5mm below the filler neck level mark. Refit filler cap.

Fig. 6



CALORIFIER FITTINGS FIG. 7

The fittings as shown in Fig.7 form the original connections of the thermostat bypass system, these connections may be used to feed the calorifier installation on board but under NO CIRCUMSTANCES should the attached circuit be restricted by means of a valve.

WARNING: THERE MUST ALWAYS BE AN OPEN CIRCUIT

PRIMING THE ENGINE OIL SYSTEM

As only a residual amount of oil is present in the oil pump filter and oil galleries of the engine it is therefore necessary to prime the system before the engine is run. Connect the engine starter batteries, operate the key starter switch with the stop control out, crank the engine over until pressure registers on the oil pressure gauge. Stop cranking and check the engine and gearbox for oil or water leaks.

BLEEDING THE FUEL SYSTEM

Slacken the bleed screw on the injection pump Fig. 9

Operate the fuel lift pump Fig. 8 until fuel coming out of the bleed point is free from air bubbles. Retighten screw. Start engine and check for fuel leaks.

Note: For External Fresh Water Cooled Engines.

These engines are fitted with an electrically operated fuel lift pump. To bleed these fuel systems slacken the bleed screw Fig. 9. Operate the electrical fuel lift pump by turning the starter key to the run position. Hold for a few seconds, this will allow the trapped air to be expelled.

Caution: DO NOT RUN THE STARTER FOR MORE THAN 30 SECONDS CONTINUOUSLY. ALLOW 2 MINUTES BETWEEN ENGINE CRANKING.

Fig. 8

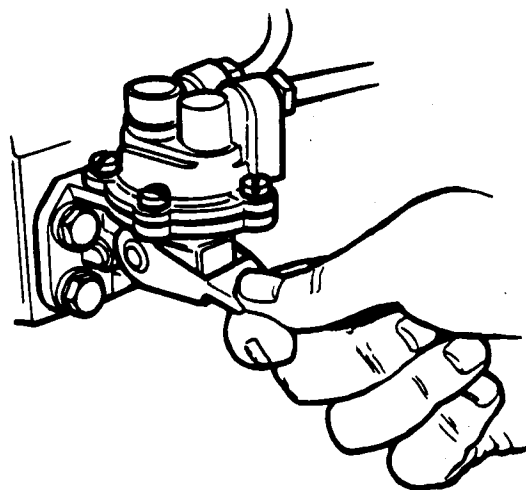
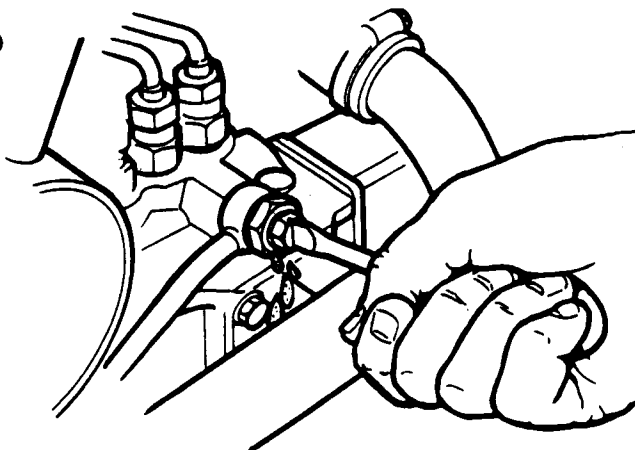


Fig. 9



INITIAL START

With all systems filled, primed and checked the engine may be started. Run it for 2 to 3 minutes then stop it. Top up engine, gearbox oil and water levels to the high mark. The engine and gearbox are now ready for use. Oil pressure should be observed within 15 seconds.

NORMAL STARTING PROCEDURE

- 1 Put gearbox selector lever in neutral.
- 2 Set the throttle at half speed.
- 3 Turn the key to 'H' position on starter switch and hold for 20 seconds (this preheats the glow plug). This is not necessary for a warm engine.
- 4 Turn the key to 'H & S' position and the starter motor will crank up the engine.
CAUTION: If the starter fails to crank up the engine within 10 seconds, release the switch key and wait for the starter motor to come to a complete stop. Then turn the key to 'H & S' position again. Do not engage the starter motor for more than 30 seconds, then wait 2 minutes between unsuccessful attempts.
- 5 Move the throttle position to idle as soon as engine starts.
- 6 Oil pressure should be observed within 15 seconds.

RUNNING IN

The care given to an engine in the first 20 hours of operation will result in longer life, better performance and more economical operation. During this period follow these recommendations.

- 1 Warm up the engine before placing it under load.
- 2 Do not operate the engine at idle or full load for more than 5 minutes.
- 3 Avoid constant speed.
- 4 Observe oil pressure and temperature gauges.
- 5 Check the oil and coolant levels frequently.

COMPLIANCE WITH THE FOLLOWING RECOMMENDATIONS CAN RESULT IN LONGER LIFE, BETTER PERFORMANCE AND MORE ECONOMICAL OPERATION OF YOUR ENGINE.

Routinely perform all of the specified maintenance, including the "First Start of the Day" checks.

Use anti-freeze during all seasons to protect the cooling system from corrosion as well as freezing damage.

Never operate the engine without a thermostat.

Use quality fuel that is free of water and other contaminants.

Monitor the oil pressure and temperature indicators frequently.

AVOID FULL THROTTLE OPERATION WHEN THE ENGINE IS COLD.

When starting a cold engine, bring the engine up to operating speed slowly to allow the oil pressure to stabilise as the engine warms up.

If temperatures are below 0°C (32°F), operate the engine at moderate speeds for 5 minutes before full loads are applied.

AVOID IDLING THE ENGINE FOR MORE THAN 10 MINUTES

Long periods of idling may be harmful to your engine because combustion chamber temperatures can drop so low that the fuel may not burn completely. Carbon can then form which may clog the injector spray holes and also cause valves and piston rings to stick.

AVOID OVERHEATING THE ENGINE

Coolant temperature must not exceed 99°C (210°F) with a 70kPa (10 psi) expansion tank cap AND A MINIMUM OF 50% mixture of ethylene-glycol and water.

IDLE THE ENGINE A FEW MINUTES BEFORE ROUTINE SHUTDOWN

After full load operation, idle the engine 3 to 5 minutes before shutting it off to allow the lubricating oil and coolant to carry heat away from the combustion chamber, bearings, shafts, etc.

AVOID LOW COOLANT TEMPERATURE OPERATION

Continual operation at low coolant temperature below 60°C (150°F) can be harmful to the engine. Low coolant temperature can cause incomplete combustion allowing carbon and varnish to form that can damage piston rings and injector nozzles. Also, the unburnt fuel can enter the crankcase diluting the lubricating oil causing rapid wear to other moving parts.

DO NOT OPERATE THE ENGINE WITH LOW OIL PRESSURE

When the engine is at normal operating temperature, the minimum oil pressures required are:-

Idle (800 RPM) 110 kPa (10 psi)
Full Speed and Load 240kPa (25 psi)

DO NOT OPERATE THE ENGINE WITH FAILED PARTS

Practically all failures give some warning before the parts fail. Be on the alert for changes in performance, sounds and visual tip-offs that indicate either service or repair is needed. Some important clues are:-

- Engine misfiring or vibrating severely
- Sudden loss of power
- Unusual engine noises
- Fuel, oil or coolant leaks
- Sudden change in the engine operating temperature
- Excessive smoke
- Loss of oil pressure

SAFETY PRECAUTIONS

Safety is built into every engine; however, like any other mechanical device, it can present serious threat to life and limb if imprudently operated and maintained. Remember that the best safeguards against accidents are to keep ever mindful of the potential dangers and to always use good common sense.

FAULT FINDING

ENGINE WILL NOT START

Starter does not crank engine	ELECTRICAL FAULT Battery run down Lead disconnected Faulty starter switch Faulty starter motor
----------------------------------	--

Starter cranks engine slowly	ELECTRICAL FAULT Battery partly run down Terminal(s) loose Connections dirty Faulty starter motor
	MECHANICAL FAULT Wrong grade engine oil

Starter cranks engine normally	ELECTRICAL FAULT Faulty glow plugs Faulty wiring connection
	MECHANICAL FAULT Injection timing incorrect Poor cylinder compression Blocked air intake

Fuel Not Reaching Injection Pump	FUEL FAULT Insufficient fuel in tank Blocked fuel pipeline Blocked fuel tank vent Restricted fuel filter Air leaks in pipeline
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Fuel Reaching Injection Pump	Air in fuel system Faulty injectors
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ENGINE RUNS INCORRECTLY

	MECHANICAL FAULT	FUEL FAULT
Engine overheats	Insufficient water Insufficient lubricating oil Drive belt slack or broken Thermostat sticking Injection timing incorrect Water pump needs attention Engine needs top overhaul	Faulty injector(s)
Engine knocks	Bearings worn Piston slap Broken valve spring(s) Injection timing incorrect	Faulty injector(s) Air in system
Engine misfires	Sticking valve(s) Incorrect valve clearance(s) Leaking cylinder head gasket Sticking piston rings Engine needs top overhaul Broken injector pipe	Faulty injector(s) Air in system Faulty injection pump
Engine does not give full power	Sticking valve(s) Worn piston rings and bores Incorrect valve clearance Sticking piston rings Injection timing incorrect Engine overheating	Air in system Fuel filter restricted Faulty injector(s) Insufficient fuel in tank Dirty air intake
Engine idles imperfectly	Governor idling setting incorrect Injection timing incorrect Sticking valve(s) Broken valve spring(s)	Air in system Fuel filter restricted Faulty injector(s) Blocked fuel tank vent Insufficient fuel in tank Faulty injection pump
Excessive fuel consumption	Loose or broken fuel pipe connection Injection timing incorrect	Dirty air intake Faulty injector(s)
Exhaust emits excessive White smoke	Injection timing incorrect Poor compression Water in the cylinders	
Exhaust emits excessive Black smoke	Insufficient coolant	Faulty injector(s) Inj. pump maximum stop screw out of adjustment
Exhaust emits excessive Blue smoke	Engine needs top overhaul Worn piston rings and bores	Faulty injector(s)

DAILY OR EVERY 10 HOURS

Check fuel level
Check alternator, water pump, drive belt condition.
Check the engine and gearbox oil, top up as necessary.
Check the water level in the heat exchanger and if necessary top up with the relative mixture of water/anti-freeze, or inhibitor.
Check for abnormal sounds or vibrations.

AFTER FIRST 25 HOURS

Change the engine oil and renew the engine oil filter.
Check the valve rocker clearance.
Check the belt drive.
Check water hose connections.
Check all electrical equipment.
Change fuel filter element.
Check and service injectors.
Check and adjust engine idling speed as necessary (use a Thornycroft dealer)
Check torque on cylinder head bolts.

ENGINES IN REGULAR USE**EVERY 50 HOURS**

Check electrolyte level in batteries.
Check strnegth of anti-freeze solution.

EVERY 100 HOURS

Change engine oil.
Change engine oil filter.
Check air cleaner and clean if necessary.
Check drive belts.
Check state of charge of batteries.
Check oil level in gearbox.
Check and adjust engine idling speed as necessary.

EVERY 200 HOURS

In addition to the 100 hour maintenance

Renew the fuel filter element.

EVERY 400 HOURS

In addition to the 100 and 200 hour maintenance schedules

Inspect the glow plugs.
Change the gearbox oil.
Check valve clearances.
Check and service injectors as necessary (use a Thornycroft dealer)
Check all engine connections and external bolts, nuts, studs and plugs.
Check the starter motor and alternator for corrosion, loose connections etc.
Check and service injectors.

EVERY 800 HOURS

In addition to the 100, 200 and 400 hour maintenance schedules
Check cylinder compression pressure.
Check injection equipment.
Flush cooling system and renew coolant.
Inspect starter pinion and flywheel ring gear.

ENGINES USED OCCASIONALLY HALVE THE HOURS RECOMMENDED AFTER FIRST 25 HOURS

Run the engine until it reaches normal operating temperature, stop the engine, then using the hand pump, drain the oil into a suitable container. Fig. 10

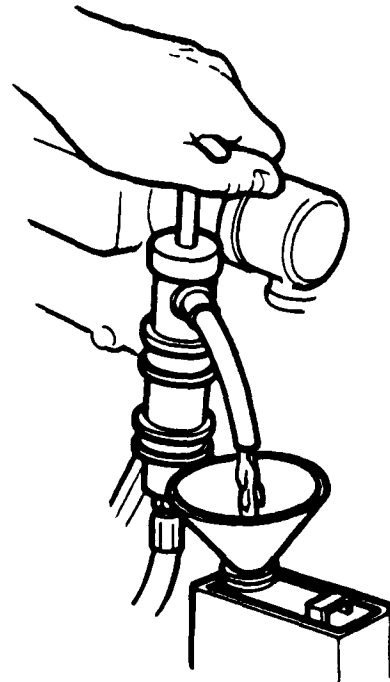
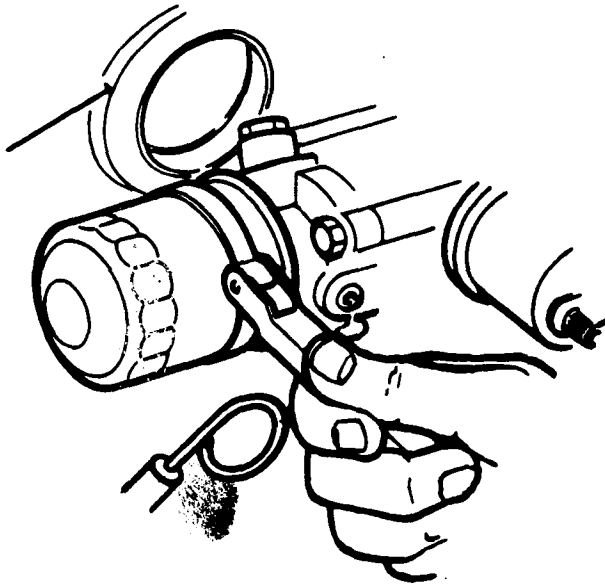


Fig. 10

Fig. 11



Unscrew the oil filter cartridge using a strap wrench, discard the cartridge and its sealing ring. Fig. 11

Lightly smear the sealing ring with engine oil Fig. 12 and screw the filter on using hand pressure only.

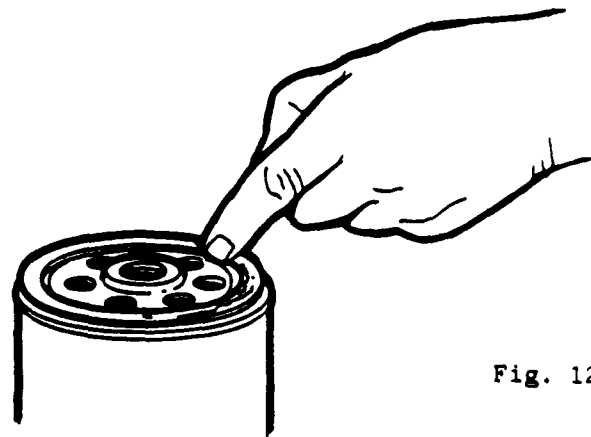
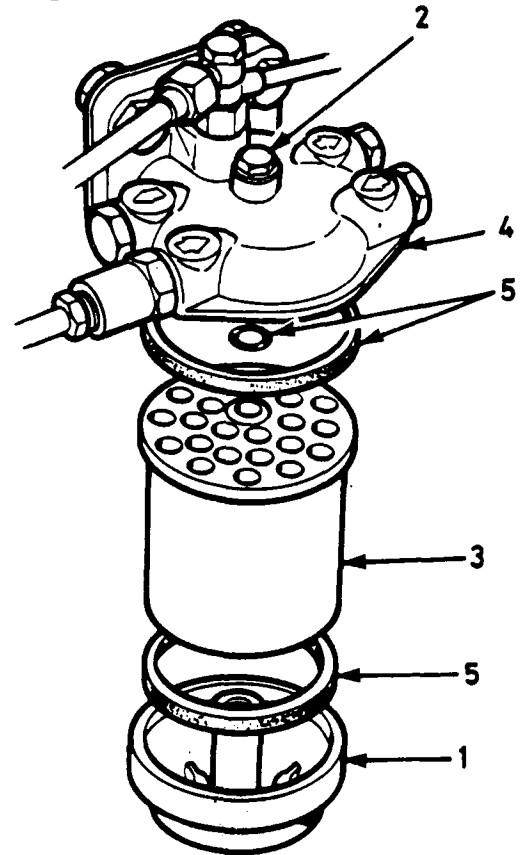


Fig. 12

Fill the engine up to the maximum mark on the dipstick. Operate the key starter with the stop control out and crank the engine over till pressure registers on the gauge. Push stop control and start the engine. Check for oil leaks, run for 2 minutes, stop the engine and check oil level.

Fig. 13



To change the fuel filter, stop the engine. Turn off fuel tap (supply). Support the filter base '1' and unscrew the centre bolt '2'. Detach the base and twist the element '3' to separate it from the filter head '4'. Remove the three sealing rings '5' from the head and base. Clean the base and assemble the filter using new element and sealing rings, fitting the element with its strengthened rim uppermost. Bleed the fuel system as described on Page 4.

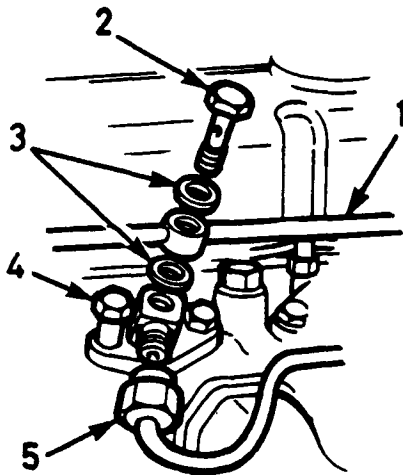


Fig. 14.

FUEL INJECTORS

Injector cleaning and spray testing can only be carried out with specialised equipment, therefore this must only be done by a distributor or dealer.

To remove the injectors Fig. 14, disconnect the spill rail '1' by removing the banjo bolt '2', Note: the sealing washers '3' on each side of the spill rail banjo union. Remove the fuel feed pipes '5' then the injector securing bolts '4' and withdraw the injector assembly.

When replacing injector assembly, torque securing bolts '4' to 1.5 - 2 kg.m (10.8 - 14.5 ft.lbs).

CHANGING THE GEARBOX OIL

The gearbox oil must be changed when the gearbox has reached operating temperature. (After about 1/2 hour driving the craft).

To help the oil drain easily from the gearbox first remove the oil filler dipstick plug from the top of the gearbox. Place a suitable container under the gearbox and remove the drain plug from the underside of the gearbox and allow the oil to drain completely Fig. 15. The drain plug is in approximately the same position on the underside of Hurth and Newage PRM gearboxes.

Refit the drain plug. Fill the gearbox to the maximum mark on the dipstick. Refit the filler plug, start the engine in neutral, and run the engine for 1 minute to allow the oil to circulate. Stop the engine and check the oil level. Top up if necessary to the maximum mark on the dipstick.

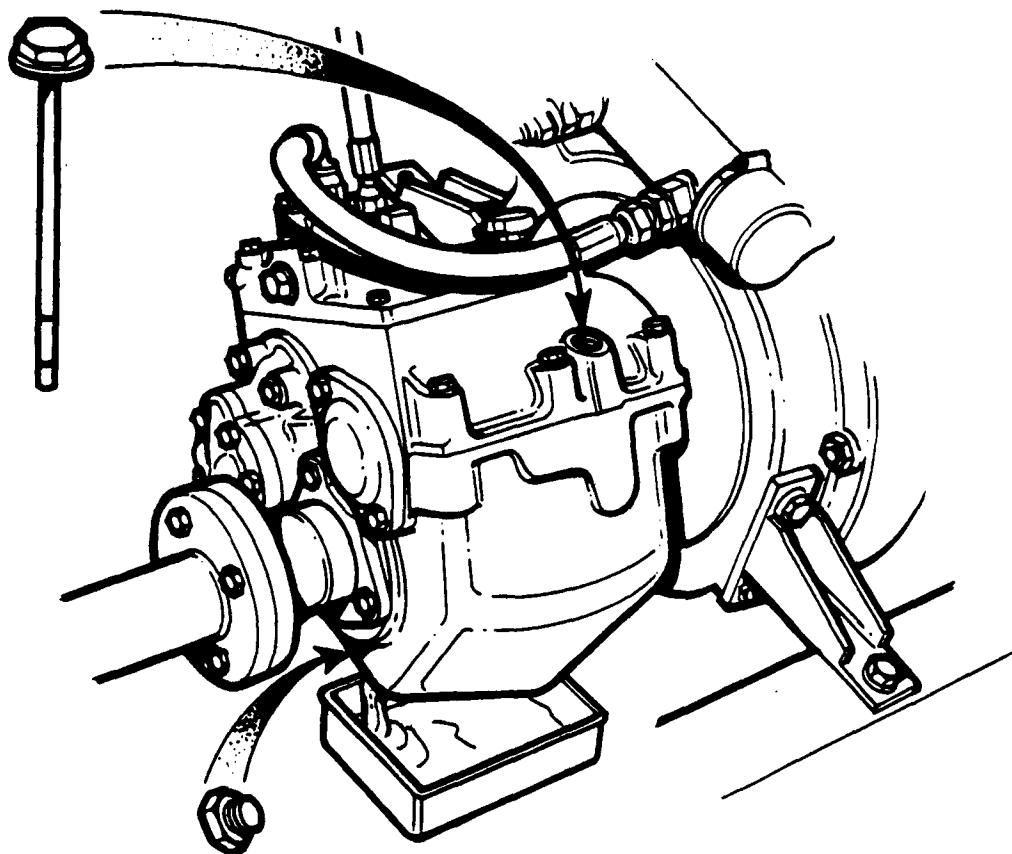


Illustration shows Newage PRM 160 Gearbox

Fig. 15

CLEANING AIR FILTER

To remove air filter; Pull off breather hose then slacken the screw arrowed in Fig.16. This allows access (by removal of the outer casing of the filter) to the two set screws which hold the main body of the filter to the inlet manifold adaptor. Remove the setscrews. Submerge the complete air filter in a bath of clean paraffin or diesel fuel, agitate it vigorously to remove dirt particles. Shake the filter dry by hand or blow dry with compressed air, then refit.

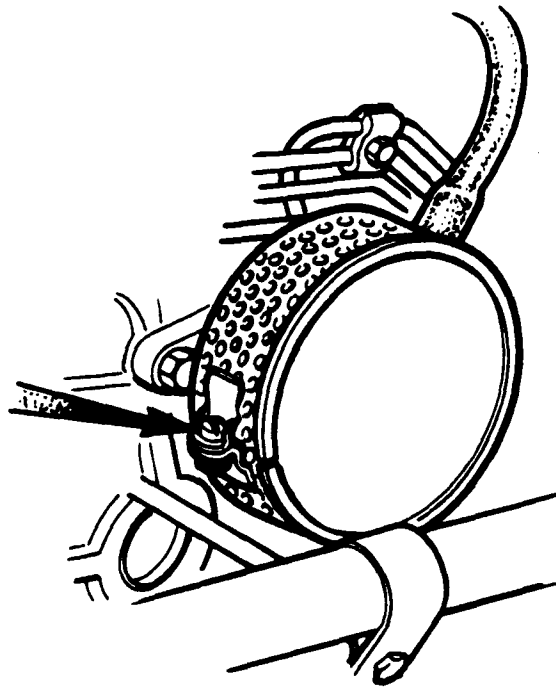


Fig. 16

CAUTION: WHEN USING A COMPRESSED AIR LINE GREAT CARE
MUST BE OBSERVED AND GOGGLES MUST BE WORN.

SAFETY - BEFORE ATTEMPTING THIS OPERATION DISCONNECT THE STARTER BATTERIES**Adjusting Drive Belt**

Slacken the nuts and bolts (Fig.17) 1, 2 and 3 move alternator away from the engine until the deflection of the belt (arrowed) is 10 - 12mm (0.39 - 40.47 in) when depressed using finger pressure only at the longest point between pulleys. Excessive tension will cause early wear of the belt, water pump bearing and alternator bearing. While a slack belt will slip, causing overheating of the engine and insufficient charging of the battery. Check deflection after retightening.

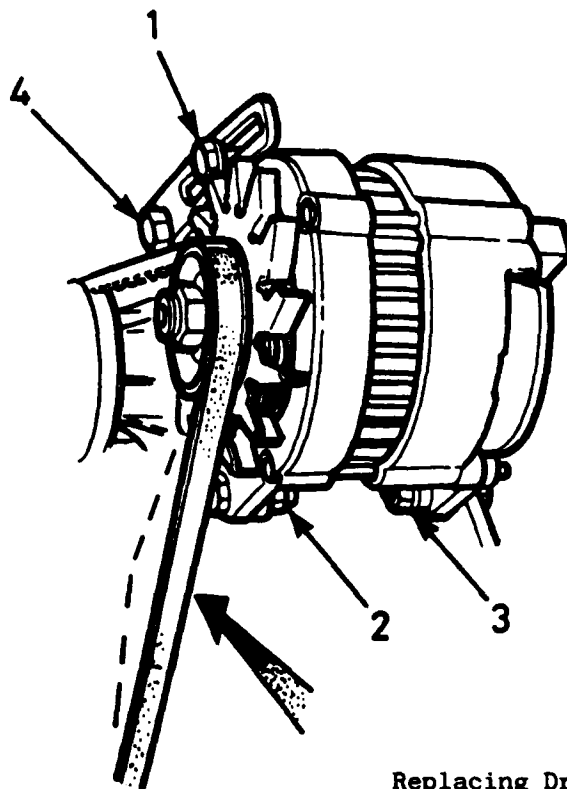


Fig. 17

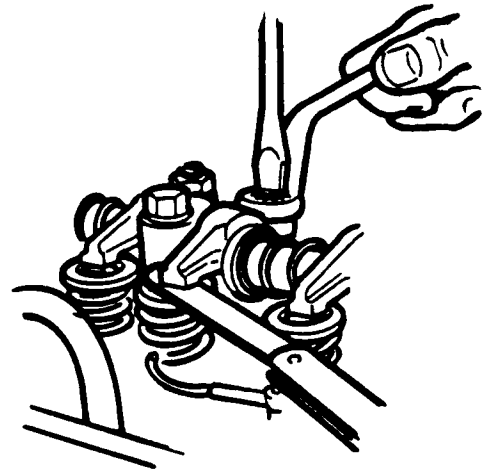
Replacing Drive Belt

Slacken the nuts and bolts 1 - 4 and move alternator in towards engine. Remove old belt from pulleys and replace with new drive belt. Retighten nuts and bolts. Following the instructions above readjust the drive belt tension.

SAFETY - BEFORE ATTEMPTING THIS OPERATION DISCONNECT THE STARTER BATTERIES

The checking or setting of valve clearances must be done with the engine cold.

Fig. 18



Adjusting Valve Clearance

Remove air breather pipe from rocker cover, slacken rocker cover bolts and remove rocker cover.

Adjust the valve clearance at top dead centre of each cylinder as described below.

Align the timing marks on the gear case and the crankshaft pulley as shown Fig.20. In this position, No.1 cylinder is in top dead centre of its compression stroke. Check both intake and exhaust valve clearances of the cylinder. If the valves have no specified clearance, adjust by means of the adjusting screws Fig.18. Remember to align the timing marks properly; if not, the valve will interfere with the piston because of wrong cam position.

Next, the piston on No.3 cylinder comes to top dead centre. Turn the crankshaft 240° clockwise from the above position, aligning the timing mark of the crankshaft with that of the gear case. Then check and adjust the valve clearance.

To check No.2 cylinder valve clearance, turn the crankshaft another 240° clockwise, then align the timing marks and check and adjust the valve clearance in a similar manner.

Recheck the clearance with the locknuts tightened and readjust if necessary.

Valve Clearance

Inlet Valve	0.25mm	(0.0098 in)
Exhaust Valve	0.25mm	(0.0098 in)

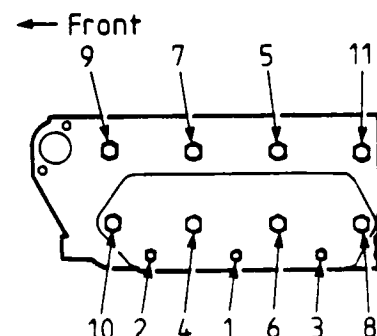


Fig. 19 Cylinder Head Bolts Tightening Sequence

10mm dia bolts 7-8 kgm
(50.6-57.8 ft lbs)

12mm dia bolts 11-12 kgm
(79.5-86.8 ft lbs)

60E only

12mm dia bolts 12-13 kgm
(86.3-94 ft lbs)

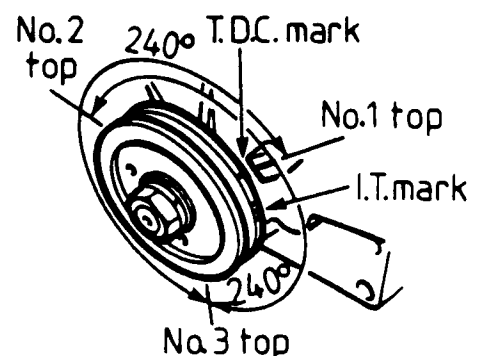


Fig. 20 Timing Mark

SAFETY BEFORE ATTEMPTING THIS OPERATION DISCONNECT THE STARTER BATTERIES

The checking and setting of valve clearances must be done with the engine cold.

Adjusting Valve Clearance

Remove air breather pipe from rocker cover, slacken rocker cover bolts and remove rocker cover.

Slacken the locknut and adjust with a screwdriver until correct clearance is obtained Fig.21 Set clearances in the following sequence.

Set No.1 tappet with No.8 valve fully open
Set No.3 tappet with No.6 valve fully open
Set No.5 tappet with No.4 valve fully open
Set No.2 tappet with No.7 valve fully open
Set No.8 tappet with No.1 valve fully open
Set No.6 tappet with No.3 valve fully open
Set No.4 tappet with No.5 valve fully open
Set No.7 tappet with No.2 valve fully open

Recheck the clearance with the locknuts tightened and readjust if necessary.

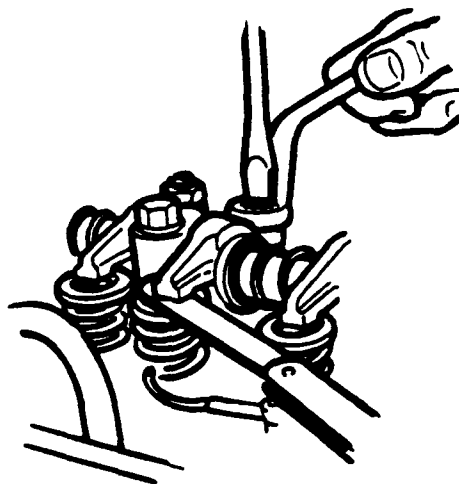


Fig. 21

Valve Clearance

Inlet Valve 0.25mm (0.0098in)
Exhaust Valve 0.25mm (0.0098in)

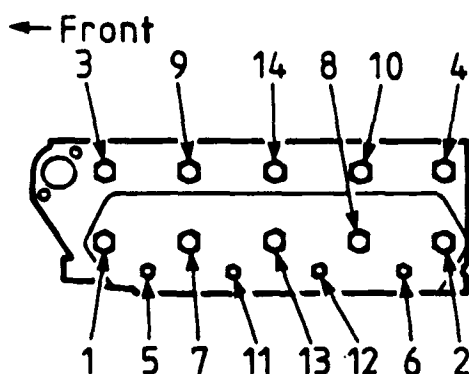


Fig. 22

Fig. 22 Cylinder Head Bolts Tightening Sequence

80C only

12mm dia bolts 11-12 kgm
(79.5-86.8ft lbs)
10mm dia bolts 8-9 kgm
(57.5-64.7ft lbs)

80D and 80E

12mm dia bolts 12-13 kgm
(86.3-94 ft lbs)
10mm dia bolts 8-9 kgm
(57.5-64.7ft lbs)

CHANGING COOLANT

Remove filler cap from heat exchanger, place a suitable container beneath the connection Fig.23 slacken the clip and pull the hose away from the heat exchanger as shown, allow to drain. Open drain tap Fig.24 and allow coolant to drain from cylinder block into a suitable container.

Fig. 23

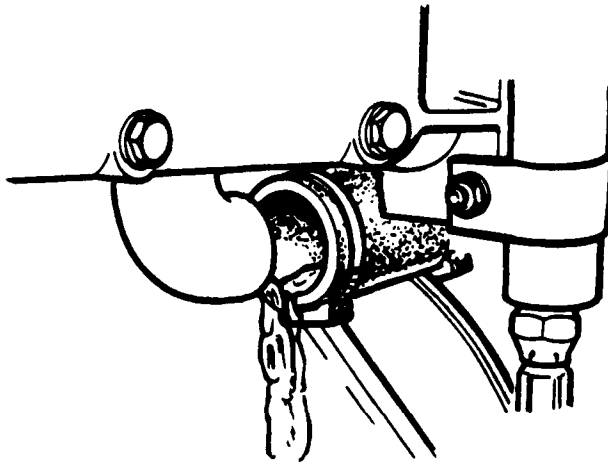
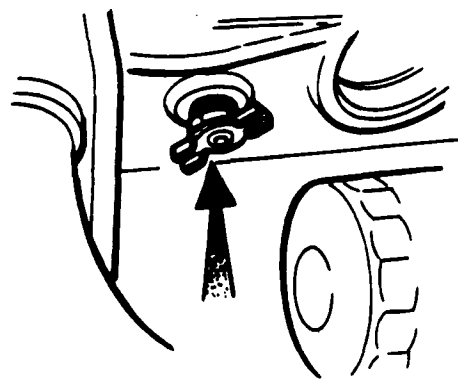


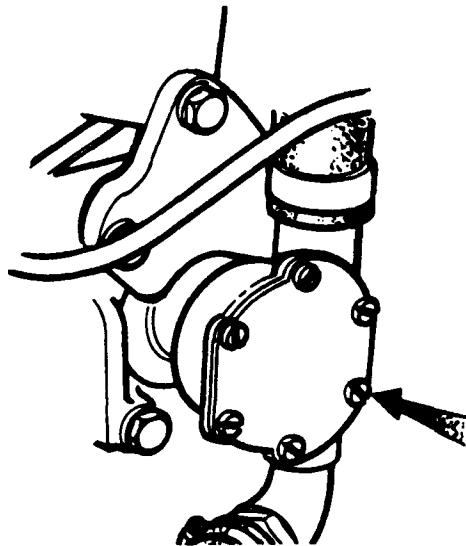
Fig. 24



DRAIN THE RAW WATER SYSTEM

Slacken the six screws Fig.25 on the raw water pump. Remove end covers from heat exchanger and drain tubes either by removing the tube stack or by blowing out with compressed air. Remove oil cooler and drain tubes or blow out with compressed air. Alternatively disconnect raw water pipework before gearbox oil cooler and pipe from oil cooler into a container of anti-freeze mixture and flush through system returning anti-freeze mixture from water injection bend back into container, this ensuring that any water pockets contain anti-freeze. NOTE: ANTI-FREEZE MIXTURE MUST BE OF CORRECT STRENGTH FOR CONDITIONS TO BE ENCOUNTERED.

Fig. 25



CAUTION: WHEN USING A COMPRESSED AIR LINE GREAT CARE MUST BE OBSERVED AND GOGGLES MUST BE WORN.

ROUTINE MAINTENANCE OF SEA WATER SYSTEM IFWC

THESE NOTES DO NOT APPLY TO EXTERNAL FRESH WATER COOLED ENGINES.

Examine and clean the sea inlet strainer at regular intervals. Do Not remove the strainer when the engine is running as foreign matter can be drawn into the system and cause irreparable damage to the pump. The sea cock must be FULLY OPEN when the engine is running. If the sea cock is partially closed, air can be drawn in with consequential failure of the sea water pump and engine overheating. Check the sea water discharge pipe immediately after starting the engine to see if the sea water pump is functioning.

The engine MUST NOT run without a flow of sea water through the heat exchanger.

SEA WATER PUMP, the sea water pump is self priming and fitted with a neoprene impellor. It depends on the sea water for its lubrication. DO NOT run dry. More than 30 seconds running without water will burn the impellor and be contributory to an early failure. When replacing the end cover gasket, it is essential to use the correct part; variation of the gasket thickness can cause loss of self priming ability or seizure.

LAYING UP THE ENGINE

1. Run the engine until hot, drain the oil from the engine sump, reverse gear and reducing gear (if fitted), and re-fill with clean new oil, renew the fuel filter and lubricating oil filter elements.
2. Turn off the main fuel cock on the fuel tank and disconnect the fuel suction pipe from the suction connection on the fuel feeder pump. Rig up a small temporary fuel tank connected to the suction side of the feeder pump and fill it with a high quality, low viscosity corrosion-inhibiting oil such as Shell Fusus A. (It is essential to pipe up the temporary line as described, so as to include the feeder pump and filter in the circuit.)
3. Run the engine at about half speed for a further 15 to 20 minutes to circulate the new oil through the bearings, and the corrosion inhibitor through the injection equipment.
4. Drain the cooling system as described on Page 18 (or fill with recommended anti-freeze mixture) and any jacketed exhaust bends or silencers.
5. Turn off the sea cock, disconnect the water suction connection on the sea inlet and drain the suction pipe to the engine.
6. Check and clean the sea inlet strainer (if fitted).
7. Remove the electrical equipment components from the engine and store them ashore in a warm dry place. Wrap the components securely if they are liable to get dirty or dusty while ashore.
8. Remove the engine sea water pump and bilge pump (if fitted). These pumps are of the rubber impellor type and these should be stored, preferably with the impellers removed and tied up to the exterior of the pump and kept in the dark. On no account must the impellers be oiled as this will cause swelling and consequent failure.
9. Blank off the engine air intake and also the exhaust outlet and any cooling water discharge pipes at the skin of the boat.
10. Well grease any parts of the engine liable to rust or corrode.

If the boat is to be hauled out of the water for storage

Disconnect the tailshaft coupling before hauling the boat out of the water.

If the sterngear is equipped with external sand excluders, care must be taken to prevent the shaft from sliding aft more than 12mm ($\frac{1}{2}$ in) when the couplings are disconnected.

Check the propeller and external sterngear for damage.

Open the sea cock (if fitted) to drain the sea inlet.

ROUTINE MAINTENANCE DURING LAY-UP

Turn the engine at least 3 to 4 revolutions every four weeks to maintain satisfactory oil films on bearings, bores, etc.

If the boat is lying afloat, check that bilge water does not rise enough to enter the engine or reverse gear through the dipstick holes or shaft seals.

RE-COMMISSIONING

Make good all cooling circuit connections and refill the cooling system.

Replace the electrical equipment and check that all connections are good.

Adjust belt tension as necessary.

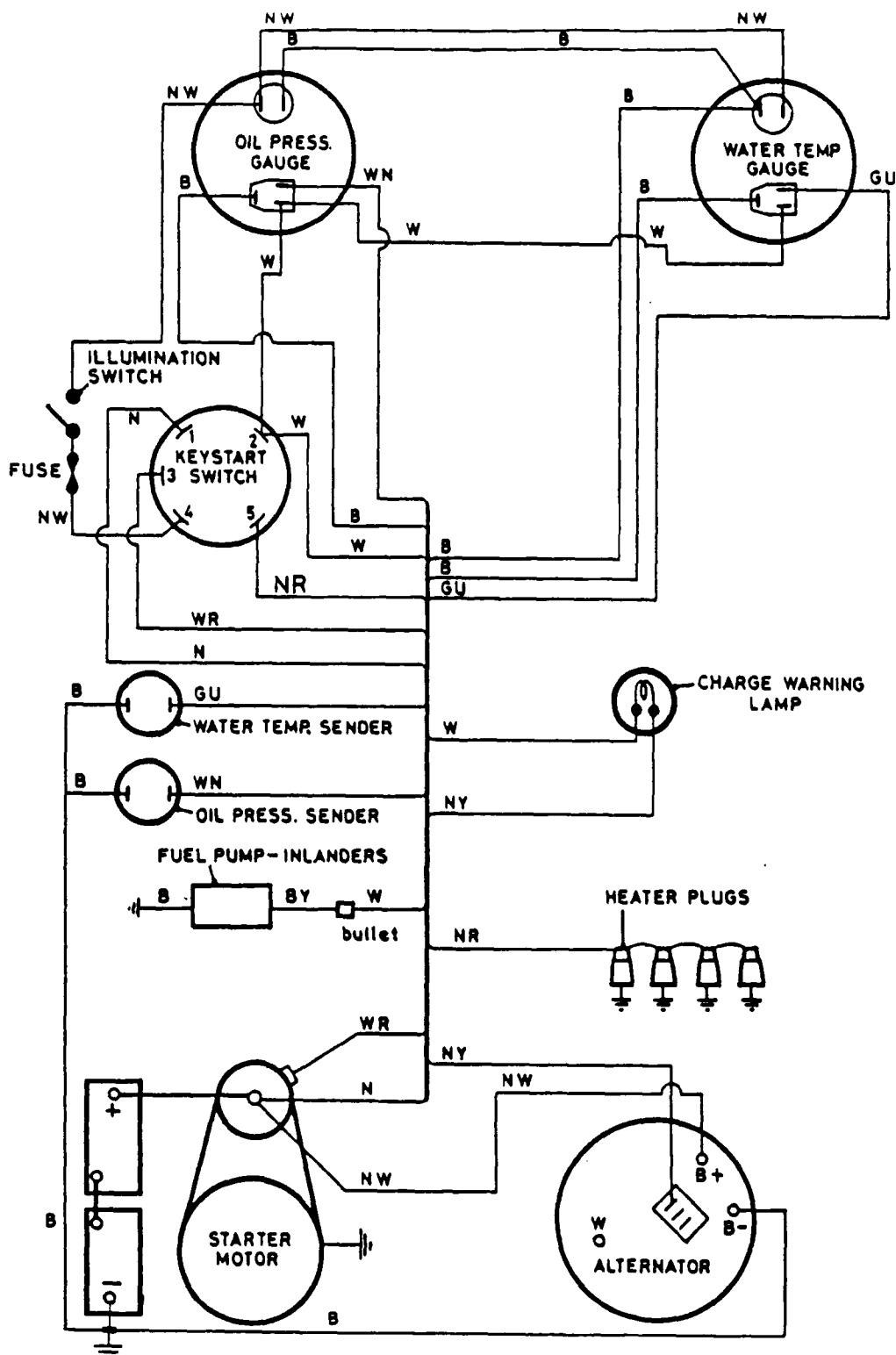
Replace the engine sea water pump and bilge pump (if fitted). Adjust belt tension as necessary.

Slack off the stern tube gland if it was tightened up when preparing the boat for laying-up.

Remove all plugs and covers from skin-side fittings and air intake.

Turn the engine by hand at least two complete turns to ensure that everything is free before attempting to start up.

CODE	COLOUR
B	BLACK
N	BROWN
U	BLUE
G	GREEN
LG	LIGHT GREEN
O	ORANGE
P	PURPLE
R	RED
S	SLATE
K	PINK
W	WHITE
Y	YELLOW



CODE	COLOUR
B	BLACK
N	BROWN
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