INSTRUCTIONS

STUART

Diesel Marine Engine

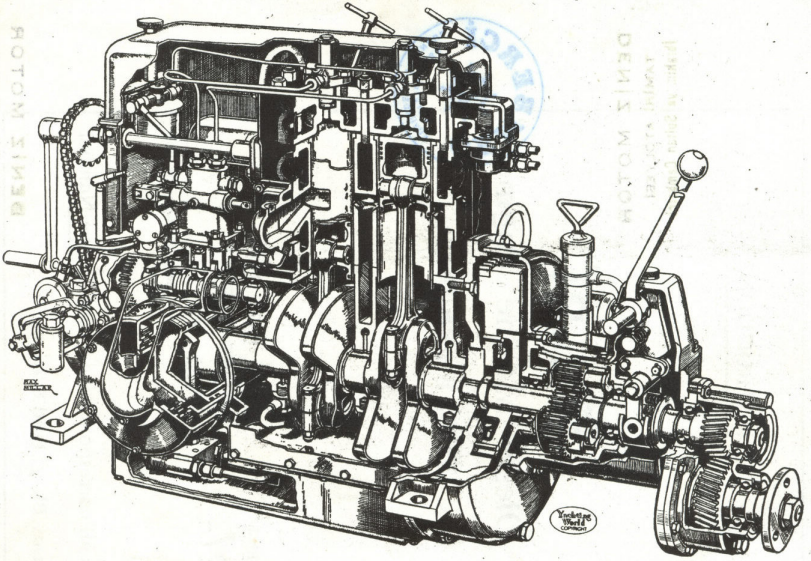
TYPES H2M & H2MR

PRICE
2/-

This Book must accompany Engine
H2M /.....
Enter the Engine No. here

In all correspondence quote Engine Number

Instr. Bk. 71 (2nd Edition)


ROTOR ENGINE
DENIS WANKEL

STUART

9 B.H.P. DIESEL ENGINE

ENGINE DATA

Type		Two-stroke compression ignition, pump scavenged
Number of cylinders		Two
Bore and stroke		$2\frac{3}{4}$-in. × 4-in.
Swept volume		47.52 cu.-ins. (779 c.c.)
Compression ratio		16.5 : 1
Weight, dry, with reverse gear		H2M 530-lb. 240 kgs.
,, ,, with reduction gear		H2MR 540-lb. 244 kgs.
B.H.P., 12 hour rating		9
B.H.P., maximum		11
Maximum governed speed		1,500 r.p.m.
Tick-over or idling speed		600-700 r.p.m.
Maximum piston speed		1,000 f.p.m.
Combustion system		Open chamber
Injection pressure		2,500 p.s.i. (170 atms.) enjektör basıncı
Lubricating oil pressure		60 p.s.i.
Sump oil capacity		7-9 pints (4-5 litres)
Gearbox oil capacity		H2M 1 pint (0.5 litres)
		H2MR $1\frac{1}{8}$ pints (0.75 litres)
Fuel		Gas oil or light diesel oil
Lubricating Oil		H.D. 20/50
Propeller, three blades		H2M 13-in. × 8-in. at 1,500 r.p.m.
		H2MR 17-in. × 17-in. at 732 r.p.m. pervane

Note—Throughout the Instruction Book the engine is described as it would be if installed in a boat.

Looking at the engine from astern, i.e. the gearbox end, the port side is on the left, starboard on the right. The enclosed flywheel is between engine and gearbox; the hand starting gear is at the forward end.

The book is divided into the following sections :—

ILLUSTRATIONS

SECTION A

PREPARATIONS

A1 **Fuel.** Light diesel oil or gas oil, conforming to B.S.S. 209/47, Class A.

Fuel containing any residual oil must not be used.

Fuel oil bought in bulk must be allowed adequate time to settle before transferring to the service tank; sludge and water in the oil will sink to the bottom. The draw-off tap should be a little above the bottom of the storage tank and a drain provided at the lowest point to enable the sludge and water to be drawn off occasionally.

When filling the service tank use a funnel with a fine gauze strainer.

A2 **The need for absolute cleanliness throughout the fuel system cannot be too strongly emphasised. The successful operation of a small diesel engine requires perfectly clean fuel. Dirt entering the system with the fuel will damage the working parts, block the holes in the injectors and result in a whole train of troubles.**

A3 **Priming the Fuel System.** Before starting for the first time and whenever the system has been allowed to run dry or has been dismantled, it must be primed. Take off the cover. Take out the screw on top of the fuel oil filter and operate the priming lever of the fuel lift pump until fuel containing no air bubbles issues from the top of the filter. Replace the screw. Next undo one of the delivery connections on the top of the injection pump, remove the delivery valve holder and lift out the delivery valve and spring. Operate the priming lever again until fuel flows. Replace the valve, spring and holder, making sure that they are perfectly clean, and refix the delivery connection. Do the same with the other connection. Air in the pipes between pump and injectors will be cleared when the engine has been turned over a few times.

LUBRICATION

A4 **Use Heavy-Duty Oil of S.A.E. 20 Viscosity.** Suitable oils are Vacuum Delvac 520, Shell Rotella Oil 20, Wakefield Castrol CR20, Duckham 20W50, Esso Tro-Mar HD20.

These oils contain additives which help to prevent the deposit of carbon and piston rings sticking.

Gearbox. Use the same oil.

Greasers. Mobil Hub Grease, Price's Amber A, Duckham's HPG, are suitable.

Stern Tube Greaser. A water-repellent grease such as Mobil Grease No. 2 (in the Tropics No. 3). This grease must **not** be used on the engine.

RUNNING INSTRUCTIONS

A5 **Before Starting the Engine always:—**

(1) See that you have enough fuel. See that the spare fuel nozzle with holder is on board.

(2) Check the lubricating oil level :—wipe the dipstick, replace and take it out again and check that level lies between the maximum and minimum marks. Check the oil level in the gearbox.

(3) Give all greasers a slight turn.

(4) Turn the seacock to the "on" position.

(5) Put the gear lever in neutral.

STARTING

A6 **Electrically.** Put the throttle lever vertical. Press the starter button; the engine should fire within a few seconds; if it does not, ease back the lever slightly. After a little practice the best position for starting will be found. Do not rotate the engine for more than about ten seconds at a time ; allow the starter to come to rest before making another attempt or the starter ring and pinion will be damaged. If the engine fails to start after several tries, take out the compression release valves and inject about a teaspoonful of lub. oil into each cylinder. Replace the valves (screw them down tightly) and try again. The oil raises the compression and helps to seal the rings which may be dry if the engine has stood for a long time. After the injection of oil the engine will almost invariably start, even under very cold conditions. Persistently difficult starting indicates poor compression due to stuck rings or to wear.

A7 **Starting by Hand.** The fuel system having been primed, if the engine will not start electrically, or if the battery is flat, remove the compression release valves and turn the engine over a few times with the throttle open until the injectors are heard to be acting. In cold weather put some oil into one cylinder, replace the compression release valves and swing the engine vigorously over compression.

Under freezing conditions, two teaspoonfuls of oil may be necessary.

A8 **Warming Up.** As soon as the engine has started, look at the oil pressure gauge. This will read about 80 p.s.i.; it falls to about 60 p.s.i. at full speed when warm and about 20 p.s.i. when idling. (If no pressure is shown stop the engine at once and investigate). Bring the throttle lever back nearly to idling.

Give the engine a few minutes to warm up at low speed before putting on load; it will increase the life of the engine.

A9 At first no water will issue from the exhaust outlet because it is recirculated by the thermostat. As this warms up water and steam will issue from the outlet.

Cylinders, when the engine is fully warmed up, are just too hot to be borne by the hand. The ammeter should show at least a small charging rate. A low rate means that the battery is up and only a trickle charge is passing.

A10 **Getting under way.** Move the gear lever to ahead (or astern) as far as it will go ; the gear lever must always be pushed right home ; the throttle is used for controlling speed.

Never "drive on the clutch" nor try to go slowly by slipping the clutch, it will cause unnecessary wear.

A11 **Stopping.** Put the gear lever in neutral and the control into the idling position, press the stop-button until the engine stops.

Never turn off the fuel supply for this may cause air-locks and render re-priming necessary.

A12 **Frost.** If there is risk of freezing, drain the cylinder jackets. The drain cock is on the starboard side of the engine just above the air silencer. Loosen the valve caps of the circulating pump.

RUNNING

A13 Look occasionally to see that the cooling water or steam is coming through.

Observe lubricating oil pressure and see that dynamo is charging.

A14 You can go from ahead straight into reverse and *vice-versa* without harm. When the gear is engaged, the throttle can once more be opened.

Do not forget that with the engine at half or three-quarter power, fuel consumption will be much less than at full power whilst the reduction of speed of the boat will be slight.

Never allow the fuel tank to get quite empty. If you do you will have to re-prime the fuel system as described in para. A3.

A15 The engine must never, on any account, be overloaded.

Overload is indicated at once by a change in the colour of the exhaust which is normally a faint blue. Over-load changes it to black, caused by partly burned fuel. Running for any length of time in this condition results in stuck piston rings and clogged injector holes. There may be a momentary puff of black smoke when the engine is opened up suddenly, but this is harmless.

The gearbox will warm up to 80° C. (176° F.) on a long run; this is normal.

Remember to grease the stern tube bearing, half a turn every 3 or 4 hours.

A16 If possible, take the boat out for a few minutes' run. This is the best way of finding out whether everything is in order. In any case:—

Check Oil Level in sump and gearbox. Oil will be black, due to detergent doing its work.

Give a turn to greasers on throttle gear and crankshaft pulley.

Clean strainer in seacock.

Check specific gravity (not less than 1.25) of battery electrolyte.

Run the engine; check oil pressure (about 60 p.s.i. at full speed).

See that dynamo is charging. Examine circulating water pump gland for leakage.

The usual indication that something is wrong is black smoke from the exhaust when engine is under load.

If exhaust is black, first check injectors. A C.A.V. Nozzle Setting Outfit (their part No. ET 122PA) is essential if one has any number of engines to maintain. Injectors **can** be checked on the engine (see para. B3) but it is much simpler to use the Nozzle Setting Outfit.

If injectors are in order, check air pump valves thus:—Put a hand over each air intake in turn. If the suction on one is less than on the other, a valve is probably defective (see para. C10).

If this is not the trouble, remove exhaust manifold and examine ports for carbon build-up. If exhaust ports are blocked, also clean inlet ports and silencer (see Section C).

If the engine has run for any length of time with defective air valves the ports must be examined for carbon build-up.

SECTION B

MAINTENANCE

B1 Keep the engine clean. If this is done a leaking joint or connection will be seen and can be put right. Remember, pressures in fuel pipes are very high and fuel oil creeps everywhere.

The routine maintenance tasks are shown in the schedule. Do not neglect to carry them out or the engine may fail when you need it most.

Before working on the engine it is strongly advised that a preservative for the hands, such as Rosalex, be rubbed in ; some skins are very sensitive to fuel oil.

The spare fuel injection nozzle and holder must always be in perfect condition. Obviously it is best to replace a nozzle which needs attention and recondition the defective one at leisure.

B2 Satisfactory injection depends on the correct working of the whole fuel system ; satisfactory charging with air depends on the condition of the air pump, air passages and exhaust system, and the pressure in the cylinders depends upon the pistons, rings and bores being in good condition.

Loss of power, heavy knock and smoky exhaust all show that something needs attention.

B3 **Fuel Injectors.** The quickest way to tell whether fuel injection is in order is to take out the compression release valves, open the throttle and gently turn the engine by hand.

The sound of the nozzles injecting can be heard.

A dirty injector is the most common cause of poor performance. Attend to the injectors regularly—say every month, whether the engine shows signs of the need or not. Use a C.A.V. nozzle setting outfit, if available, but if it is not, an injector can quite well be tested on the engine. Remove it with pipe complete and attach again so that the injector hangs over the side of the engine. Turn off the fuel; there will be enough in the filter for the test. Hold a piece of paper under the nozzle and turn the engine over by hand so that fuel is sprayed on the paper. Take care that your hand is not sprayed—the pressure is so high that the skin would be penetrated. There must be no dribble. The spray must be similar in direction and quantity from the two holes. If one is blocked (wholly or partially) or there are signs of dribble, fit the spare injector and recondition the original one without delay. After testing injectors, re-prime fuel system (see para. A3).

B4 **Cleaning the Injector.** Perfect cleanliness is essential—the minutest particle of dirt can do serious damage.

Remove the nozzle from the holder by unscrewing the cap-nut. The needle valve is removed from the nozzle with the fingers; it and the bore of the nozzle should be examined for signs of carbon deposit or discolouration. If the nozzle holes are blocked clean them with the pricker, very gently to avoid breaking the slender wire (diam. .25 mm.). Both nozzle and needle valve should be allowed to soak in clean paraffin, and the valve should then be cleaned with a **brass** wire brush and then polished with a clean soft rag. Reassemble the valve in the nozzple while immersed in clean paraffin and work the two together until they are quite free. **On no account attempt to grind in the needle valve.** Detailed instructions are in the C.A.V. Handbook No. 2002/2. Unless you have access to a nozzle testing outfit do not interfere with the setting of the injector spring, as you will not be able to reset it to the correct pressure.

B5 **Lubricating Oil Filter.** Loosen the bolt on top of the cover, remove the bowl and take out the element. Dismantle this by undoing the knurled knob underneath. Wash the components and also the bowl in paraffin. When reassembling do not overtighten the bolt or the bowl may be distorted and leak. After cleaning always, when the engine is first run, see that it is not leaking.

B6 **The Water Pump** needs little attention beyond tightening the gland (just enough to prevent it leaking) : the ball bearing on the

B16 If trouble should be experienced, deal with it promptly. The following schedule will assist in locating it and gives a guide to the remedy.

Symptoms—

Engine will not start—starter dead, or only turns sluggishly.

Probable cause, action to take—

1—Is battery charged ? Are connections to battery and switches tight and clean ?

2—Check starter motor (para. B10).

3—Starter pinion jammed; remove end cap on starter and turn squared end of shaft.

4—Loosen decompressor valves, turn engine by hand a few times to circulate oil.

Starter motor rotates engine at speed but engine will not fire or, runs for a few revolutions and stops.

5—Fuel cock closed. Tank empty. Remedy obvious.

6—Fuel system needs priming (para. A3).

7—Decompressor valves leaking. Clean them and their seats.

8—Control lever wrongly set (para. A6).

9—Lack of compression. Piston rings dry. Engine too cold ; inject oil into cylinders (para. A7).

10—Obstruction in fuel system or a dirty filter element (para. B8).

11—Engine needs decarbonising (para. C1).

12—Injection nozzles blocked or defective (para. B4).

13—Exhaust system blocked.

14—Fuel lift pump failure (para. D4).

Engine tends to stall when put into gear.

16—Idling-stop out of adjustment (para. D35).

17—Engine only firing on one cylinder. Check injectors (para. B3).

18—Defective fuel system; see 6, 10 and 14 above.

Engine runs unevenly.

19—Defective injectors (para. B3).

20—Injection pipes leaking, check tightness.

21—Air in fuel system ; prime it (para. A3).

22—Sticking fuel pump plungers broken fuel pump spring (see C.A.V. Booklet).

23—Broken valve springs in air pump (para. C10).

Engine knocking, smoky exhaust, loss of power.
Try to locate cause : then stop the engine as soon as you can.

24—Engine overloaded. Maximum speed stop out of adjustment (para. D35).

25—Injection nozzles defective (para. B3).

26—Engine needs decarbonising ; rings stuck, pistons dry (see Section C).

27—Exhaust ports or pipes need cleaning (see Section C).

28—Air pump valves defective (para. C10).

29—Fuel pump timing slipped (para. D32. Engines up to No. 99 only).

30—Incorrect grade of fuel (para. A1).

31—Engine and shaft out of alignment (see Section E).

32—Damaged propeller.

Blue smoke from exhaust.

33—If continuous and excessive, rings may be stuck or engine may need a rebore.

Low oil pressure.

Stop the engine at once (para. A8).

34—Insufficient oil in sump.

35—Wrong grade of oil.

36—Defective gauge or pipe.

37—Relief valve plunger stuck or spring broken (para. F7).

38—Worn oil pump, worn bearings, slack unions, damaged oil pipes (paras. D10, D15, D19).

Engine overheating, insufficient flow of water.

39—Seacock turned off or seacock filter dirty.

40—Dirt under circulating pump valves.

41—Leak in suction pipe.

42—Defective thermostat (para. C7).

banjo-link needs greasing once or twice a year. See that valves and valve seats are in good condition.

To re-pack the gland, remove all old packing, then wrap the new packing seven times snugly round the plunger and make a clean cut across all turns with a razor-blade. Insert the rings so as to divide the packing into separate rings. Insert the rings one at a time and press each home, staggering the joints. Do not screw the gland down more than enough to prevent leakage.

After re-packing the gland, turn the engine carefully and see that the gland nut does not foul the banjo link.

B7 **The Crankcase.** Drain, then fill with about 6 pints of flushing oil. Run the engine for 15 minutes at no load and full speed. Drain once more and re-fill with new engine oil. Remove the magnetic plug at the forward end of the crankcase and clean it.

B8 **Fuel Filter.** Take out the element. It it is very dirty, replace by a new one ; **do not** attempt to clean it. Cleaning results in dirt being transferred to the delivery side of the filter and into the fuel pump, where it willdo serious damage. It is cheaper to buy a new element than a new pump.

B9 **Lubrication of Dynamo.** Every 500 hours inject a few drops of engine oil into the hole marked "OIL" in the end of the bearing housing. For Commutator end bearing lubrication, see fig. 1.

The Starter Bearings need no lubrication.

B10 **Inspection of Dynamo and Starter Brush Gear.** Check that the brushes move freely in their holders by holding back the brush springs and pulling gently on the flexible connectors. If a brush is inclined to stick, remove it from its holder and clean it with a petrol-moistened cloth. Be careful to replace brushes in their

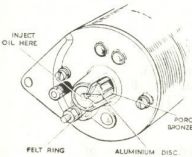


FIG. 1

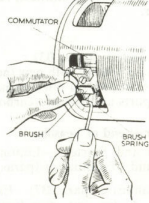


FIG. 2

original positions in order to retain the "bedding." Brushes which have worn so that they will not "bed" properly on the commutator must be replaced by new ones. The commutator should be clean, and should have a polished appearance. If dirty, clean it by pressing a fine dry cloth against it while the engine is slowly turned by hand. If this is not effective moisten the cloth with petrol.

Method of checking brush gear is illustrated in fig. 2.

B11 **Belt Tension.** Occasionally inspect the driving belt. Adjust by turning the generator on its mounting. Avoid overtightening; there should be just sufficient tension to drive without slipping.

B12 **Control Box.** No maintenance nor adjustment will normally be required. If it appears that the battery is being over-charged, or if the battery does not remain in a charged condition, testing and adjustment of the equipment should be entrusted to a Lucas Service Depot or Agent.

MAINTENANCE SCHEDULE

B13 **Every ten hours' running or at weekly inspection.**

Give a turn to the **greasers** on the throttle gear and on the pulley at the forward end of the crankshaft, refill if necessary.

Clean the strainer in the seacock.

Circulating Pump. If the gland leaks tap it round gently with a blunt instrument.

Batteries. Specific gravity of electrolyte should not be allowed to fall below 1.25. Top up with distilled water only. Vaseline the terminals to prevent corrosion.

Give a drop of oil occasionally to the joints of the **control linkage.**

If **the chain** shows rust or stiffness, remove and soak in Redex oil for $\frac{1}{2}$ hour.

B14 **Every 250 hours.**

Service injectors (para. B3).

Drain sump and fill with new (**not** reclaimed) oil.

Clean lubricating oil filter element (para. B5). Examine exhaust ports and remove carbon (para. C1).

B15 **Every 500 hours or at end of Season.**

Dynamo and Starter :—Lubrication and Inspection of Brush Gear and Commutator (paras. B9 and B10).

Flush crankcase (para. B7). Examine fuel filter element (para. B8). Carry out decarbonising and top overhaul (Section C).

SECTION C

DECARBONISING AND TOP OVERHAUL

C1 **Exhaust Ports.** Drain the cylinder block and take off exhaust manifold, first disconnecting the pipe from the water pump. Turn the engine to bring each piston to bottom dead centre before cleaning the ports. Remove all carbon with a scraper, taking great care not to damage rings or piston or to leave carbon in the cylinder.

If time is short, just carry out para. C1. If exhaust ports are badly choked, examine inlet ports also (para. C4).

C2 **The Exhaust System.** Dismantle and burn out the exhaust pipes. Remove the silencer end and clean the inside; make sure that all the holes in the inlet and outlet pipes are clear.

C3 **The Cylinders.** Remove the engine covers. Loosen the collar on the starting shaft and pull it forward, after removing the chain. Disconnect the fuel injection pipes and the water pipes from the thermostat.

Now undo the nuts and lift the cylinder head. Remove the joint and gently lift the cylinder block. Don't try to start the cylinder by driving a screwdriver between it and the crankcase—it will cause a leak from the air chest.

C4 Remove injectors and service them (C.A.V. Booklet 2002/2), clean the carbon from the holes in the cylinder head and scrape the combustion chambers. Clean all the cylinder ports and polish the bores with a rag. If there is any brownish deposit of lacquer in the bores, remove it with methylated spirits and jeweller's rouge. Examine the bores for scoring and wear (para. D13).

To clean the inlet ports, remove the small doors at each end of the cylinder block. If it is necessary to replace the joints under these doors, make sure that only those supplied by the makers are used. A joint of incorrect thickness will upset the control of the air flow into the cylinders (correct thickness is 0.010-in.)

silindirin hava akış kontrolun. kalınlığı

C5 Take out the circlips and remove the piston pins with the extractor (tool 8454). Do not mix up the pistons. As you take them apart mark cylinder and pistons with chalk so that you may be **quite** certain of assembling them as before. Remove the rings from the pistons.

C6 **Stuck Rings.** Soak in methylated spirit and ease gently with a penknife in the gap. Remove by running a thin penknife round behind the ring—scrape them clean. Lay out the piston rings in order, and label them so as not to mix them up ; each ring must go back in its own groove. Soak the pistons in methylated spirits to loosen the carbon and remove it from the top and the grooves by brushing carefully with a brass wire brush. Stuck rings are the usual cause of loss of compression. Clean the inside of the pistons.

C7 Pistons are marked "E" on the side that faces the exhaust port. Assembled the wrong way, the gaps in piston rings will catch in the ports and break.

Clean all jointing compound off the bottom of the cylinder and the top of the crankcase and renew the joint between them. It is essential that it be absolutely tight.

Dismantle the thermostat housing. Put thermostat in nearly boiling water to check that it opens.

C8 Assistance is needed in replacing the cylinder block. Be careful to avoid damaging hands and piston rings. Put two wooden blocks below the cylinder block so that, if it suddenly slips over the pistons, it does not come down and pinch the fingers. Bring the pistons to mid-stroke and lower the cylinder block over the studs. While one person supports the weight of the block, with the steel bar, the other should guide the top of the pistons into the cylinder bores. Piston rings must be placed so that their open ends embrace the pins in the ring grooves. Squeezing the rings, feed them into the chamfer at the bottom of each cylinder. Make sure that the joint is lying flat and is evenly coated with jointing compound before the cylinder is lowered home.

C9 At T.D.C. the piston is level with the top of the cylinder liner ; if it is not, adjust with extra cylinder base joints.

Replace the cylinder head joint, so that the holes line up with the water holes, and then the head.

Tighten the cylinder head nuts evenly, working round several times to make sure that they are all tightened the same amount.

A good rule is to renew the element after about 1,000 hours' running but it may need replacing before that. Clean the filter bowl.

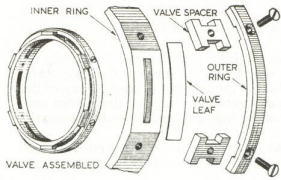


FIG. 3

C10 **Air Pump Valves** (fig. 3 and fig. 5, para. F3). Remove the air ducts and silencers. Loosen the nut securing the crankcase breather. Take off the valve casings, tapping them gently with a block of wood to break the joint. The delivery valve rings are then exposed, the suction valve rings being in the casings. Examine the leaves to see that they are seating squarely over the slots in the rings. Lift each leaf by a matchstick through the slots and examine for cracks.

If any of the leaves show signs of damage, replace them. The inlet valve is secured to the valve casing by three screws (P). Take them out, knock off the valve retaining plate (R) and remove the valve ring assembly for examination. The delivery valve comes off the pump cylinder. Held between cylinder and valve casing, it is sealed by an O ring on both sides.

Valves should be dismantled on a large sheet of paper so that none of the parts be lost. Remove the screws holding the outer and inner rings together and then, laying the valve flat on the paper, carefully lift the outer ring; it will carry the "H" shaped valve spacers with it. The six leaf springs will jump out as the outer ring comes off. Replace any damaged leaves; new leaves must be flat.

C11 To reassemble, place the outer ring over the inner one and push the valve spacers half-way home, lifting the outer ring to do this. Having inserted a leaf in each slot, push the outer ring and the six spacers home. Replace the six counter-sunk screws. Then wash the valve in petrol.

Do not hold any of the valve components in a vice; it is easy to distort them, and spoil the air seal.

If O rings are stretched or damaged they must be replaced.

SECTION D

MAJOR OVERHAUL

D1 The work described in the following section should only be carried out by an experienced mechanic. It is best done ashore in clean dry surroundings. Take great care not to damage any of the components. Lay them out carefully as they are dismantled and do not dismantle any part of the engine unless it is really necessary.

Dismantling the Engine. The engine is dismantled in the following order; cylinder block and air valves have been dealt with in Section C.

1—Air Silencers and Air Ducts
2—Dynamo
3—Lubricating Oil Filter
4—Engine Cover
5—Hand Starting Gear
6—Circulating Water and Fuel Lift Pumps
7—Fuel Filter and Engine Cover End Plate
8—Fuel Injection Pump and Tappets
9—Governor Spring Housing and Linkage
10—Starter
11—Sump
12—Lubricating Oil Pump
13—Gearbox and Flywheel Housing
14—Flywheel
15—Cylinder Block, Head and Pistons
16—Connecting Rods
17—Crankcase End Cover, Camshaft and Driving Gears
18—Air Pump
19—Lubricating Oil System Piping
20—Partition Plate
21—Crankshaft and Main Bearings

D2 **Hand Starting Gear.** Remove the screw in the end of the crankshaft and the pulley. The ratchet ring on the chain wheel is engaged by three spring loaded dogs on the vee pulley.

D3 **Circulating Water Pump.** Before taking it off remove the fuel lift pump as its operating plunger is driven from an eccentric on the water pump spindle and must be withdrawn.

D4 **Fuel Lift Pump.** This is a standard A.C. Sphinx Type Y to their drawing No. 1524213. It is similar to those on motor car engines and may be obtained from most garages. It will be necessary to bend the hand priming lever to clear the dynamo driving pulley. Failure is almost certainly due to the diaphragm having cracked. A diaphragm is among the spare parts; when used, obtain another without delay.

D5 **Fuel Oil Pipes.** If dismantled make sure that the pipes are clean, that joint washers are in good condition and joints are tight.

D6 **Fuel Injection Pump.** Full instructions are given in the C.A.V. Booklet 2000/4. Servicing these pumps is a highly skilled operation so, if possible, send the pump to the engine makers. If it is necessary to remove the fuel injection pump, first take off the end plate carrying the filter.

D7 A new or reconditioned fuel pump has the elements correctly "balanced." This ensures that the same amount of fuel is injected into each cylinder. If the pump has been dismantled, pay particular attention to the C.A.V. instructions on this point. It is easy to assemble the fuel pump rack and quadrants so that there is an error of one or two teeth in their engagement. Make sure that both clamp cheeks on the two quadrants face in exactly the same direction and that the adjusting marks on the toothed quadrants and the regulating sleeves are together.

D8 **Fuel Pump Tappets.** The pump stands on the tappet guide, each tappet being retained in the guide by a screw engaging a slot. Examine the tappets, rollers and pins for wear; replace if necessary. Make sure that the tappets are not crossed over and on no account disturb the adjusting screws in the top which engage the pump plunger guides. The screws affect the timing; it is possible to smash the pump if the screws are not positioned correctly. For adjusting tappets, see para. D33.

D9 **The Sump.** Remove the pipe from the sump drain pump. There is a paper joint between sump and crankcase.

D10 **Lubricating Oil Pump.** On a bracket on the underside of the crankcase. Before removing, disconnect the main delivery pipe and the small pipe to the air pump. Be careful not to bend it for it delivers oil into the trough in the air pump connecting rod.

The pump body, bracket and cover plate are held together by five set-screws. To remove the driving gear, it is held in a vice with soft jaws so as not to damage it, and the nut removed. Take off the wheel and key; the main shaft with rotor comes out downwards. The driven rotor runs on a fixed spindle secured by a grub screw engaging with the flat on the spindle. This screw locates the oil feed hole in the spindle, supplying oil to the air pump.

The end clearance of the rotors should be 0.0005-in. to 0.002-in. If it exceeds 0.003-in. or if the cover plates are scored, send the pump to the makers for repair. To check end clearance, clean up the joint faces, re-assemble body, bracket and rotors, lay a straight-edge across and check the clearance with a feeler gauge. Check the cover plate in the same way; adding the clearances, the total must not exceed 0.003-in.

The oil strainer is attached to the pump body by a nipple. On refitting, take care that its bottom face is horizontal.

D11 **Flywheel Housing.** The gearbox and flywheel housing are attached to the crankcase partition plate by bolts and studs. Before removing them, place supports under the engine and gearbox to carry their weight.

D12 **The Flywheel.** Attached to a flange on the crankshaft by six bolts and a locating dowel, the flywheel may be withdrawn from the crankshaft by means of two extractor bolts (tool M.28100). Examine the gear ring on the flywheel for damage and wear.

D13 **Cylinder Block, Head and Pistons.** Remove as described in para. C3. The diameter of a new cylinder bore is 2.75075 to 2.75025-in. When the wear at the top of the piston ring travel exceeds 0.005-in., i.e. when the diameter exceeds 2.755-in. new liners are required, or the existing liners honed and oversize pistons fitted. Makers standard oversize piston and rings are +.010-in., +.020-in. and +.030-in. standard piston ve yüzüklerin degeri

D14 Liners are honed to size after pressing in. It is recommended that re-sleeving be done by the makers, as, due to the ports, special methods are necessary. Generally, the piston will have as long a life as the liner and should be replaced at the same time. The piston ring gap as fitted is 0.008 to 0.013-in. Replace when the gap, with the ring in the unworn part of the bore, exceeds 0.025-in.

piston yüzük aralığı

The figures of wear are approximate only. The design is too new for more exact ones.

D15 **Connecting Rods.** The connecting rod and its oilways should be very carefully cleaned. An oil duct leads to an annular groove around the small end bush, with four holes for lubricating the piston pin. Make sure that all these holes are clear.

The piston pin and small end bush should be checked for wear. The diameter of the pin is 1.000 to 0.99975-in. A pin wears oval; when its minimum diameter falls below 0.998-in., it and the bush should both be replaced. The diameter of the bush is 1.00025 to 1.000-in. When it exceeds 1.002-in., it should be replaced.

piston milin kutru

Examine the big end bearings for pitting and scoring. The tin surface may have worn off the upper half, but it may still be serviceable. The bore is 2.003 to 2.0015-in.; bearing shells should be replaced when the maximum bore exceeds 2.005-in.

When re-fitting, make certain that everything is absolutely clean. Dirt will result in the break-up of the bearing surfaces.

Connecting rods and caps are numbered, numbers toward the port side ; this is essential. No. 1 rod is at the forward end.

D16 **Crankcase End Cover.** This carries the ball races supporting the crankshaft and camshaft. Remove the camshaft cover plate which encloses the camshaft ball race, screw two $\frac{1}{4}$ U.N.F. jacking screws (tool M24100) into the holes on each side of the end cover and ease the cover off. Tap the end of the camshaft while doing this to shift the camshaft ball race.

On engines earlier than No. 100, be careful not to damage the crankshaft oil seal: so, before replacing the end cover take off the crankshaft nut.

D17 **Camshaft and Governor.** The camshaft cannot be taken out until the C.A.V. pump, tappet guide and governor spindle have been removed. To remove the governor spindle drive out the locking pin in the bell crank, take off the nut at the top of the spindle and lower spindle and operating fork into the crankcase.

If the camshaft is tight in the rear ball race, gently tap it forward by means of a brass drift through the opening for the fuel pump in the top of the crankcase. The governor has two weights acting through a sliding sleeve and thrust bearing against the fork on the governor spindle. Ahead of the governor is the alloy cast iron driving gear.

The rear ballrace is a tight fit in the crankcase ; it may be removed by heating the crankcase. It should be free when the temperature of the crankcase is near boiling point.

Examine the camshaft ball bearings for wear.

D18 **Crankshaft and Main Bearings.** Before removing the crankshaft detach the partition plate from the after end of the crankcase. The crankshaft end flange runs in the bore of the partition plate ; an oil-return groove prevents leakage.

Handle the crankshaft with great care ; it carries the spiral gears driving the lubricating oil and water pumps and the spur wheel driving the camshaft. On engines before No. 100, the gears are locked by the crankshaft nut, and the camshaft driving gear has a coned bore engaging with a cone on the water pump drive gear. This is for timing the camshaft. Crankshaft end float is taken up by thrust washers on each side of the centre main bearing.

Remove the pipe which feeds oil to the forward bearing cap. Bearings caps are a tight fit in the crankcase ; they are removed by the bearing cap extractor (tool 12771) which is screwed into the $\frac{1}{4}$ B.S.P. hole in the centre of the caps. The cap-half of the centre main bearing is lined with copper-lead ; all others are white metalled. Caps and crankcase are numbered and must not be interchanged. Be careful not to mix the various bearing shells. Examine for pitting and wear. The bores are 2.0025 to 2.001-in. diameter. When a bore exceeds 2.005-in. at any point, fit new shells.

D19 Crankshaft journals and crankpin diameters are 2.000 to 1.9995-in. When one of them has decreased to 1.995-in. or when

the ovality of journals or crankpins exceeds 0.002-in. the crankshaft must be re-ground and undersized bearings fitted.

Before re-assembling, clean the oilways and test that they are clear. The main bearing nuts should be tightened with a torque spanner to a torque of 600-lbs. in.

D20 **Crankcase and Oilways.** Take the oil pressure relief valve out, clean it and flush out oilways in the crankcase and all oil pipes with petrol. Clean the air passages in the crankcase.

If a degreaser is available, use it for cleaning the crankcase before assembling the engine. Alternatively, wash thoroughly with petrol. Do the same to all other parts of the engine.

D21 **Air Pump** (Fig. 5, para. F3). The air pump valves are dealt with in paras. C10 and 11. After the valves have been removed take out screws (K) then remove cylinder and piston together with two jacking screws (M24100) inserted into the tapped holes in each cylinder flange. The cylinders are spigoted into the crankcase with an O ring (H) in a groove around each cylinder. This ring must be a snug fit, to prevent leak. If it has stretched, or is damaged, replace it ; soft-soap it before inserting.

Remove these and gently ease the pistons off. They are marked "port" and "starboard." Replace with the markings the right way up.

At the starboard end of the yoke is the piston pin secured by circlips. Withdraw the pin and remove the yoke from the starboard side. The connecting rod is withdrawn after removing the crankcase end cover and the driving gears from the crankshaft. Examine white metal lining of the rod bearings for pitting and wear.

D22 Fit the yoke with the connecting rod pointing to starboard, otherwise the oil jet will not lubricate the rod.

Reassemble piston and cylinder together, reversing the procedure described above. The screws, K, are specially made with a locking device. No other screws must be substituted. The piston rings are taper. The side marked "top" must be towards the top of the piston.

REVERSE GEARBOX

D23 It is attached to the flywheel housing by six studs. Do not dismantle unless necessary for repairs.

To do so, first wedge the coupling at the engine end next to the flywheel, put the lever in gear, unscrew the nut at the after end, draw off the coupling and remove the key.

In an engine with **reduction gear** the reduction gear case is removed complete with driving shaft and gear in it. The gear, shaft and bearings are lifted out of the case together for the locknut is riveted to the shaft.

The rear bearing is held by a circlip and the outer race of this bearing may remain fixed in the case, so have a tray underneath to catch the balls and cage. Circlip, race, shim, gear and key, and the second thrust race are now drawn off the shaft. The thin rim of outer races face each other.

D24 Remove the control housing with the gear lever, take out the eccentric shaft screw and withdraw the shaft. This is just below the opening in the gearbox. Take out the screw Pt. 12081. At the other end of the shaft is a plug Pt. 12082 in which is a small screw. Take out this small screw which then enables you with a rod to drive the eccentric shaft out just sufficiently to clear the serrations on the shaft. The serrations are there so that fine adjustments of the eccentric shaft can be made by moving forward or backward one serration at a time. Lift out the operating fork.

To dismantle the primary shaft assembly carried in the flywheel housing, wedge the coupling against rotation and unscrew the nut. Withdraw coupling and key and carefully drive the shaft back through the ball race. The forward cone is pressed on to the shaft and held by two keys.

The double thrust race is removed by taking out the internal circlip and warming the flywheel housing slightly. An oil seal is pressed into the front end of the flywheel housing ; be careful of this when re-assembling.

D25 Note—In a few of the earlier gearboxes, the double thrust race is replaced by a single thrust race, with a thrust washer behind it. When assembling, the thrust washer must be placed with the relieved face towards the ball race, before the race is pressed in position. The shaft is then threaded through the ball race and the thrust washer. The ball race has the thicker edge of the outer race, (marked "thrust") facing towards the engine.

D26 The secondary shaft carrying the remaining moving parts of the gearbox is removed by driving it forward ; take care not to damage the end of the shaft. The shaft, which carries the planet train, slips forward out of the clutch body which slides upon it on three keys. Do not disturb the planet train unless it is absolutely necessary. The planet pinions are retained by an end plate secured by six set-bolts. Mark the planet pinions so that they go back the same as before. The planet cage rotates on the secondary shaft and is secured by a circlip.

D27 To dismantle the clutch body and operating sleeve assembly, remove the large circlip securing the double thrust race in the body and tap the operating sleeve assembly forward and out of it.

To dismantle the sleeve, place two clamps over the double thrust race and the rear pressure plate to compress the springs enough for the circlip at the after end of the inner sleeve to be removed.

D28 The part of the gearbox most subject to wear is the floating bush between the primary and secondary shafts. The outside diameter is 0.999 to 0.998-in. If it has worn to 0.996-in., re-new. The bore is 0.75075 to 0.750-in. Replace when it exceeds 0.753-in.

D29 **Re-assembling.** Make sure that the ball thrust races are the right way round. In the case of the direct drive engine, there are two races at the after end of the gearbox. They must be assembled face to face with the thicker edges of the outer race marked "thrust" facing outwards; in the reduction gear engine, there are races on each side of the pinion and of the final output gearwheel ;

they too must be assembled with the thrust side of the races facing outwards.

Renew the flexible coupling disc if the holes are worn. Also examine the steady bush in the end of the crankshaft. This has a bore of 0.7505 to 0.7495-in. If it exceeds 0.752-in., drive out and replace; oil before assembling.

The gear control mechanism is "balanced." The force required to engage ahead and astern gear is equalised by turning the eccentric shaft, which has two flats at its port end. When the right position has been found, using the serrations described in para. D24, the tell-tale pin must point upwards. Lock it by the eccentric screw shaft.

Backlash in the control mechanism is eliminated by removing one or more of the paper joints from the underside of the gear control housing.

FUEL INJECTION SYSTEM

D30 **Adjusting the Fuel Injection Equipment and Control Mechanism.** This must be done with the greatest care. The successful operation of the engine depends upon correct injection.

D31 **Timing the Fuel Pump.** The spill-port of the injection pump is set to close 25 deg. before Top Dead Centre. This controls the moment at which fuel is injected into the cylinders.

To check the timing, remove the door on the flywheel housing. There are two sets of marks on the flywheel, corresponding to the "top dead centre" and "injection point" of the two cylinders and a fixed pointer in the housing. Find the mark stamped TDC—I; 25 deg. ahead of it is another mark stamped IP—I. This must be opposite the pointer when delivery of fuel to No. 1 cylinder is about to begin. No. 1 cylinder is that farthest from the flywheel and is fed by the corresponding cylinder of the fuel pump.

Remove the fuel injection pipe to No. 1 cylinder and the delivery valve holder, valve and spring. Replace the delivery valve holder only, set the control to the full load position and operate the priming lever of the fuel lift pump, when fuel will flow out of the top of the delivery valve holder. Slowly rotate the engine in the direction in which it runs—clockwise when viewed from the forward end—until the fuel ceases to flow. This is the point at which the pump spill-port closes. At this point, the mark IP—I is opposite the pointer in the flywheel housing when the timing is correctly set. Permissible error is $1\frac{1}{2}$ deg. or $\frac{3}{8}$-in. at the flywheel rim.

D32 **On engines up to No. 99.** To adjust the timing, loosen the crankshaft nut and tap the end of the crankshaft with a block of wood and hammer. This will free the cone on the camshaft driving gear. The camshaft may then be turned using a box spanner on the end nut. Set the flywheel to I.P—I and turn the camshaft **anti-clockwise** until the spill-port closes and fuel ceases to flow. Tighten the crankshaft nut and re-check the timing, turning the engine in a clockwise direction. If it is correct drive up the crankshaft nut really tight, using a hammer on the spanner; re-check the timing.

On later engines there is no timing adjustment, but camshaft driving gears must be assembled so that marks on the teeth of crankshaft and camshaft gears come together.

D33 Now re-assemble the delivery valve and holder of No. 1 cylinder and check the timing of No. 2 cylinder in the same way. If the timing of No. 2 cylinder is incorrect, i.e. if the two pump cylinders are not exactly at 180 deg. they may be adjusted by altering the height of No. 2 tappet. Remove the fuel pump and expose the tappets. If the timing is late, the tappet screw must be raised: if early, it must be lowered. Turning the screw through one flat (60 deg.) alters the timing by approximately 1 degree. Make sure that the locknut is securely tightened after adjustment. If the tappets have been disturbed, they must be adjusted to the correct height. Remove the pump, turn the engine until both tappets are at the bottom of their travel and with the gauge (tool 12822) supplied, set the tappet screws so that they lie 0.190-in. above the top face of the tappet carrier, with the paper joint removed. It may be necessary subsequently to alter these settings slightly to get both spill timings correct.

D34 **Balancing the Fuel Pumps.** A new injection pump is sent out correctly "balanced," i.e. the delivery of fuel from the two cylinders is equal at any rack setting. Provided the instructions given in para. D7 have been correctly followed, an overhauled pump should also be in balance, but it is well when an engine has been given a complete overhaul to check the balance by the exhaust temperature. Two $\frac{1}{4}$-in. B.S.P. Plugs in the top of the exhaust manifold cover holes provided for the use of thermometers.

Run the engine on load and after giving it a few minutes to warm up, read the thermometers. They should be within 10 deg.C. (18 deg. F.) of each other at full load. Change them over and read them again and take the average of the two readings for each cylinder. If one cylinder is giving a low temperature, it is not receiving enough fuel. Remove the cover plate on the starboard side of the pump and loosen the clamping screw in the quadrant of the pump cylinder corresponding to the low temperature. With a small screwdriver (nail will do) turn the regulating sleeve slightly anti-clockwise. Re-tighten the quadrant clamping screw and re-check the temperature.

The full load delivery of the fuel pumps is 16.6 cub. mm. per stroke, or 9.6 c.c. in 600 strokes; if a pump tester is available the elements may be balanced at this delivery.

THROTTLE CONTROL MECHANISM

D35 With the boat under way and the engine well warmed up, check engine speed by means of a tachometer, then push the fuel pump rack further open until the exhaust turns black. Normal full throttle speed must be at least 50 r.p.m. lower.

To adjust the maximum load position, slack off the ball joint at the end of the rod linking the throttle lever to the governor, loosen the locknut on the rod, and turn the ball joint. To raise speed, shorten the rod; to lower it, lengthen it. Adjust idling speed

by the idling stop on the governor spring housing. Screwing it in raises speed. The engine should idle at about 600 r.p.m. Check that it is possible to stop the engine by pushing the stop button.

Do not try and get too much out of the engine, particularly if the boat may be in the hands of unskilled people ; any possibility of overloading the engine must be avoided, for that would soon result in deterioration and rapid deposit of carbon.

SECTION E

INSTALLATION INSTRUCTIONS

E1 A special book 'Installation Instructions' (No. 26—price 2/-) for marine engines in general is available—the following notes deal with special points of interest.

Keep all the equipment scrupulously clean. Serious trouble can be caused by dirt getting into the component parts of the fuel system before use.

Put on one side tools and handbooks to hand to the owner.

Please return the packing crate and cases and inform us of despatch.

E2 **Slinging.** There are three slinging eyes on the engine—one on each side of the flywheel casing and one at the forward end of the cylinder block—seen when the cover is off. Do **not** sling by passing a rope round the dynamo pulley.

E3 **Engine Bearers.** Angle of installation must not exceed 12 deg. The engine bearers should be slotted for the square bronze blocks, the studs screwed home and the locking pins inserted.

Carve out a dip in the bearer on the port side so that the lubricating oil filter is easily accessible.

E4 **The engine must be accurately in line with the propeller shaft when the boat is in the water.** Alignment, though perfect when the engine was installed, may become incorrect, due to slight movement in the structure of the boat ; no boat is perfectly rigid.

E5 The alignment should be checked a few days after installation Take off the coupling nuts and slide the propeller shaft back. Rotate the shaft. The coupling must run truly ; if not, the shaft is bent. Slide the shaft forward ; it should meet the coupling on the engine truly. Test with feelers between the faces of the coupling in four places, top and bottom and both sides, to make certain that the two shafts are truly in line.

SECTION F

GENERAL DESCRIPTION

F1 The engine is described as if it were installed in a boat. The flywheel and gearbox are at the after end; hand starting gear at the forward end. (Hand starting at the other end cannot be arranged). "Port Side" is on the left, "Starboard" on the right.

The Stuart H2 Engine is a two-cylinder two-stroke engine of the "loop scavenged" open combustion chamber type, air being admitted and exhaust released through ports in the cylinder wall. Air for scavenging and combustion is supplied by a reciprocating air pump at the forward end of the engine.

The reverse gearbox is in two forms :—direct drive, type H2M, and with reduction gear, type H2MR.

Fig. 10, inside the back cover is a cross-section of the engine.

F2 **The Crankcase** is a corrosion-resisting aluminium alloy casting. The flywheel is enclosed in a housing attached to the crankcase. The crankshaft, of high-duty cast iron, runs in three steel-backed thin-walled main bearings. The lower half of the centre main bearing is copper-lead-lined; all others are white metalled. There is a ball bearing at the forward end. Main and connecting rod bearings are fed with oil under pressure.

An eccentric on the crankshaft drives the air pump; all auxiliaries are at the forward end.

The Camshaft on which is the governor, is driven through spur gears and runs on ball bearings.

The **Cast Iron Sump** holds about 1 gallon of oil; lubrication is by a submerged gear pump.

The **Cast Iron Pistons** have four compression and one scraper ring; the top ring chromium plated. The cylinder block and head are cast iron: dry liners of alloy iron are used. They stand proud of the cylinder block .003-.008 in. do ensure a gas-tight joint. There are accurately machined inlet and exhaust ports in the liners.

Air at about 3 p.s.i. is delivered by the air pump to an air chest at the bottom of the cylinder block whence vertical passages lead to the inlet ports.

The combustion chamber is in the cylinder head. Cylinders and fuel pump are enclosed in a sheet steel case. A cast iron exhaust manifold is on the starboard side. Each cylinder has a compression relief valve.

When the engine is running the descent of each piston first uncovers the exhaust port and the pressure falls to near atmospheric.

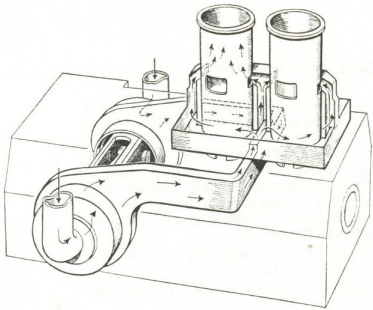


Fig. 4. Shows how air is transferred from air pump to ports in cylinder liners via ducts in crankcase and cylinder block

A little lower down the piston uncovers the inlet ports, compressed air rushes in, sweeps the remaining spent gas out of the cylinder and charges it with fresh air which, as the piston rises, is compressed.

F3 **Air Pump.** Fig. 5, is a transverse section. Two aluminium pistons connected by a yoke (B), are driven by a gunmetal connecting rod (C) from the eccentric (D) on the crankshaft. Each piston (A) has two compression (E) and one scraper ring (F). The cylinders (G), cast iron, are spigotted into the crankcase and sealed by an O ring (H).

Air enters through silencers and air ducts. "Circoflex" suction and delivery valves are used.

The valves are in two concentric rings, the suction valves inside the delivery (figs 3 and 5). Air, entering the centre of the valve, passes through six slots covered by thin beryllium-copper leaf springs. Suction lifts the leaves and, when delivery begins, they spring back and seal the slots. The delivery valve is similar, opening under pressure and closing when the suction stroke begins. It is sealed by an O ring on each side (J).

Compressed air passes from inside the valve casing through slots in the pump cylinder flange to an annular cavity in the crankcase, thence through a transverse passage above the centre main bearing to the air chest (fig. 4).

E6 **Stern Tube Bearings.** The shaft must not run in a rubber bearing except under water. Oil shaft and bearing with a vegetable oil such as Castor Oil before inserting the shaft and submerge as soon as possible. Do not use mineral oil.

E7 **Fuel System.** Make the fuel pipe short and direct to avoid air locks.

E8 **Exhaust System.** The satisfactory performance of any two-stroke diesel engine may be affected quite seriously by a badly installed exhaust system. So follow these instructions exactly ; it is worth while taking a little extra trouble to get a good installation. Have as few bends as possible, and use **bends**, not **elbows.**

A 3-ft. length of galvanised pipe between the engine and silencer is ideal ; it may have to be slightly more on occasion but do not, on any account, exceed 5-ft. There is no objection to **reducing** the length of this pipe. For the tail-pipe, 1½-in bore, is used. Keep this as short and straight as possible. It is permissible to fit the exhaust outlet just below water level. If there is any possibility of the sea entering the exhaust system (as in a following sea) a swan neck must be fitted.

There must be a fall of at least 18-in. from the exhaust manifold to the silencer to avoid any possibility of the cooling water, injected into the silencer, finding its way into the engine. There is no objection to a moderate rise to the outlet. The flow of exhaust gas through the system will carry the water with it.

E9 **Cooling Water System.** The STUART seacock has three connections round the top end, to one of which the vent pipe is connected. If the seacock is not vertical, connect to the uppermost one. Carry the pipe well above water level and bend the top over.

The lower connection on the seacock is connected to the suction of the circulating pump and the one half-way up the barrel to the lower connection on the thermostat. A pipe from the upper connection on the thermostat is connected to the silencer. The thermostat cover may be in any one of three positions as may be most convenient for neat pipe-work.

The seacock must be accessible ; the strainer will need cleaning. The suction pipe should be short, but it must have some flexibility ; a reinforced rubber pipe is sometimes used. The inlet must be placed where the water passing it is "solid"—low down, not too close to the stern nor near the keel, or there is a risk of air bubbles causing failure of the pump.

If the engine is below water level, suction may be erratic unless special valves, caps and springs are used. These can be supplied.

The solderless pipe unions used for making the water pipe connections are fitted as follows:—

Thread nut on pipe, push olive on pipe until $\frac{1}{8}$-in. pipe projects. Place the pipe in the union, see that it is quite square with the union. Screw down the nut. Do not bend the pipe close to the union, leave at least $\frac{1}{2}$-in. of pipe straight.

E10 **Gear Lever.** Gear lever may be fitted in either of two positions, whichever is more convenient. It is secured by means of a cotter. To change the position, take out the cotter and turn the lever over.

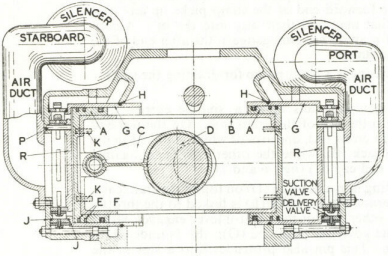


FIG. 5

FUEL INJECTION

F4 The pump is on top of the crankcase. It is operated by tappets driven by the camshaft.

The pump delivers fuel through steel pipes to the injectors in the cylinder heads. They open at a pressure of 2,500 p.s.i. and spray fuel through two-hole nozzles into the highly compressed and therefore heated air.

The governor controls the position of the fuel pump rack, determining the amount of fuel delivered to the engine. The throttle control bears against the governor spring, so the engine is always under control of the governor; it cannot race and will run quite steadily at all speeds.

F5 **Lubrication.** The gear pump is submerged, drawing oil through a gauze strainer.

Oil is delivered to a full-flow filter on the port side of the engine. From the filter, drilled holes carry oil to the centre and rear main bearings and to a pressure relief valve; this, covered by a plug, is at the after end of the crankcase on the port side.

A pipe feeds the forward main bearing. Oil from the front and rear main bearings passes through passages in the crankshaft to the big ends, thence ducts supply to the small ends.

A hole in the fixed spindle of the driven gear in the pump coincides each revolution with a hole in that gear and oil is sent through a pipe attached to the top inside face of the crankcase, into a trough in the air pump connecting rod feeding the big and small end rod bearings. The camshaft, governor, water pump spindle and the various driving gears are all lubricated by splash.

The oil filler is on top, the dipstick is on the starboard. A magnetic plug at the forward end of the sump picks up any iron and steel particles that may find their way into the oil. A connection is provided for an oil pressure gauge at the after end of the crankcase, above the starter.

On the flywheel casing is a hand-pump for draining the sump.

F6 **Governor.** The governor acts upon a spindle carried in a standard screwed into the top of the crankcase. On the top end of this spindle is a bell-crank (A), one arm of which is linked to the fuel injection pump rack (B), while the other arm bears against the governor spring end cap (C) (figs. 6 and 7).

The governor spring is in a housing (D) on top of the crankcase. One arm of the governor control lever (E) is linked to the throttle lever. A slot in the other arm of the control lever engages with a pin so as to move the governor push rod (G); this is underneath the governor spring. This pin also protrudes into a slot in the inner governor spring end cap.

If the throttle lever is moved anti-clock, the governor spring is compressed by the movement of the inner end cap and the speed of the engine increases.

Turning it the other way as far as it will go reduces speed to "dead slow." Then, by pressing the red stop-button on the end of the link rod the pin (H) bears against the governor bell crank moving the fuel pump rack to the no-fuel position, stopping the engine.

F7 The injection pump is supplied with fuel by a lift pump on the forward end of the crankcase, so the fuel tank can be below the level of the pump. The lift pump delivers fuel through a filter under the engine cover. Fuel leaking from injectors returns to the fuel filter.

F8 **Cooling.** The engine is water cooled. The plunger pump is on the port side, forward end. At 1,500 r.p.m. it delivers about 80 gallons of water per hour to a connection in the exhaust manifold, thence into the cylinder block below the exhaust ports. Water passes round the cylinders and up to two brass thimbles pressed into the cylinder head. These direct water around the injectors ; water then passes to a thermostat at the after end of the head.

There are two outlets from the thermostat housing. When the engine is cold, most of the water leaving by the lower outlet returns to the seacock, to be re-circulated; this ensures rapid warming up. The thermostat opens at 120 to 140 deg. F. (49 to 60 deg. C.) and diverts some of the cooling water to waste and the temperature is maintained at the correct value. The vent pipe on the seacock to prevent air lock is essential.

Waste water passes through the water cooled silencer into the tail pipe and goes overboard with the exhaust.

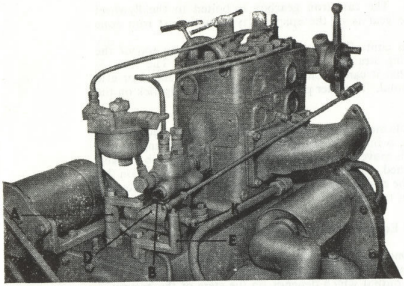


FIG. 6

F9 **Exhaust.** The exhaust system is a most important factor in the performance of a two-stroke engine. Installation instructions (para. E8) must be carefully followed. From the manifold the exhaust passes through 3-ft. of pipe to the silencer, which has a detachable cover for cleaning purposes. Water cools the silencer and tail pipe.

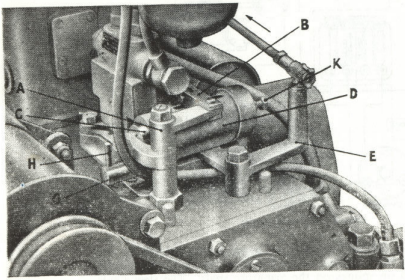


FIG. 7

F10 **Gearbox.** The cast iron gearbox is bolted to the flywheel housing. The gear is of the epicyclic type, with cast iron cone clutches.

Reverse is controlled by a lever in a housing on top of the gearbox having straight fore and aft movement. The lever is cranked so that it can be either vertical when in neutral or else nearly horizontal. The filler plug is on top and the dipstick on the port side.

F11 The throttle mechanism, attached to the thermostat housing on the port side, is linked to the governor. To stop the engine, the reverse lever is moved to neutral and the red painted knob marked "stop" is pushed. Idling speed is set by the screw (K, fig. 7) on the port side of the engine cover just above the water pump. Screwing inwards raises the speed.

Electrical Equipment—Lucas 12 volt

F12 **The Dynamo** is belt driven by a pulley at the forward end. Belt tension is adjusted by rocking the dynamo. A sealed control unit regulates the output which depends on the state of the battery—high when the battery is low, tapering down to a trickle when the battery is fully charged.

The switchboard has an ammeter and oil pressure gauge.

A push button on the switchboard actuates the starter through a solenoid.

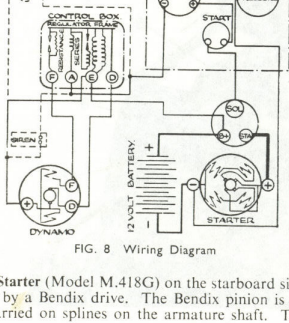


FIG. 8 Wiring Diagram

F13 **The Starter** (Model M.418G) on the starboard side rotates the flywheel by a Bendix drive. The Bendix pinion is on a screwed sleeve carried on splines on the armature shaft. The sleeve can

travel along the shaft against a compression spring which cushions the shock of engagement with the gear ring on the flywheel.

When the starter switch is closed the shaft and sleeve rotate suddenly. Owing to inertia, the pinion does not rotate but slides along the screwed surface of the sleeve into engagement with the gear ring on the flywheel and rotates it.

As soon as the engine fires it runs away from the starter and causes the pinion to be screwed back along the sleeve out of engagement.

A starting handle at the forward end turns the engine by chain and a free wheel mechanism.

F14 **Mounting.** The engine has two feet at the forward end of the crankcase and two on the flywheel housing. Great care has been taken over balancing the engine, which, as it has two firing cycles per revolution, is particularly free from vibration.

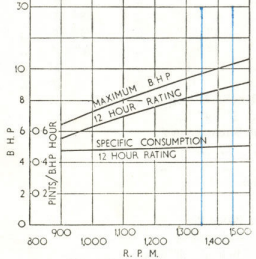


FIG. 9 Power Curves

METRIC EQUIVALENTS
of dimensions used in this book

Inches	mm.	Inches	mm.	Inches	mm.	Inches	mm.
0.0005	0.01	0.7495	19.04	0.998	25.35	2.0015	50.84
0.002	0.05	0.750	19.05	0.99975	25.39	2.0025	50.86
0.003	0.08	0.7505	19.06	1.000	25.40	2.003	50.88
0.005	0.13	0.75075	19.07	1.00025	25.41	2.005	50.93
0.008	0.20	0.752	19.10	1.002	25.45	2.75025	69.86
0.010	0.25	0.753	19.13	1.995	50.67	2.75075	69.88
0.013	0.33	0.996	25.30	1.9995	50.78	2.755	69.98
0.025	0.64	—	—	2.001	50.83	—	—

TOOLS

Bolts and Screws have U.N.F. threads, spanners being marked with dimensions across flats. B.S.F. Spanners are provided for the hexagon headed plugs etc., used on the engine.

£	s.	d.	Part No.				
1	6		2280	Flat Spanner	$\frac{1}{4}'' \times \frac{5}{16}''$ B.S.F.		
2	0		2282	,, ,,	$\frac{3}{8}'' \times \frac{7}{16}''$,,		
3	0		2284	,, ,,	$\frac{1}{2}'' \times \frac{9}{16}''$,,		
4	0		2301	,, ,,	$\frac{5}{8}'' \times \frac{11}{16}''$,,		
5	0		12430	Ring Spanner $1\frac{1}{8}''$	,,		
3	6		2294	,, ,,	$\frac{7}{8}''$,,	*marked*	
1	6		12736/B	Flat Spanner	$\frac{1}{4}'' \times \frac{5}{16}''$ U.N.F.	44×50	A F
1	6		12736/D	,, ,,	$\frac{3}{8}''$,,	56	,,
3	0		12736/E	,, ,,	$\frac{7}{16}'' \times \frac{9}{16}''$,,	68×75	,,
3	6		12736/F	,, ,,	$\frac{1}{2}'' \times \frac{5}{8}''$,,	75×94	,,
1	6		12740/B	Box ,,	$\frac{1}{4}'' \times \frac{5}{16}''$,,	$\frac{7}{16}'' \times \frac{1}{2}''$	,,
2	0		12740/D	,, ,,	$\frac{3}{8}''$,,	$\frac{9}{16}''$	,,
2	6		12740/E	,, ,,	$\frac{1}{2}''$,,	$\frac{3}{4}''$	,,
1	0		9460	Tommy Bar $\frac{3}{8}'' \times 7''$ long			
	6		13022	,, ,, $\frac{1}{4}'' \times 4''$,,			
	6		8821	Key, Grub Screw $\frac{5}{32}''$ A.F.			
	6		9343	,, ,, ,, $\frac{3}{16}''$,,			
1	0		2297	,, ,, ,, $\frac{1}{4}''$,,			
2	6		7793	Screwdriver			
6	0		7792	Pliers			
12	6		8454	Extractor, Piston Pin			
2	6		12771	,, Bearing Cap			
	6		M24100	,, Bolt $\frac{1}{4}'' \times 1''$ long			
	6		M28100	,, ,, $\frac{1}{2}'' \times 1''$,,			
5	0		11976	,, Nozzle Holder			
2	6		12822	Gauge, Tappet			
1	2	6	11707	Nozzle Cleaning Kit in Holdall			
7	6		5421	Funnel, with Waterproof Gauze Filter			
6	0		13024	Oilcan			

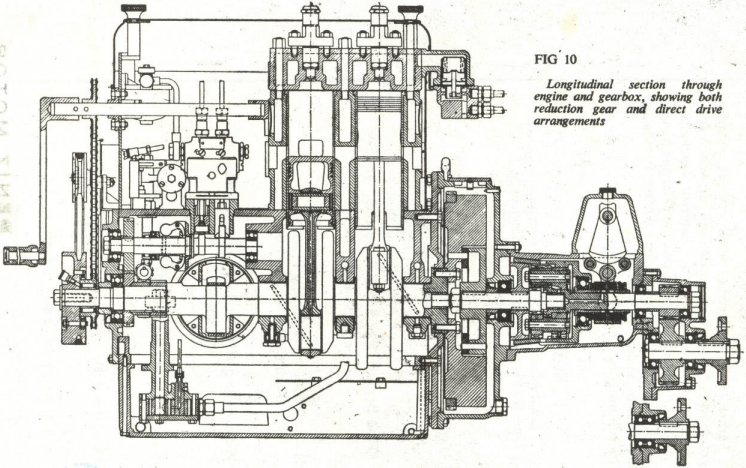


FIG 10

Longitudinal section through engine and gearbox, showing both reduction gear and direct drive arrangements

Guarantee

Stuart Turner, Ltd., undertake, within twelve months from date of delivery, to repair or replace any part which fails through defective workmanship or material (excluding accident, misuse or neglect) provided that the defective part is returned carriage paid to the Works with a written statement that a claim is made under this guarantee.

Liability is limited to the above guarantee.

Stuart Plants

are made in the following sizes:—

Type R	½ to 1½ B.H.P. Engines.
,,	300 Watt Lighting Plant.
,,	500 ,, ,, ,,
,,	750 ,, ,, ,,
Type P4	1 to 2 B.H.P. Engines.
,,	1000 Watt Lighting Plant.
Type P5	2 to 3 B.H.P. Engines.
,,	1½ K.W. Lighting Plant.
Type P55	4 to 7 B.H.P. Engines.
,,	3 K.W. Lighting Plant.

Marine Engines, 1½, 4 and 8 B.H.P.
Pumps and Pumping Plants.
Small Centrifugal Pumps.

We shall be glad to send full specifications on request.

STUART TURNER, Ltd.

Makers

Henley-on-Thames, England

Telephone—660

Telegrams—*Stuart, Henley-on-Thames* (2 *words*)

Printed in England 11/58 G. & Co.—1000