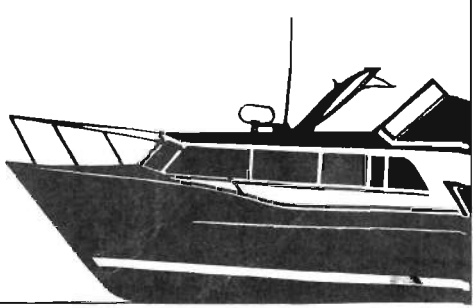
Perkins engines

SERIAL # ED 70C58U549C31.6

handbook
for marine diesel engines

TRANS. MOD # HBW-150-2A

4.108M



handbook for 4.108M diesel engines

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n addition to the above, there are Perkins Distributors in the majority of countries throughout the world. For further details, apply o Perkins Engines Limited, Peterborough, or to one of the above companies.

PF 2 Duragard Oil Filter
557 5840
PF 2

engine guarantee

The guarantee applies to new engines and spare parts only. It does not cover second hand engines or parts, spurious parts, accessories and proprietary fittings.

Perkins do not accept guarantee claims direct from Boat Owners. If a claim under guarantee becomes necessary, the Boat Owner should contact the nearest Perkins Marine Distributor, his approved Dealer or the Company from whom he purchased his craft.

The full terms of Perkins guarantee are set out in the Engine Guarantee Certificate which is issued with each engine and should be found with the ship's papers, having been passed by the Perkins Distributor to the Boatbuilder concerned.

It would assist if the Guarantee Certificate could be produced on any occasion that a claim is made.

examples of service facilities

Service Instruction

Perkins Engines, Inc.
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Phone: (313) 595-9600

Service Publications

The following Service Literature may be purchased through your local Perkins Distributor.

Workshop Manuals
Fault Finding Guide
Crankshaft Regrinding
Installation and Maintenance Guide for Static Standby Engines
etc.

USE ONLY GENUINE PERKINS PARTS

contents

This handbook has been issued to guide operators in the correct use and maintenance of Perkins Marine Diesel engines. Providing an engine is correctly installed, correct maintenance and certain precautions are observed, then no operating difficulties or failures should be experienced. All matters relating to marine propulsion are covered, also fault diagnosis and remedy, and minor repairs which the average marine operator can undertake, whilst his craft is afloat.

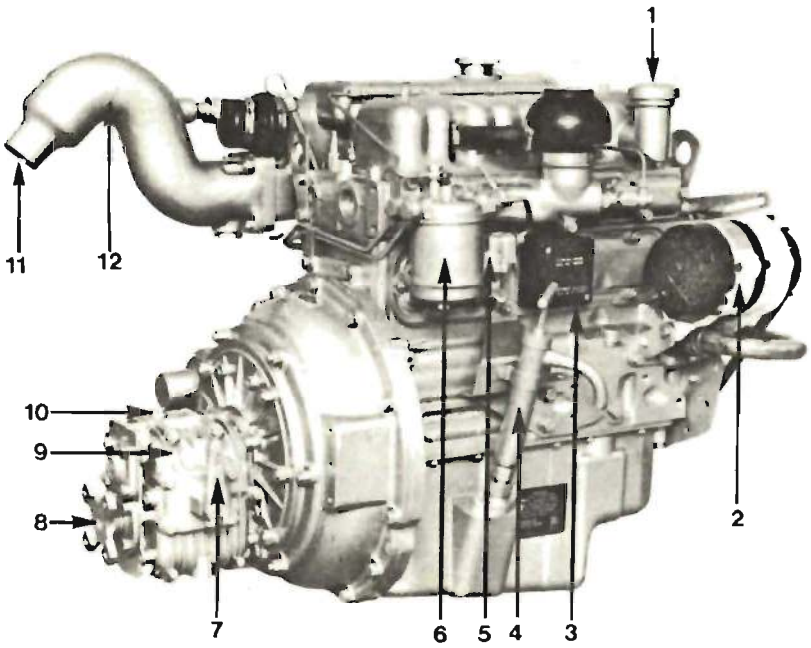
ON BOARD TOOLS

An "on board" tool kit for engine work is available but the following tools and general spares are suggested to supplement the kit: —

Hose clips, assorted.
Hose, assorted (convoluted type useful).
Fresh water pump driving belt.
Sea water pump impeller.
Wire (20 SWG).
Insulating tape.
Jointing compound.
Magnet (keep away from compass).
Mechanical fingers.
Self-gripping wrench.
Asbestos lagging.
Low pressure fuel pipe olives.
Small hacksaw with spare blade.
Assorted files.

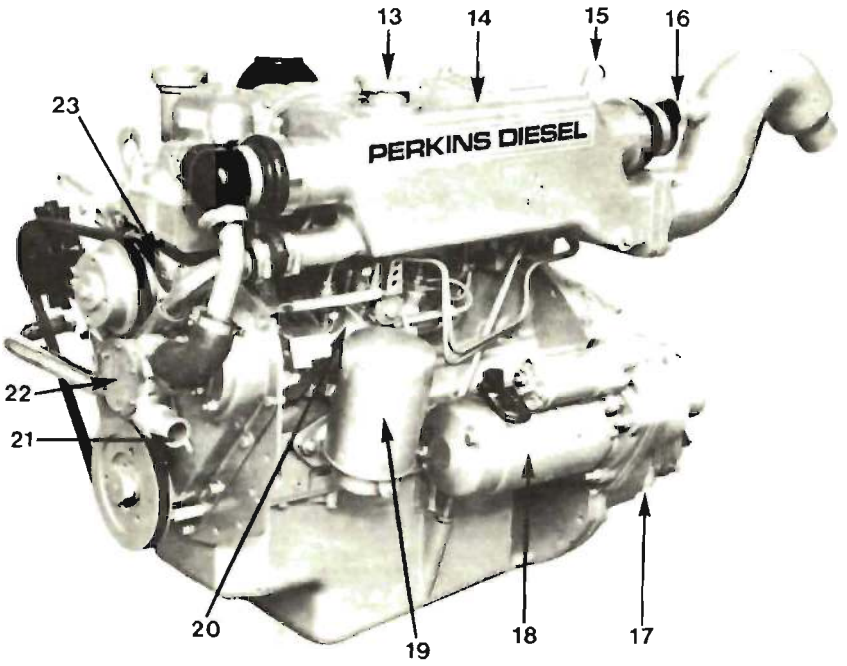
For some engines an on board spares kit can be purchased from your Perkins Marine Distributor.

Perkins Engines are built to individual requirements to suit the applications for which they are intended and the following engine views do not necessarily typify any particular specification.



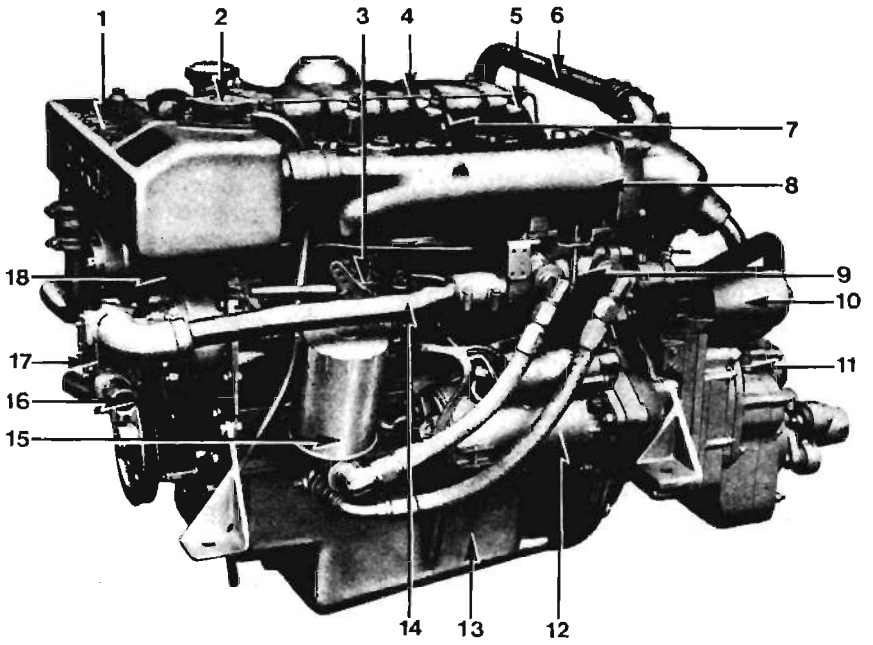
"NEW" 4.108M ENGINE

1. Oil Filler
2. Generator (Alternator)
3. Relay (C.A.V.)
4. Lubricating Oil Sump Drain Pump
5. Fuel Oil Lift Pump
6. Fuel Oil Filter
7. Ahead and Astern Engagement Lever
8. Gearbox Output Flange
9. Gearbox (Hurth Mechanical)
10. Gearbox Filler Plug and Dipstick
11. Exhaust Outlet
12. Seawater Cooled Exhaust Outlet Pipe



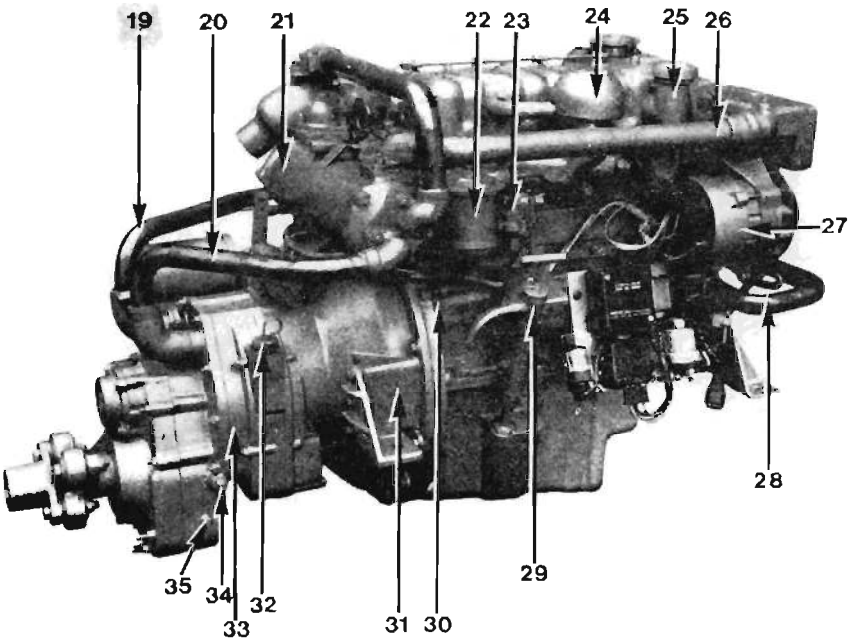
"NEW" 4.108M ENGINE

13. Fresh Water Filler Cap
14. Heat Exchanger, Fresh Water Header Tank and Exhaust Manifold (Fresh Water Cooled)
15. Lubricating Sump Oil Level Dipstick
16. Seawater Pipe from Heat Exchanger Tube Stack to Exhaust Outlet Seawater Ejection Point
17. Gearbox Oil Drain Plug
18. Starter Motor
19. Lubricating Oil Filter Canister
20. Fuel Injection Pump
21. Seawater Pump Inlet (from sea cock)
22. Seawater Pump
23. Fresh Water Pump



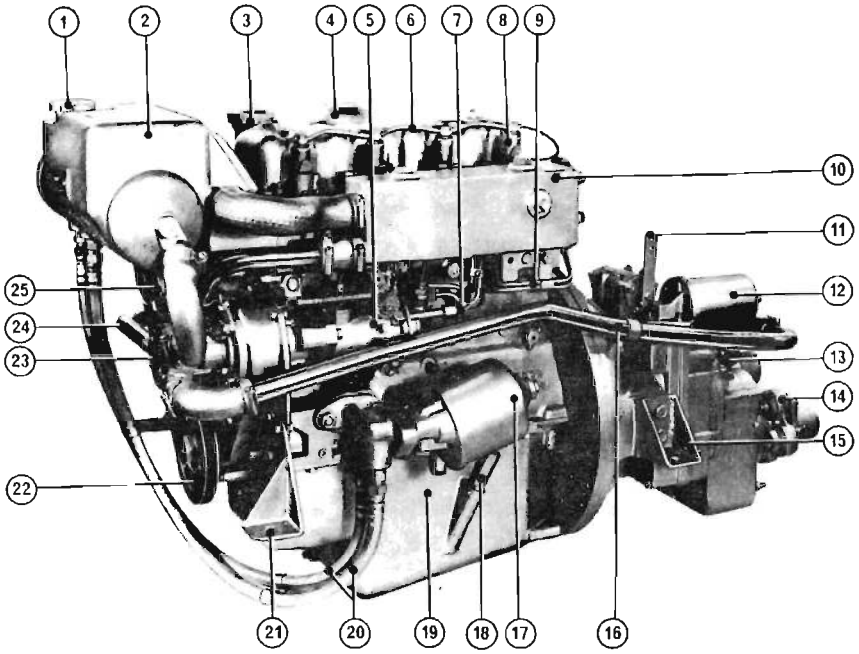
LOWLINE 4.108M ENGINE

1. Fresh Water Header Tank
2. Fresh Water Filler Cap
3. Fuel Injection Pump
4. Fuel Oil Leak-off Pipe
5. Atomiser (injector)
6. Sea Water Pipe from Heat Exchanger to Manifold
7. Engine Lubricating Oil Dipstick
8. Exhaust Manifold
9. Engine Lubricating Oil Cooler
10. Gearbox Lubricating Oil Filter
11. Reduction Gearbox Lubricating Oil Filler
12. Starter Motor
13. Engine Lubricating Oil Sump
14. Sea Water Pipe from Sea Water Pump to Lubricating Oil Cooler
15. Engine Lubricating Oil Filter
16. Sea Water Pump Inlet (from Sea Water Cock)
17. Sea Water Pump
18. Fresh Water Pump



LOWLINE 4.108M ENGINE

19. Sea Water Pipe from Lubricating Oil Cooler to Gearbox
20. Sea Water Pipe from Gearbox to Heat Exchanger
21. Heat Exchanger
22. Fuel Oil Filter
23. Fuel Oil Lift Pump
24. Air Filter
25. Engine Lubricating Oil Filler
26. Fresh Water Pipe from Header Tank to Heat Exchanger
27. Generator (alternator)
28. Fresh Water Pipe from Cylinder Block to Header Tank
29. Lubricating Oil Sump Drain Pump
30. Cylinder Block Fresh Water Drain Tap
31. Flywheel Housing
32. Gearbox Lubricating Oil Combined Dipstick and Filler
33. Gearbox
34. Gearbox Water Drain Plug
35. Reduction Gearbox Oil Level Plug



HIGHLINE 4.108M ENGINE

1. Fresh Water Filler Cap
2. Heat Exchanger
3. Oil Filler
4. Air Filter
5. Fuel Injection Pump
6. Atomiser Leak Off Pipe
7. Pressure Pipes, Injection Pump to Atomisers
8. Atomiser
9. Fuel Pipes, Filter to Injection Pump
10. Exhaust Manifold
11. Ahead and Astern Engagement Lever
12. Gearbox Oil Filter
13. Reduction Gearbox Oil Filler
14. Output Flange
15. Rear Engine Support
16. Water Pipe, Gearbox to Sea Water Pump
17. Lubricating Oil Filter
18. Connection for Oil Sump Pump
19. Sump
20. Oil Cooler Pipes
21. Front Engine Support
22. Crankshaft Pulley
23. Sea Water Pump
24. Water Pipe Exhaust Manifold to Cylinder Block
25. Fresh Water Pump

engine identification

The engine type with which this handbook is associated is designated 4.108M.

The first figure in the engine designation denotes the number of cylinders. The second group of figures denotes the engine capacity in cubic inches. The letter "M" is for "marine".

Engine Serial Number

The serial number is stamped vertically on the fuel pump mounting flange of the cylinder block as shown in Fig. 1.

With earlier engines, the first three figures of the engine number represented the capacity of the engine in cubic inches, the letter "U" signified that the engine was built in the United Kingdom and the last group of figures comprised the engine serial number.

With current engines, the number consists of up to fifteen letters and figures e.g. ED13541U510123D.

Where information, spare parts or assistance is required, this number should always be quoted in full.

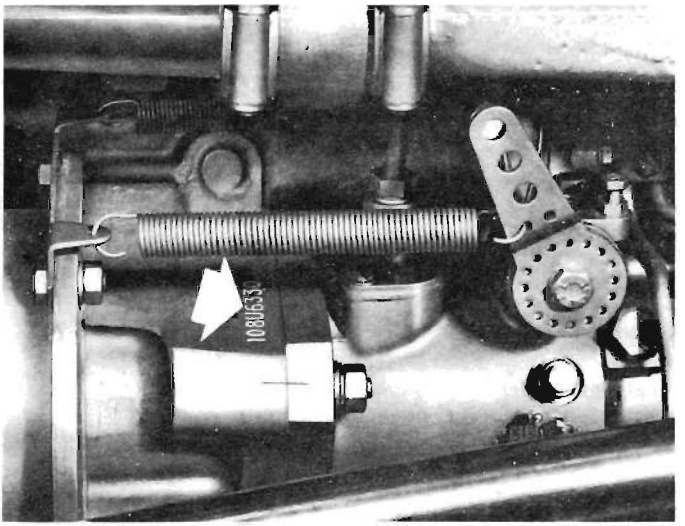


Fig. 1
Engine No. Location 4.108M.

engine data

Type	Four Stroke, Indirect Injection
No. of Cylinders	4
Nominal Bore	3.125 in (79,37 mm)
Stroke	3.5 in (88,90 mm)
Cubic Capacity	107.4 in^3 (1,76 litre)
Compression Ratio	22 : 1
Firing Order	1, 3, 4, 2.
Valve Tip Clearance	0.012 in (0,30 mm) Cold
Oil Pressure	30 - 60 lbf/in^2 (2,1 - 4,2 kgf/cm^2) or 207 - 414 kN/m^2 at max. speed and normal operating temperature.

Sump Capacities

	Imp. Pts.	Litres	US Quarts
"New" 4.108 and Low-line Engines (Refill)	7.9	4,5	4.8
"New" 4.108 and Low-line Engines (Total)	9.4	5,3	4.7
High-Line Engines (Refill)	7	4	4.2
High-Line Engines (Total)	8.5	4,8	5.1

Rating Details

Pleasure Craft (High Speed)	47 shp (51 bhp or 38 kW) at 4,000 rev/min
Pleasure Craft	45 shp (48 bhp or 36 kW) at 3,600 rev/min
Commercial Craft	37 shp (40 bhp or 30 kW) at 3,000 rev/min

Note:
Maximum rev/min is dependant on hull design as the correct engine rating should be matched to the duty of the boat.

operating instructions

PREPARATION FOR STARTING

ENSURE FUEL IS TURNED ON !

Open engine coolant seacocks (does not apply with keel cooled engine).

Check coolant level in header tank (does not apply with direct cooled engines).

Check engine and gearbox lubricating oil levels (see pages 38 and 44 for approved oils).

Ensure that the fuel tank contains considerably more than sufficient fuel for the intended voyage. The fuel oil should conform to one of the specifications given on page 26.

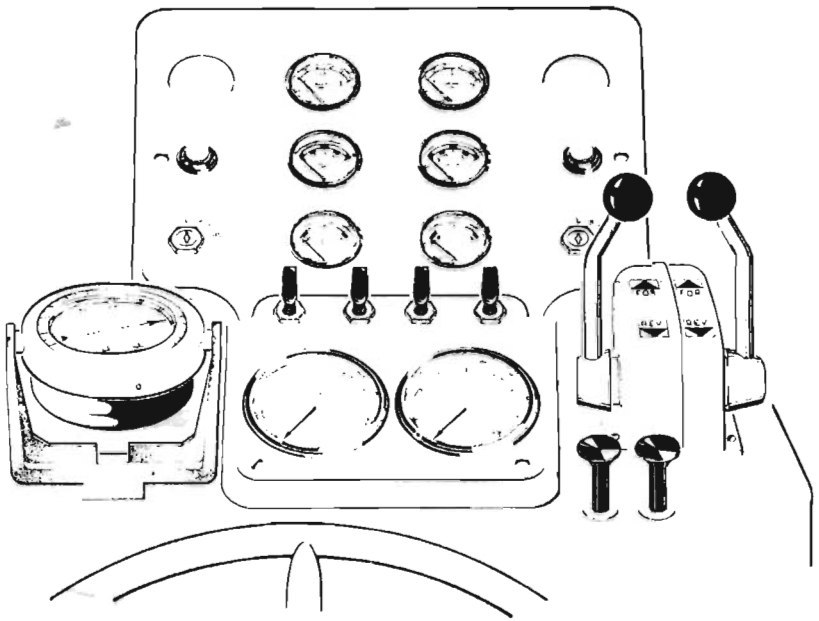


Fig. 2. Typical engine control panel.

Starting the Engine

Place gearbox control in neutral gear.

Turn starter switch to position "R" fig.3 and ensure that the engine stop control is in the run position (i.e., pushed fully home).

Place engine speed control in maximum speed position.

If the engine or weather is warm, turn starter switch in a clockwise direction to the "HS" position.

As soon as the engine starts, release the switch to the "R" position.

Be sure that the starter pinion and engine have stopped rotating before re-engaging the starter motor, otherwise damage may result.

If weather is cold, ensure cold start aid reservoir contains fuel oil. Turn on tap between reservoir and cold start aid. Current engines have a direct feed cold start aid where fuel is supplied from the fuel filter and no tap is fitted.

Turn starter switch to the "H" position and hold it there for fifteen to twenty seconds.

Then turn the starter switch to the "HS" position, thereby engaging the starter motor.

If the engine does not start after twenty seconds, return the switch to the "H" position for ten seconds and then re-engage the starter motor by switching to the "HS" position.

As soon as the engine starts, release the switch to the "R" position and turn off the tap on the cold start aid reservoir (where fitted).

Earlier Heat Start Switch

The cold start switch supplied with earlier engines is shown in fig. 4.

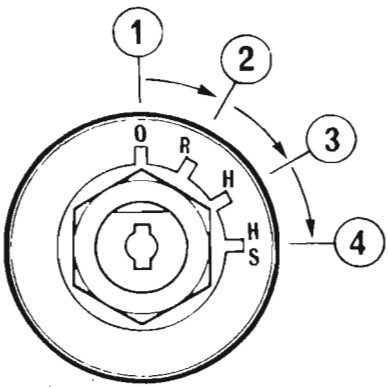


Fig. 3

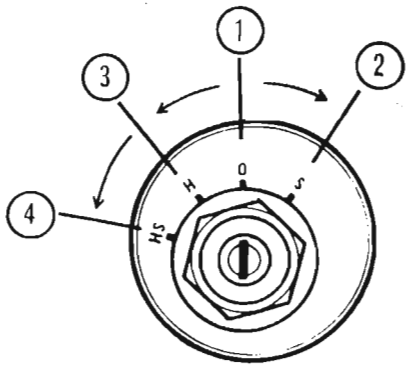


Fig. 4

With this switch, starting a warm engine is effected by turning the switch in a clockwise direction to the "S" position.

In cold weather, the switch should be turned to the "H" position for fifteen to twenty seconds and then to the "HS" position in order to engage the starter motor.

As soon as the engine starts, the switch should be returned to the "O" position.

Where this type of switch is used, it was sometimes customary to have a separate switch for the electrical circuits and this should be turned on before starting the engine and turned off after stopping the engine.

Starting the Engine (Alternative Method)

With some engines, a different starter switch is provided and the cold start aid is operated by means of a separate push button switch.

The cold starting procedure however is the same, i.e.

Switch on by turning the starter switch in a clockwise direction to the first position.

Press the heater button for fifteen to twenty seconds and then, with the heater button still pressed, turn the starter switch in a further clockwise direction to engage the starter motor. As soon as the engine starts, release both starter switch and heater button.

TO STOP ENGINE

A spring loaded stop control is located near the normal engine controls and functions by cutting off the fuel at the fuel injection pump.

To operate, pull the knob and hold in this position until the engine ceases to rotate. Ensure that the control returns to the run position, otherwise difficulty may be experienced in restarting the engine.

Switch off by turning switch to position "O".

Note. Where an engine is fitted with an electrical operated stop solenoid, the stop button on the engine control panel should be operated by pressing and holding there until the engine has stopped.

Things to Note

When the engine starts, check the following points:

(a) That oil pressure is registered on gauge(s).

(b) That charging rate is indicated on ammeter/generator light goes out.

(c) That coolant is discharging overboard.

Instruments (see Fig. 5)

These serve to give the operator important information about the running of the engine, fuel state, temperature etc.

Generally speaking instruments have not the accuracy that a laboratory meter has and this should be borne in mind when reading them: nevertheless they may be used to ensure correct functioning of the engine(s).

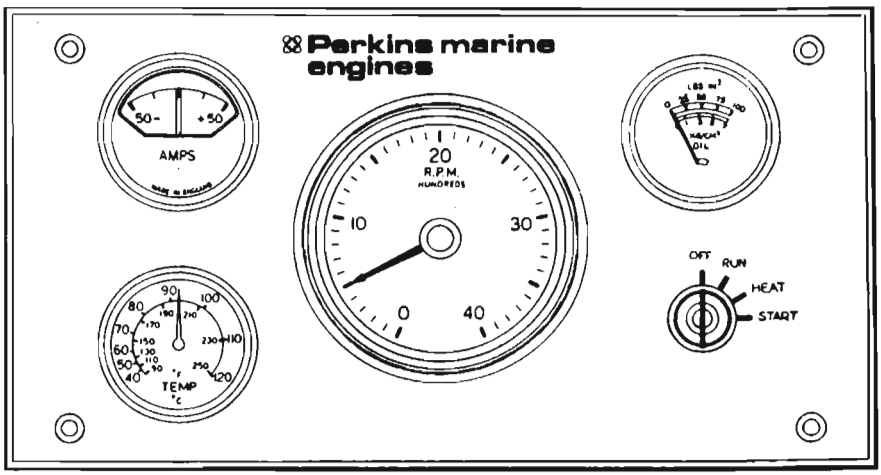


Fig. 5
Typical Instrument Panel.

Engine Oil Pressure Gauge

This is one of the most important instruments and should be checked for correct operation as soon as the engine starts. Normal oil pressure is 30/60 lbf/in² (2,1/4,2 kgf/cm²) or 207/414 kN/m² at maximum engine speed and normal operating temperature. However it should be remembered that during the life of the engine there will be a gradual drop in oil pressure. This is perfectly normal as bearing surfaces wear. There will also be a slight drop in pressure when the oil is hot or if the wrong grade of oil is used in certain climatic conditions. See page 44 for correct oil grades.

Gearbox Oil Pressure Gauge

Where this is fitted the pressure should be within the ranges given on page 39. Here again there will be a slight pressure drop when the oil is hot.

Tachometer

This provides the operator with the engine revolutions per minute (rev/min). The number indicated has usually to be multiplied by one hundred to give engine rev/min, e.g. 20 x 100 = 2,000 rev/min.

Water Temperture Gauge

This indicates the temperature of engine coolant. Coolant temperatures should remain within the ranges given on page 30. If high temperatures are experienced investigate the cause immediately (see page 46).

Running In

It is not necessary to gradually run-in a new or factory rebuilt engine and any prolonged light load running during the early life of the engine can in fact prove harmful to the bedding in of piston rings and liners.

Full load can be applied on a new or factory rebuilt engine as soon as the engine is used, **provided that the engine is first allowed to reach a coolant temperature of at least 140°F (60°C).**

Angle of Heel — Sailing Boats

Auxiliary yacht installations may require the engine to be run whilst beating to windward. Under these conditions, the boat may heel up to 25° without adverse effect on the lubricating system, providing the boat is righted occasionally in order to lubricate the valve assembly.

preventive maintenance

If a Perkins marine diesel engine is to give long and trouble free service, it is imperative that it be maintained in accordance with the following Periodical Attentions: —

Daily or Every 8 hours (whichever occurs first)

Check coolant level.

Check sump oil level.

Check oil pressure (where gauge fitted).

Check gearbox oil level.

Every 100 hours or 2 months (whichever occurs first)

Drain and renew lubricating oil (see pages 36 and 45).

Renew lubricating oil filter canister (see page 36).

Clean air intake gauze.

*Check drive belt tension.

Clean water trap.

Check engine for leakage of oil and water.

Lubricate dynamo rear bush (where fitted).

Every 400 hours or 12 months (whichever occurs first)

Renew final fuel filter element.

Check hoses and clips.

Drain and clean fuel tank.

Change gearbox oil.

Service atomisers.

Check and adjust valve clearances.

Every 2,400 hours

Arrange for examination and service of proprietary equipment, i.e. starter motor, generator, etc.

An operator is usually familiar with the type of water he is operating in. It is therefor left to his own discretion to check the weed trap, in the water intake, at appropriate intervals.

*Drive belt tension should be checked monthly on engines rated above 3,000 rev/min.

post delivery checkover

After a customer has taken delivery of his Perkins Marine Diesel engine, a general checkover of the engine must be carried out after the first 25/50 hours in service.

The checkover should comprise the following:–

1. Drain lubricating oil, renew lubricating oil filter canister and refill sump to full mark on dipstick with new oil.
2. Remove rocker assembly and check cylinder head nuts and/or setscrews are to the correct torque of 60 lbf ft (8,3 kgf m) or 81 Nm.

   Note. When retightening cylinder head nuts/setscrews, the engine coolant outlet should be at its normal operating temperature.

   If the nut/setscrew moves when re-tightening, then tighten to a torque of 60 lbf ft (8,3 kgf m) or 81 Nm.

   If the nut/setscrew does not move before the correct torque is achieved, then slacken off 1/12 to 1/6 of a turn (30° to 60°) and then re-tighten to the correct figure.

   After re-tightening all the nuts/setscrews, the first 10 positions should be re-checked without further slackening off to ascertain they are still tightened to the torque figure quoted.
3. Refit rocker assembly and set valve clearances to 0.012 in (0,30 mm) cold.

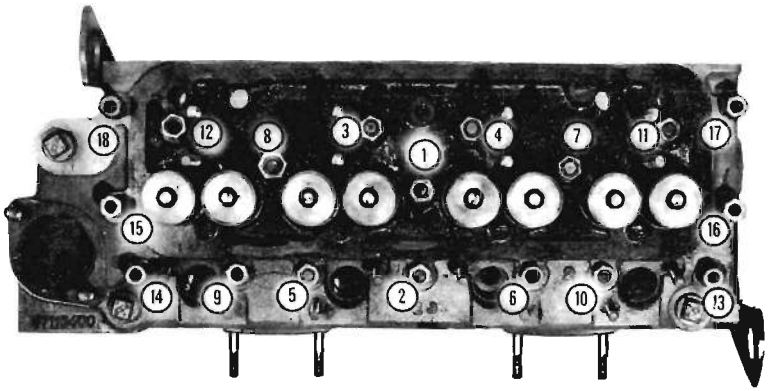


Fig. 6
Tightening Sequences for Cylinder Head Nuts.

4. Check coolant level in header tank and inspect for coolant leaks.
5. Check external nuts, setscrews, mountings, etc., for tightness.
6. Check water pump drive belt tension.
7. Check electrical equipment and connections.
8. Check for lubricating and fuel oil leaks.
9. Check engine idling speed (see page 29).
10. Check general performance of engine.

preservation of laid up engine

Where a boat is to be laid up for several months, the engine should be protected as follows:

1. Clean all external parts.
2. Run engine until warm. Stop and drain the lubricating oil sump.
3. Renew the lubricating oil filter canister.
4. Clean out engine breather pipe.
5. Fill lubricating oil sump to correct level with new oil of an approved grade.
6. Drain all fuel oil from fuel tanks and filters. Put into the fuel tank at least one gallon of one of the oils listed under "Recommended Oils for the Preservation of the Fuel System" (see page 22). If, because of the construction of the fuel tank, this quantity of oil is inadequate, break the fuel feed line before the first filter and connect a small capacity auxiliary tank. If the fuel tank(s) cannot be drained they should be filled with fuel and an inhibiting oil put into a temporary tank inserted in the fuel feed line.
7. Bleed the engine as detailed on page 27.
8. Start engine and run it half speed for 15 minutes when the oil will have circulated through the injection pump, pipes and atomisers.
9. Seal the air vent in the tank or filler cap with waterproofed adhesive tape.

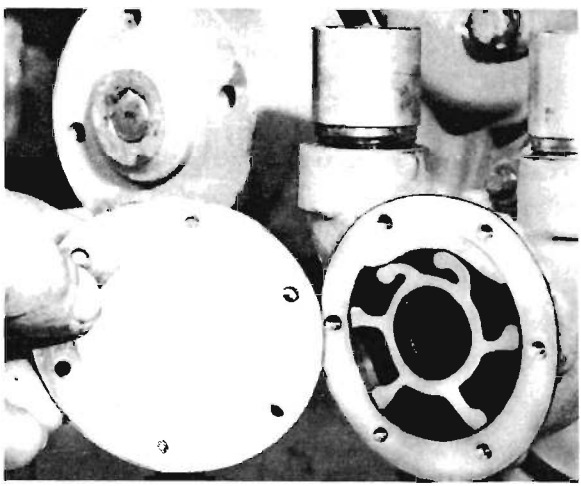


Fig. 7

Removing Sea Water Pump End Plate

10. Drain water from heat exchanger and engine cylinder block. The heat exchanger should be removed and serviced; the cylinder block may be flushed back through the drain points with the thermostat removed. If it is decided to refill the fresh water system with antifreeze the precaution on page 24 should be followed. Air venting is necessary when filling the cooling system, see page 32 (Not applicable with "New" 4.108M engines).
11. Remove end plate from the sea water circulating pump and lubricate the interior of the pump body with Glycerine (see fig. 7), or remove impeller for lay-up period. Always use a new joint when refitting back plate.
12. Remove the atomisers and spray into the cylinder bores ¼ pint (0,14 litre) of lubricating oil divided between all cylinders. Rotate the crankshaft one complete revolution and replace atomisers.
13. Remove the air cleaner and any piping. Seal the air intake with water-proofed adhesive tape.
14. Remove the exhaust pipe and seal the manifold port.
15. Remove cylinder head cover, lubricate the rocker assembly and replace cover.
16. Remove water pump driving belt.
17. **Batteries**
    (a) Remove the batteries and top up cells with distilled water.
    (b) Recharge.
    (c) Clean the terminals and lightly smear with petroleum jelly.
    (d) Store in a cool, dry, dust free place. Avoid freezing risk.
    (e) Recharge once a month.
18. **Starters and Generators**
    Clean terminals and lightly smear with petroleum jelly. The generator, starter and control board must be protected against rain.

OILS RECOMMENDED FOR PRESERVATION OF FUEL SYSTEM

	Lowest Temperature to be expected during lay-up
Esso IL815	25°F (— 4°C)
Esso IL1047	0°F (—18°C)
Shell Calibation Fluid "C" (U.K.)	0°F (—18°C)
Shell Calibration Fluid "B" (Overseas)	—70°F (—57°)
Shell Fusus "A"	—15°F (—26°C)
Shell Fusus "A" R1476 (Old Type)	25°F (— 4°C)

No attempt should be made to restart the engine until the temperature has been at least 15°F (9°C) above that shown in the table, for not less than 24 hours, otherwise there may be difficulty in obtaining a free flow of fuel.

The proprietary brands of oils listed are recommended for the purpose by the oil companies. They may not be available in all parts of the world, but suitable oils may be obtained by reference to the oil companies. The specification should include the following: —

Viscosity: Should not be greater than 22 centistokes at the lowest ambient temperature likely to be experienced on re-starting.

Pour Point: Must be at least 15°F (9°C) lower than the lowest ambient temperature to be experienced on restarting and should be lower than the lowest temperature likely to be met during the lay-up period.

The oils selected are not necessarily suitable for calibrating or testing pumps.

PREPARING THE ENGINE FOR RETURN TO SERVICE

When the engine is to be returned to service, the following procedure must be observed: —

1. Thoroughly clean all external parts and refit sea-water pump impeller (where applicable). Use a new joint when fitting end plate.
2. Remove adhesive tape from the fuel tank vent or filler cap.
3. Drain fuel tank to remove any remaining oil and condensed water and refill the tank with fuel oil. If tanks have been filled, drain water from trap if this has been provided by the boat builder.
4. Fit new fuel filter element.
5. Vent and prime the fuel injection pump (see page 27).
6. Close all coolant drain taps and fill the system with clean coolant. For air venting the cooling system, see page 32. Check for leaks. Remember that if a coolant solution of 25 per cent anti-freeze manufactured to BS3151 has been left in the system, then a life expectation of one year can be expected of the solution.
7. Rotate fresh water pump by hand to ensure freedom of water pump seals. If the pump will not rotate with a reasonable amount of persuasion then it will have to be removed to determine the cause.
8. Refit water pump driving belt.
9. Remove the rocker cover, lubricate rocker assembly with engine oil. Replace cover.
10. Remove adhesive tape from the air intake, refit the air cleaner and any intake pipe. Clean the gauze and if it is the oil bath type,fill with engine oil to the correct level.
11. Remove adhesive tape from the exhaust manifold port and refit exhaust pipe.

12. **Starter and Generator**
    Wipe the grease from the terminals and check that all connections are sound. If the starter is fitted with a Bendix type of drive, lubricate with a little light engine oil. CA45 co-axial starters, except where they are fitted with dust covers, should be given the same treatment.
13. Connect the batteries.
14. Check the level and condition of the oil in the sump. Change the oil if necessary.
15. Start the engine in the normal manner checking for oil pressure and electrical rate of charge. Whilst the engine is reaching its normal running temperature, check that it is free from water and oil leaks.

Note:
If the foregoing instructions are observed, the laying-up and returning to service should be carried out efficiently and without adverse effect on the engine. However, Perkins Engines Ltd., cannot accept liability for direct or consequential damage that might arise following periods of lay-up.

frost precautions

Precautions against damage by frost should be taken if the engine is to be left exposed to inclement weather either by adequately draining the cooling system or where this is not convenient, an anti-freeze of reputable make and incorporating a suitable corrosion inhibitor may be used.

Should it be the policy to protect engines from frost damage by adding anti-freeze to the cooling system, it is advisable that the manufacturers of the relevant mixture be contacted to ascertain whether their products are suitable for use in Perkins Engines and also to ensure that their products will have no harmful effect on the cooling system generally.

It is our experience that the best results are obtained from anti-freeze which conforms to British Standard 3151 or has been approved by testing in accordance with British Standard 5117, Clause 5 to give at least as good a result as BS.3151.

The coolant solution containing 25 per cent anti-freeze manufactured to BS.3151 in water in a properly maintained engine should maintain its anti-freeze and anti-corrosive properties throughout the winter season in the U.K. and in general, a safe life of 12 months may be reasonably expected.

When draining the water circulating system, the tap on the cylinder block must be opened. There may be other drain taps on exhaust manifolds, oil coolers etc., all of which must be opened, see page 34.

On earlier engines, the clips securing the hose between the cylinder block connection and the copper pipe to the header tank (keel cooled applications), or between

the cylinder block connection and the copper pipe to the exhaust manifold (heat exchanger applications) should be slackened and the hose pulled away from the connection to drain this area.

When the engine is drained, the fresh water pump is also drained, but moisture may remain around the pump seal or, if the pump leakage drain hole is blocked, a quantity of water may remain in the pump.

Operators are therefore advised to take these precautions when operating in temperatures below freezing point.

1. Before starting the engine release drive belt and turn the fresh water pump by hand: this will indicate if freezing has taken place. If freezing has taken place, this should free any ice formation.
2. If it is impossible to turn the pump by hand, the engine should be filled with warm water.

After an anti-freeze solution has been used, the cooling system should be thoroughly flushed in accordance with the manufacturers instructions before refilling with normal coolant.

If the engine is to be laid up for the winter season, the raw water circuit should be drained. Before commencing draining, the sea cock should be turned off, then all drain cocks opened and drain plugs removed. The removal of a sea water hose at the lowest point on the engine will assist in complete drainage of the raw water.

If the foregoing action is taken, no harmful effects should be experienced but Perkins Engines Ltd., cannot be held responsible for any frost damage or corrosion which may be incurred.

fuel system

The importance of cleanliness in all parts of the fuel system cannot be overstressed. Dirt and sludge are killers to the engine life blood.

FUEL OIL SPECIFICATION

The fuel oil used in Perkins Marine Engines should conform to the following specifications: —

United Kingdom
B.S.2869: 1967 — Class A1 and A2.

United States
A.S.T.M./D.975 — 66T — Nos. 1-D and 2-D.
Federal Specification VV-F-800a: Grades DF-A, DF-1 and DF-2 (according to operating ambient temperature).

Germany
DIN-51601 (1967).

France
J.O. 14/9/57 Gas Oil or Fuel Domestique.

Italy
Cuna-Gas Oil NC-630-01 (1957).

India
IS: 1460/1968 — Grade Special and Grade A.

Sweden
SIS 15 54 32 (1932)

Switzerland
Federal Military Specification 9140-335-1404 (1965).

Fuel oils available in territories other than those listed above which are to an equivalent specification may be used.

BLEEDING THE FUEL SYSTEM

Should the operator be unfortunate enough to run out of fuel, or whenever any part of the system between the fuel tank and fuel injection pump has been disconnected, the fuel system will have to be bled.

Ensure there is sufficient fuel in tank and **that the fuel tank cock, where fitted, is turned on.**

1. Slacken air vent valve on top of control gear housing (see fig. 10).

2. Slacken vent valve fitted on one of the two hydraulic head locking screws (see fig. 8). Unscrew vent plug on top of fuel filter where fitted.

3. Operate priming lever on fuel feed pump (if this is not possible, the camshaft driving the lift pump lever may be on maximum lift; turn engine one revolution) and when fuel, free from air bubbles, issues from each venting point, tighten the screws in the following order: —

    1. Fuel filter cover vent screw (where fitted).
    2. Head locking screw.
    3. Governor vent screw.

4. Slacken the pipe union nut (see fig. 9) at the pump inlet, operate the priming lever and retighten when fuel, free from air bubbles, issues from around the threads.

5. Slacken unions at atomiser ends of two of the high pressure pipes.

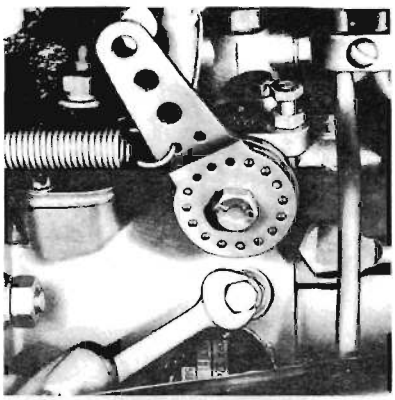


Fig. 8

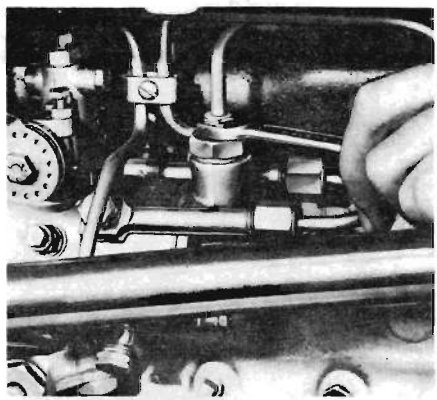


Fig. 9

6. Set accelerator to the fully open position ensuring that the stop control is in the "run" position.

7. Turn engine until fuel, free from air bubbles, issues from both fuel pipes.

8. Tighten the unions on both fuel pipes, and the engine is ready for starting. In the unhappy event of the batteries becoming flattened during the above operation, look to your flare locker (did you check its contents before leaving port?). If in any doubt about battery condition the load on the battery can be used during cranking by preventing air being drawn into the air intake. Remove air filter and close off intake by pressing a large sheet of stiff cardboard or similar over intake, or remove atomisers.

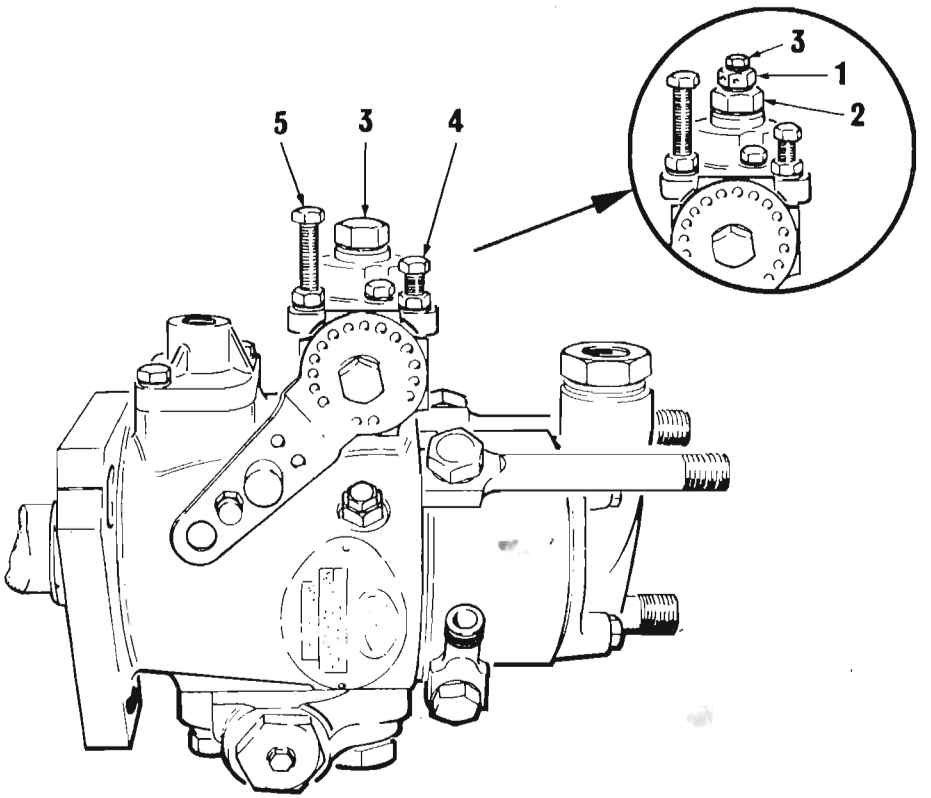


Fig. 10. Fuel Pump (anti-stall device shown inset).

1. Anti-stall device body.
2. Anti-stall device body locknut.
3. Air vent screw
4. Idle adjustment screw.
5. Maximum speed screw.

ANTI-STALL DEVICE

(see fig. 10).

1. Slacken locknut (2) sufficiently to enable the anti-stall device body (1) to be unscrewed two complete turns.
2. Adjust idling speed to 625 rev/min with idling adjustment screw (4).
3. Screw down anti-stall device body (1) until there is a very slight increase in engine speed, bring back half a turn and lock with lock nut (2).
4. Accelerate engine to maximum no load rev/min and immediately return to idling.

Should the period of return from maximum rev/min to idling exceed three seconds the device has been screwed in too far.

IDLING SPEED SETTING

This must be set in conjunction with the setting of the anti-stall device (see above).

FUEL FILTER

To renew filter element

1. Clean exterior of filter assembly.
2. Unscrew setscrew at top of filter bowl (see fig. 11).
3. Either lower filter bowl clear and discard element or lower base and discard element (see fig. 12).
4. Clean filter head and bowl or base in suitable cleaning fluid.
5. Check sealing rings and, if damaged, renew.
6. Fit new element to filter bowl or new element to base.
7. Place square against filter head and tighten setscrew.
8. Bleed fuel system as described previously.

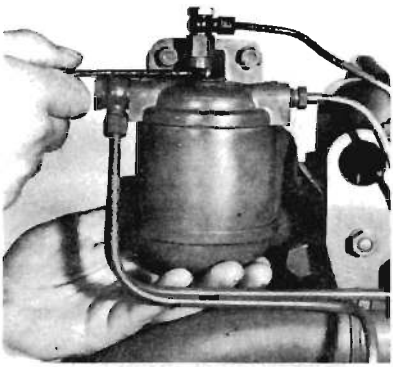


Fig. 11

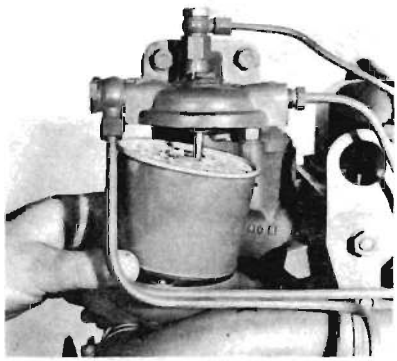


Fig. 12

ATOMISER TESTING AND REPLACEMENT

Often a particular atomiser or atomisers causing trouble may be determined by releasing the pipe union nut on each atomiser in turn, with the engine running at a fast "tick-over". This will prevent fuel being pumped through the nozzle to the engine cylinder, thereby altering the engine revolutions. If after slackening a pipe union nut, the engine revolutions remain constant, this denotes a faulty atomiser.

When fitting a replacement atomiser it should be noted that the joint between the atomiser and cylinder head is made by a special copper washer. Care should be taken to ensure that only this type of copper washer is used. The recess in the cylinder head, the faces of the copper washer and the corresponding face of the nozzle holder cap nut must be perfectly clean if a leakproof joint is to result. Fit new copper washers each time an atomiser is replaced. The nuts on the flange should be tightened down evenly to prevent the atomiser nozzle being canted and so nipped in the cylinder head. Uneven tightening will almost certainly result in blowby. Over tightening high pressure fuel pipe nuts will result in split olives.

The atomiser securing nuts should be tightened to a torque of 12 lbf ft (1,7 kgf m) or 16 Nm.

The high pressure pipe unions should be tightened to a torque of 15 lbf ft (2,1 kgf m) or 20 Nm.

cooling system

Three different systems are possible for water-cooled marine engines.

Heat Exchanger Cooling

This can be one of three types which are fitted to the 4.108 marine engine.

High Line 4.108M Engine: Combined "fresh" to "raw" water heat exchanger and header tank mounted on the front of the engine.

Low Line 4.108M Engine: Separate heat exchanger and header tank. The header tank is mounted on the front of the engine with the heat exchanger mounted at the rear of the engine above the flywheel housing.

NEW 4.108M Engine: Combined heat exchanger, header tank and fresh water cooled exhaust manifold mounted on the port side of the engine. This takes the position of the standard type exhaust manifold.

The fresh water is thermostatically controlled and a pressure cap allows the maximum water temperature to safely exceed the sea level boiling point of 100°C (212°F) and thus gives a safe margin over the normal operating temperature. The "raw"

water is circulated by a positive displacement type pump, the water then usually being discharged into the exhaust pipe. "Raw" describes the primary cooling medium which may be sea, river, lake or canal water.

Direct Cooling

This arrangement uses raw water circulated directly through the jackets, coolers, etc. The water temperature which is thermostatically controlled has to be maintained below 65°C (150°F) to avoid salt deposition.

Keel Cooling

When the raw water condition is such that it cannot be circulated through the cooling system, thus making Heat Exchanger or Direct cooling impossible, keel cooling may be used. Perkins engines are not supplied for keel cooling but it is possible to adapt a heat exchanger cooled "low-line" engine for this purpose. Low-line engines are fitted with separate header tank and heat exchanger tube stacks which makes this conversion easier than engines with combined header tank/heat exchangers.

Coolant Capacities — Heat Exchanger System

"New" 4.108 Engine	11 pints (6,24 litres) 6.6 US Quarts
Low-Line and High-Line Engine	13 pints (7,38 litres) 7.8 US Quarts

Cooling System Maintenance

Rubber Impeller Type Water Pump

The pump should **never** be run in a dry condition (impeller blades will tear) and if the engine is to be withdrawn from service for any length of time, it will be necessary to lubricate the water pump with glycerine. This is effected by removing the pump end plate, giving access to the interior of the pump, which can then be lubricated with glycerine introduced through the top-most pipe connection after removing the rubber hose. Turn engine over to spread the lubricant.

ALWAYS CARRY A SPARE IMPELLER

Water Pump Drive Belt

Check tension of water pump drive belts (see Page 19). When correctly adjusted, sideways movement on the longest unsupported length should be 3/8 in. (10 mm.).

Heat Exchangers

Heat exchanger tube stacks can be removed for servicing by slackening the

remaining hardware on hose clips and removing both end covers. Both "O" seals can now be removed and the tube stack withdrawn from the casing.

If the tube stacks are badly choked the best method of cleaning is to place the assembly in a boiling caustic soda solution. This will loosen all foreign matter adhering to the unit. Generally speaking, however, the fresh water side i.e. the outside of the tubes, should be fairly clean as these are on the closed circuit. The inside of these tubes which may have salt water passing through them are more likely to require cleaning. If these are not badly scaled enough to require the caustic soda solution treatment described above, they can be cleaned by pushing a length of 1/8 in (3,2 mm) diameter steel rod down the tubes to dislodge any foreign matter. It is IMPORTANT when doing this, that the rod is pushed through the tubes in the opposite diretion to that in which the water flows also that the rod does not damage tube walls. When replacing tie rods, do not overtighten nut. Torque to 25 lbf ft (3,46 kgf m) or 34 Nm.

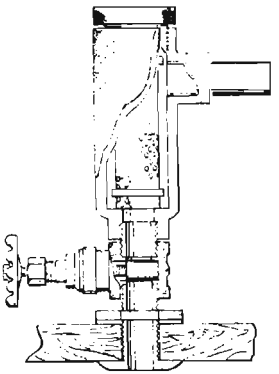


Fig. 13

Seacocks and Strainers

Ensure that seacocks are open prior to starting the engine and that, after the engine has started, there is a flow of water from the discharge pipe. The operator knows his home water so cleaning of the strainer is left to his discretion, but regular checks should be made of the engine water temperature gauge. Fig. 13 shows a typical seacock position.

Air Venting the Cooling System

NOTE: The cooling system of the "New" 4.108 engine does not require air venting as this occurs naturally when filling.

With heat exchanger and keel cooled engines, the following instructions should be

adhered to when putting an engine back into service following the winter lay-up period, or at any time the fresh water cooling system has to be refilled. The initial "bleeding" of the cooling system will have been attended to when the engine is first installed by the boat builder, but the air venting check is desirable following complete or partial draining for lay-up, top overhaul or other engine repairs.

With the 4.108M low line engine, air-venting the cooling system is provided for by a single air bleed screw situated on the top right hand side of the header tank, see Fig. 14.

When refilling or topping up the cooling system, remove the bleed screw and pour in coolant through the filler until coolant issues from the bleed point.

Replace the bleed screw and continue to fill the header tank to a level approximately 1 in (25,4 mm) below the pressure sealing cap.

Recheck for presence of air by unscrewing the bleed point after the engine has been run at about half throttle for a period of a few minutes or if overheating occurs on the first run under normal load conditions.

To ensure that no air is trapped in the cylinder block or cylinder head on earlier fresh water cooler engines, the following procedure should be adopted on heat exchanger cooled units.

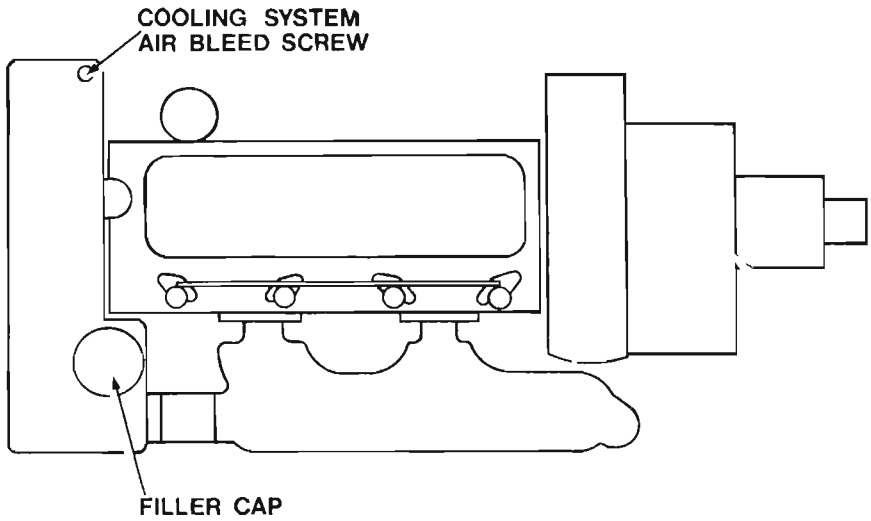


Fig. 14

Air Vent on 4.108M Low Line Engine.

1. Remove the square headed plugs in the top faces of the cylinder head and exhaust manifold marked 1, 2, and 3 in fig. 15 and add water steadily to the cooling system header tank.

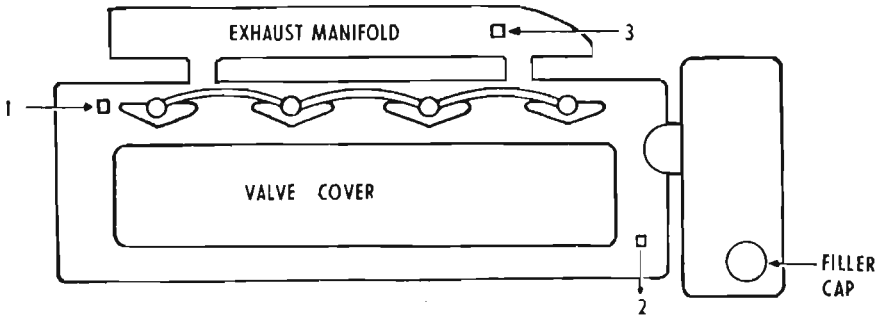


Fig. 15. Coolant Bleeding Points on Earlier Engines.

2. Replace plug 1 at rear end of cylinder head when water appears at this point.
3. Start engine and run in neutral at about 700 - 800 rev/min.
4. Continue topping up header tank, replacing plug 2 at forward end of cylinder head, and later plug 3 at forward end of exhaust manifold as the water appears at these points in turn. Finally top up the header tank to a level approximately 1 in below the pressure cap sealing flange.
5. Recheck for the presence of air at plugs 2 and 3 by gently unscrewing after engine has been run at about half throttle for a period of a few minutes or if a tendency to overheat is observed on the first run under normal load conditions.

To Drain the Coolant

Remove the coolant filler cap.

Coolant drain points will be found as follows:—

When referring to right or left hand side of engine, this is when looking forward from the gearbox end of engine.

1. Tap where water pipe runs from bottom of header tank into the front right hand side of cylinder block.
2. Tap at bottom of lubricating oil cooler (where fitted).
3. Water drain plug on right hand side of main gearbox (see engine views). TMP 12000 gearbox only).
4. Tap on heat exchanger, left hand side of engine (low line only).
5. Tap on cylinder block, right hand side rear (see engine views).

6. Water drain plug situated behind exhaust manifold at rear.

To drain, turn taps on and remove plugs until coolant ceases to flow. If no flow occurs, probe with a length of soft wire. If necessary, the taps can be removed with a suitably sized open ended spanner. When all coolant has drained off, the taps should be turned to the off position and the plugs replaced.

Whilst the engine is without coolant, it is recommended that a notice is placed in a conspicuous position to prevent the engine from being inadvertantly started.

lubricating system

The importance of correct and clean lubrication cannot be stressed too highly and references to engine oil should be taken to mean lubricating oil which falls within the specification given on pages 44 and 45. Care should be taken that the oil chosen is that specified for the climatic conditions under which the engine is operated. The sump should be filled to the correct level but DO NOT overfill above the full mark.

Oil Pressure

This should be 30/60 lbf/in² (2,1/4,2 kgf/cm²) or 207/414 kN/m² at normal working speed and temperature. The pressure will drop whilst the engine is idling also a slight drop will be experienced when the oil is hot, this is quite normal.

Renewing Screw Type Oil Filter Canisters

1. Unscrew filter canister from filter head (see fig. 16).
2. Discard old canister.
3. Clean filter head.
4. Using clean engine oil, liberally oil top seal of replacement canister.

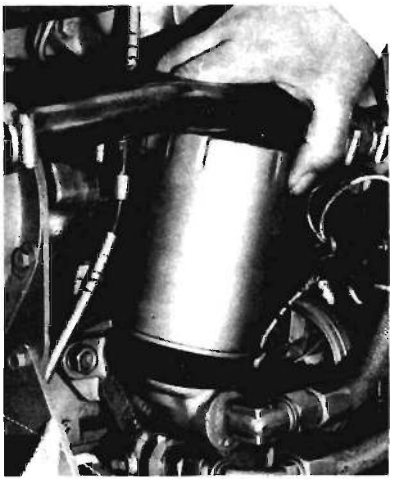


Fig. 16

5. Before fitting a new canister filter, we recommend that it be filled with clean lubricating oil. The oil should be poured slowly into the threaded stack pipe allowing time for the oil to pass through the filter element. When fitting the canister to the filter head adaptor, only a small quantity of oil in the stack pipe itself will be spilled.
6. Screw replacement canister onto filter head until seal just touches head and

then tighten by hand as per instructions on canister. Where a tool is available, tighten to 15 lbf ft (2,07 kgf m) or 20 Nm.

7. Run engine and check for leaks.
8. After the engine has been run and the filter assembly checked for leaks, restore oil in sump to its correct level.

Oil Coolers

Under normal circumstances, oil coolers will require little attention, providing the sea water inlet strainer is efficient and kept clean.

After a lengthy period of service it may be necessary to clean the tube stack and this may be effected in a similar manner to that given for the heat exchanger.

checking valve clearances (fig. 17)

This is set between the top of the valve stem and rocker arm and should be 0.012 in (0,30 mm) cold.

When setting valve clearances the following procedure should be adopted:—

1. With the valves rocking on No. 4 cylinder (i.e. the period between the opening of the inlet valve and the closing of the exhaust valve), set the valve clearances on No. 1 cylinder.
2. With the valves rocking on No. 2 cylinder, set the valve clearances on No. 3 cylinder.
3. With the valves rocking on No. 1 cylinder, set the valve clearances on No. 4 cylinder.
4. With the valves rocking on No. 3 cylinder, set the valve clearances on No. 2 cylinder.

Note. When turning engines, they should always be turned in their normal direction of rotation, i.e., anti-clockwise when viewing from the gearbox end.

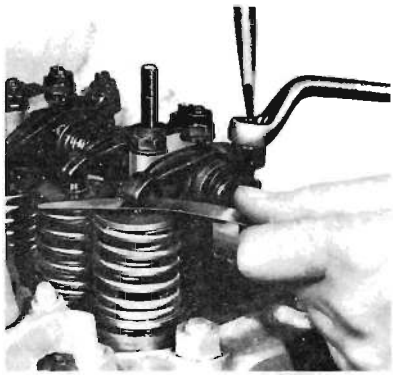


Fig. 17

gearboxes

"NEW" 4.108M Engine
HURTH HBW100 Mechanically Operated

Gearboxes should be filled with the recommended oil (see below) to the dipstick full mark before being operated. The gearbox should not be run if no oil level is shown on the dipstick as the box is immersion lubricated and splash fed. Gearbox oil should be changed after to the first 25 hours of operation and then at intervals of at least once a year.

Check oil levels about once a month. It is not necessary to screw the filler plug dipstick fully home when checking the oil level as the plug can be rested on the gearbox case.

Oil Capacity — 0.7 Imp. pint (0,4 litre) — 0,42 US Quart.

Recommended Oil — Automatic Transmission Fluid (ATF) Type A.

Maximum permissible oil temperature — 266° (130°C).

Low Line and High Line 4.108M Engines
TMP TYPE 12000 Mk II
Checking and Filling Main Gearbox

Run engine for a short time and shut down. Immediately remove dipstick and wipe blade. Re-insert dipstick and check oil level.

If it is showing between mark and bottom of dipstick rod, there is sufficient oil in the box. If oil does not show on rod, top up until bottom of rod is touched.

The mark on the rod indicates oil level when engine has been stationary for a period not less than 20 minutes. SAE 20 lubricating oil is recommended.

Checking and Filling Reduction Gearbox

Remove the oil level plug on the side of gearbox casing (see engine views). If necessary, remove the filler plug and top up with SAE 20 oil until level with the oil level plug hole.

Oil Capacity

Direct Drive	2.25 Imp. pints	1,28 litres	1,3 US quarts
Reduction Box	1 Imp. pints	0,57 litres	0.6 US quarts

Oil Pressure and Temperature

96 lbf/in² (6,75 kgf/cm²) or 660 kN/m² at 3,500 rev/min.
Maximum running temperature 180°F (82°C).
Normal running temperature 160°F (71°C).

Where the TMP12000 gearbox is fitted to the 4.108 marine engine, the following recommendation should be followed: —

It is advised that the above mentioned gearbox cooling water inlet and outlet pipe stub connections, see "A" Fig. 18 which are screwed into the upper part of the gearbox water jacket, should be checked yearly for erosion and corrosion.

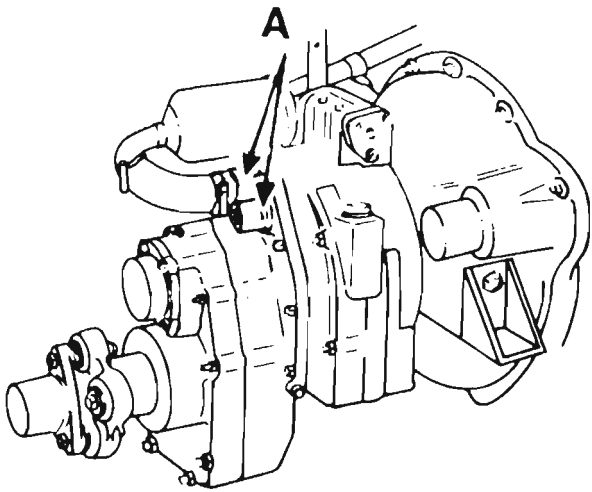


Fig. 18

Where signs of erosion or corrosion are seen on the inside or at the outer ends of the stubs, these should be renewed. Ensure when fitting the stubs that as much separation as possible exists, inside the hose, between the ends of the stubs and water connection pipes.

The latest type stubs have an increased cross section thickness and an annular groove "C" (see Fig. 19) machined in the end opposite from the threaded end "A", the metal thickness at the core of the groove "C" being less than the thread roots "A". As corrosion occurs the grooved end of the stub will show signs of erosion or become detached from the main part of the stub. Examination is easily accomplished by removal of the hose connection. Do not forget to close the seacock before removal of the hose connections and reopen the seacock when the work is com-

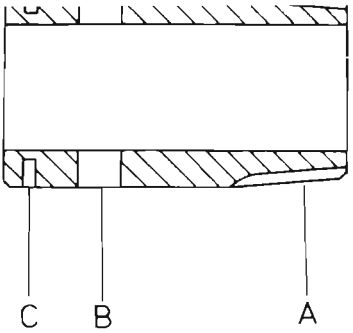


Fig. 19

pleted, before starting the engine. If the grooved end has become detached or corrosion is seen to have eaten through the core of the groove, new stubs should be fitted. Removal and refitting of the stubs is affected by inserting a bar through the hole "B" and turning in the direction required.

The stubs should be renewed every three years as normal maintenance practice.

Propeller Shaft Trailing

The HURTH mechanically operated gearbox and the TMP12000 Series gearbox may be trailed indefinitely.

Where prolonged propeller shaft trailing is being carried out, the gearbox oil level should be maintained on the full mark.

Other makes of gearboxes may be found fitted to the Perkins 4.108 marine engine and in this case, the gearbox manufacturers recommendations for propeller trailing should be followed.

electrics

Alternator

The alternator has two parts, a stator and a rotor. When the rotor rotates inside the stator windings, alternating current (AC) is produced. This is unsuitable for charging the battery so a rectification unit comprising of diodes is built into the alternator. These are connected in such a manner that the alternator output is direct current (DC) when it is delivered to the battery. The alternator output is controlled by a fully transistorised regulator which requires no servicing and is non-repairable. The alternator type can be found stamped on the alternator body or identification plate e.g. 11AC.

Starter Motors

The starter motor is of a similar construction to the dynamo with the solenoid and main switch assemblies contained inside the drive end-shield. No maintenance is required between periodic overhaul (see page 19). The machine is stamped on the body or identification plate e.g. M45G.

Electronics Screening (radar etc.)

Many pieces of equipment on board generate interference signals and these are picked up by the radio receiver indiscriminately. It is therefore desirable to screen these signals if possible. Radio interference suppression is a very wide and variable subject and it is suggested that a specialist is contacted to advise on this sometimes difficult problem.

Electrolytic Corrosion

This can occur when two dissimilar metals are brought together in the presence of sea water. Care is taken to avoid this in the design of the engine although different metals are necessary, but a brass or bronze pipe fitting attached to aluminium parts for example will result in rapid corrosion.

Particular care is necessary when installing an engine in an aluminium hull. Zinc anodes can be fitted to hulls where corrosion cannot be entirely avoided, and specialist firms will advise on the use of these.

Corrosion can also be caused by current leaking from the battery and other parts of the electrical system to the hull via the engine or metal fittings.

Battery Maintenance

WARNING. Batteries under charge give off **explosive** gas. Ensure therefore that

the batteries are properly and securely sited with plenty of ventilation and have access for maintenance. Isolate battery when not in use (isolation switch) and maintain correct electrolyte level i.e. just above top of separators.

Keep battery clean and dry to avoid possible corrosion and current leakage.

Ensure connections are clean and tight and that cable size is adequate for the installation, to avoid overheating.

Any component that may cause arcing must not be fitted in the battery space.

GENERAL PRECAUTIONS

When alternators are used in the charging circuit the following precautions must be taken: —

NEVER disconnect the battery or switch 'off' at the starter switch whilst the alternator is running. This will cause a voltage surge in the system damaging diodes and transistors.

NEVER disconnect any electrical lead without first stopping the alternator and turning all switches to the 'OFF' position. ALWAYS identify a lead to its correct terminal before disconnection. A short circuit or reversed polarity will destroy diodes and transistors.

NEVER connect a battery into the system without checking for correct polarity and correct voltage.

NEVER 'Flash' connections to check for current flow. No matter how brief the 'flash' the transistors may be destroyed.

NEVER experiment to try and adjust or repair the system unless you have had training on alternators and you have the correct test equipment and technical data.

NEVER earth the field circuit.

NEVER run the alternator on an open circuit.

NEVER attempt to polarize an alternator. When using a battery charger disconnect battery cables.

NEVER apply a battery voltage direct to the regulator or alternator field terminals as this will damage the transistors.

Disconnect the alternator terminals before carrying out any electrical welding on the

boat as the intense magnetic field created by the 'make' and 'break' of the arc may cause damage to the diodes.

Do not check for continuity of the alternator or regulator with an insulation tester, such as a 'Wee Megger' etc.

Always disconnect the battery before connecting test instruments (except voltmeter) or before replacing any unit or wiring.

lubricating oils

Lubricating oils should meet the requirements of the US Ordnance Specification MIL-L-46152 or MIL-L-2104C.

Some of these oils are listed below and next page but any other oils that meet these specifications and have a minimum viscosity index of 80 are also suitable.

NAPA SAE 30 HVY DUTY 75-110

MIL-L-46152 Oils

Company	Brand	S.A.E. Designation		
		0°F (-18°C) to 30°F (-1°C)	30°F (-1°C) to 80°F (27°C)	Over 80°F (27°C)
B.P. Ltd.	Vanellus M	10W	20W	30
	Vanellus M		20W/50	20W/50
Castrol Ltd.	Castrol/Deusol CRX	10W	20	30
	Castrol/Deusol CRX	10W/30	10W/30	10W/30
	Castrol/Deusol CRX		20W/50	20W/50
	Deusol RX Super		20W/40	20W/40
A. Duckham & Co. Ltd.	Fleetol HDX	10	20	30
	Fleetol Multi V		20W/50	20W/50
	Fleetol Multilite	10W/30	10W/30	10W/30
	Q Motor Oil		20W/50	20W/50
	Farmadcol HDX		20	30
Esso Petroleum Co. Ltd.	Essolube XD-3	10W	20W	30
	Essolube XD-3		15W/40	15W/40
Mobil Oil Co. Ltd.	Delvac 1200 Series	1210	1220	1230
	Delvac Special	10W/30	10W/30	10W/30
Shell	Rimula X	10W	20W/20	30
	Rimula X	10W/30	10W/30	10W/30
	Rimula X		15W/40	15W/40
	Rimula X		20W/40	20W/40
	Rotella TX	10W	20W/20	30
	Rotella TX		20W/40	20W/40
Total Oil Co. Ltd.	Total Super HD		20W/20	30
	Total HD2-M	10W/30	20W/40	20W/50
	Total HD3-C (Rubia S)	10W	20W/20	30
	Total HD3-C (Rubia TM)		15W/40	15W/40
	Total Universal Tractor Oil (Multagri)		20W/30	20W/30
	Total Super Universal Tractor Oil (Multagri TM)		20W/30	20W/30

MIL-L-2104C Oils

Company	Brand	S.A.E. Designation		
		0°F (-18°C) to 30°F (-1°C)	30°F (-1°C) to 80°F (27°C)	Over 80°F (27°C)
B.P. Ltd.	Vanellus C3	10W	20W/20	30
Castrol Ltd.	Castrol/Deusol CRD	10W	20	30
	Deusol RX Super		20W/40	20W/40
	Agricastrol HDD	10W	20	30
	Agricastrol MP		20W/30	20W/30
	Agricastrol MP		20W/40	20W/40
A. Duckham & Co. Ltd.	Fleetol 3	3/10	3/20	3/30
	Farmadcol 3	3/10	3/20	3/30
Esso Petroleum Co. Ltd.	Essolube D-3HP	10W	20W	30
	Essolube XD-3	10W	20W	30
	Essolube XD-3		15W/40	15W/40
Mobil Oil Co. Ltd.	Delvac 1300 Series	1310	1320	1330
Shell	Rimula CT	10W	20W/20	30
	Rimula X	10W	20W/20	30
	Rimula X	10W/30	10W/30	10W/30
	Rimula X		15W/40	15W/40
	Rimula X		20W/40	20W/40
	Rotella TX	10W	20W/20	30
	Rotella TX		20W/40	20W/40
Total Oil Co. Ltd.	Total HD3-C (Rubia S)	10W	20W/20	30
	Total HD3-C (Rubia TM)		15W/40	15W/40
	Total Super Universal Tractor Oil (Multagri TM)		20W/30	20W/30

Where oils to the MIL-L-46152 or MIL-L-2104C specifications are not available, then oils to the previous specification MIL-L-2104B may be used providing they give satisfactory service.

The above specifications are subject to alteration without notice.

fault finding chart

Fault	Possible Cause
Low cranking speed	1, 2, 3, 4.
Will not start	5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 31, 32, 33.
Difficult starting	5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 24, 29, 31, 32, 33.
Lack of power	8, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 31, 32, 33.
Misfiring	8, 9, 10, 12, 13, 14, 16, 18, 19, 20, 25, 26, 28, 29, 30, 32.
Excessive fuel consumption	11, 13, 14, 16, 18, 19, 20, 22, 23, 24, 25, 27, 28, 29, 31, 32, 33.
Black exhaust	11, 13, 14, 16, 18, 19, 20, 22, 24, 25, 27, 28, 29, 31, 32, 33.
Blue/white exhaust	4, 16, 18, 19, 20, 25, 27, 31, 33, 34, 35, 45, 56.
Low oil pressure	4, 36, 37, 38, 39, 40, 42, 43, 44, 53, 58.
Knocking	9, 14, 16, 18, 19, 22, 26, 28, 29, 31, 33, 35, 36, 45, 46, 59.
Erratic running	7, 8, 9, 10, 11, 12, 13, 14, 16, 20, 21, 23, 26, 28, 29, 30, 33, 35, 45, 59.
Vibration	13, 14, 20, 23, 25, 26, 29, 30, 33, 45, 48, 49.
High oil pressure	4, 38, 41.
Overheating	11, 13, 14, 16, 18, 19, 24, 25, 45, 47, 50, 51, 52, 53, 54, 57.
Excessive crankcase pressure	25, 31, 33, 34, 45, 55.
Poor compression	11, 19, 25, 28, 29, 31, 32, 33, 34, 46, 59.
Starts and stops	10, 11, 12.

KEY TO FAULT FINDING CHART

1. Battery capacity low.
2. Bad electrical connections.
3. Faulty starter motor.
4. Incorrect grade of lubricating oil.
5. Low cranking speed.
6. Fuel tank empty.
7. Faulty stop control operation.
8. Blocked fuel feed pipe.
9. Faulty fuel lift pump.
10. Choked fuel filter.
11. Restriction in induction system.
12. Air in fuel system.
13. Faulty fuel injection pump.
14. Faulty atomisers or incorrect type.
15. Incorrect use of cold start equipment.
16. Faulty cold starting equipment.
17. Broken fuel injection pump drive.
18. Incorrect fuel pump timing.
19. Incorrect valve timing.
20. Poor compression.
21. Blocked fuel tank vent.
22. Incorrect type or grade of fuel.
23. Sticking throttle or restricted movement.
24. Exhaust pipe restriction.
25. Cylinder head gasket leaking.
26. Overheating.
27. Cold running.
28. Incorrect tappet adjustment.
29. Sticking valves.
30. Incorrect high pressure pipes.
31. Worn cylinder bores.
32. Pitted valves and seats.
33. Broken, worn or sticking ring(s).
34. Worn valve stems and guides.
35. Overfull air cleaner or use of incorrect grade of oil.
36. Worn or damaged bearings.
37. Insufficient oil in sump.
38. Inaccurate gauge.
39. Oil pump worn.
40. Pressure relief valve sticking open.
41. Pressure relief valve sticking closed.
42. Broken relief valve spring.
43. Faulty suction pipe.
44. Choked oil filter.
45. Piston seizure/pick up.
46. Incorrect piston height.
47. Sea cock strainer or heat exchanger blocked.
48. Faulty engine mounting (Housing).
49. Incorrectly aligned flywheel housing, or flywheel.
50. Faulty thermostat.
51. Restriction in water jacket.
52. Loose water pump drive belt.
53. Gearbox or engine oil cooler choked.
54. Faulty water pump.
55. Choked breather pipe.
56. Damaged valve stem oil deflectors (if fitted).
57. Coolant level too low.
58. Blocked sump strainer.
59. Broken valve spring.

emergency measures

If the engine stops the first thing to do is check that the fuel supply is ON. If the fuel valves or taps are open then check level in fuel tank. If the engine has been run until the fuel tank is completely empty there is a very good chance that there is a lot of dirt in the fuel lines. Change the fuel filter and having refuelled, bleed the system and re-start the engine.

If the engine slows down or loses power there could be something wrapped round the propeller. Always check this first. Check air intake for obstruction and engine compartment for good supply of air. The air intake mesh may be clogged with foreign matter sucked from a dirty engine compartment.

If the engine coolant boils ease down the throttle and try to ascertain the cause. The first check here is at the sea cock to ensure adequate cooling water supply, if satisfactory, check raw water pump operation, perhaps the impeller has failed; if so replace with the spare impeller which should **always** be carried as an on board spare.

Should one engine be shut down on a twin engined installation, see page 40 for propeller shaft trailing.

If a serious leak occurs on a high pressure fuel pipe, disconnect and direct flow into a can or other receptacle and run the engine slowly and carefully on remaining cylinders. On NO account attempt to flatten the pipe as this will ruin the fuel injection pump. Leaks in low pressure fuel pipes can be temporarily repaired by the use of adhesive tape, hose and clips.

Coolant leaks can normally be dealt with by adhesive tape, hose and clips.

If a serious oil leak occurs shut down the engine immediately and try to find the cause. Oil leaks are a lot harder to cure temporarily, because of the pressure involved. However if the main flow can be stemmed to a drip or dribble place a can underneath the leak and replenish the engine with new oil (from the spare oil can) at the same rate as the loss and continually check the oil pressure gauge.

Drip trays of metal or glass fibre should be used beneath the engine to stop lubricating oil or fuel oil dripping into the bilges. Care must be taken to avoid galvanic action with the drip tray e.g. a copper tray should not be used under an aluminium alloy sump. Remember to keep the drip tray clean as this gives an early indication of leakages.