A spring (7) keeps the rocker arm (10) in constant contact with the eccentric (9) to eliminate noise. The hand priming lever is indicated at (15).

Cleaning the filter

The filter must be examined every 150 running hours, and cleaned if necessary.

Access to the filter is gained by removing the screw securing the domed cover, when the filter gauze may be lifted off its seating.

Wash the filter gauze in clean petrol (gasoline), using a semi-stiff brush or an air jet if available. Renew the cork gasket under the filter cover if on assembly it is found to be broken or has become hardened.

Make certain on refitting the cover that the fibre washer is replaced under the head of the screw. Do not overtighten the cover retaining screw; sufficient to make a fuel-tight joint is all that is necessary.

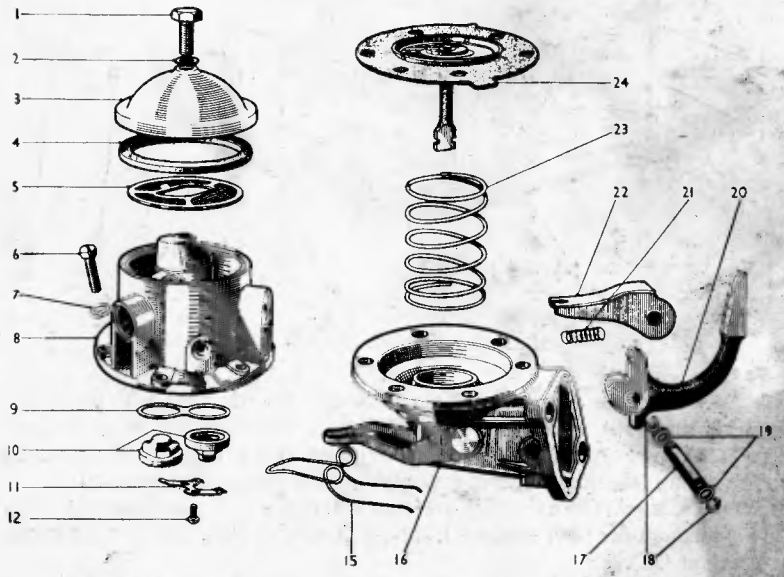


Fig. 31

The components of the fuel pump

Removing from the engine

Disconnect both pipe unions and then remove the two bolts with spring washers which secure the fuel pump to the engine crankcase; the pump and gasket may then be removed.

Dismantling the fuel lift pump

Before dismantling is commenced clean the exterior of the pump and make a file mark across the two flanges for guidance in reassembling in their correct relative positions. After separating the two main castings further dismantling of the components associated with each half is quite straightforward. The diaphragm and pull-rod assembly can be withdrawn by turning it through 90°. **No attempt should be made to separate the four diaphragm layers from their protective washers on the pull-rod as this is at all times serviced as a complete assembly and is permanently riveted together.**

Inspection of parts

Firstly, all parts (see Fig. 31) must be thoroughly cleaned to ascertain their condition. All parts in the locality of the valves should be washed in a clean paraffin (kerosene) bath.

The diaphragm and pull-rod assemblies should normally be renewed unless they show no signs of cracks or hardening and are generally in a perfectly sound condition.

Examine the upper and lower castings for cracks or damage. If the diaphragm or engine mounting flanges are distorted these should be lapped to restore their flatness.

Parts that are badly worn should be renewed. Very little wear should be tolerated in the rocker arm pin (17), the holes and engagement slot in the link (22), and the hole in the rocker arm (20). On the working surface of the rocker arm which engages with the camshaft eccentric slight wear is permissible, but on no account should it exceed ·010 in. (·254 mm.) in depth. Fuel pump valves (10) should be renewed if worn. The diaphragm spring (23) seldom requires renewing, but where necessary ensure that the replacement spring has the same identification colour and consequently the same strength as the original. Rocker arm springs (21) are occasionally found to be broken after service. All joint washers should automatically be renewed.

Reassembling the fuel lift pump

The following procedure should be adopted, dealing with the upper portion of the pump first:

Place the valve joint washer (9) in the pump upper casting (8).

Place the valves (10) in position.

Place the valve securing plate (11) in position and secure with the two screws (12).

Place the filter gauze (5) in position on top of the casting, making sure that it fits snugly.

Fit the cork washer, cover, and retaining screw as previously detailed under **'Cleaning the filter'** (see page 48).

To assemble the lower half of the pump proceed as follows:

Assemble link (22), packing washers (19), rocker arm (20), and rocker arm spring (21) in the body (16).

Insert the rocker arm pin (17) through the hole in the body, at the same time engaging the packing washers, link, and the rocker arm; then spring the retaining clips (18) into the grooves on each end of the rocker arm pin.

The rocker arm pin should be a tap fit in the body, and if, due to wear, it is freer than this, the ends of the holes in the body should be burred over slightly.

NOTE.—The fitting of the rocker arm pin can be simplified by first inserting a piece of ·240 in. (6 mm.) diameter rod through the pin hole in one side of the body far enough to engage the rocker arm washers and link and then pushing the rocker arm pin from the opposite side, removing the temporary rod as the pin takes up its proper position.

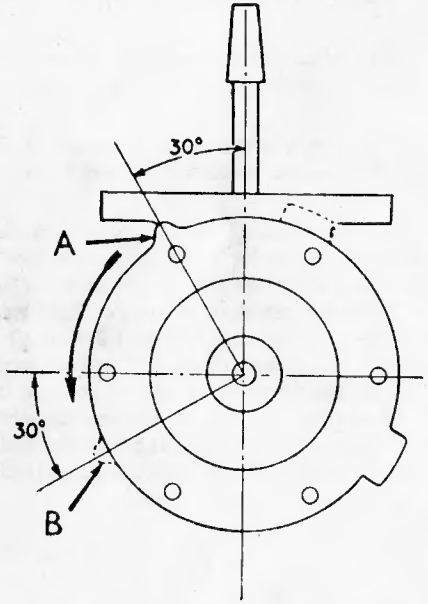


Fig. 32

Insert the diaphragm into the pump body with the locating tab in position (A). *Turn the diaphragm to the left until the tab arrives at position* (B). *At the same time engage the slots in the pull-rod with the fork in the connecting link*

To fit the diaphragm assembly to the pump body:

Place the diaphragm spring (23) in position in the pump body.

Place the diaphragm assembly (24) over the spring, the pull-rod being downwards, and centre the upper end of the spring in the lower protector washer.

Press downwards on the diaphragm, at the same time turning the assembly to the left in such a manner that the slots in the pull-rod will engage the fork in the link, ultimately turning the assembly a complete quarter-turn to the left. This will place the pull-rod in the proper working position in the link and, at the same time, permit the matching up of the holes in the diaphragm with those on the pump body flanges.

FUEL SYSTEM

FUEL LIFT PUMP

Maintenance and repair of the fuel lift pump

The A.C.-Sphinx fuel pump, type U, is mechanically operated from an eccentric on the engine camshaft. Fig. 30 gives a sectional view of the pump and an exploded view is shown in Fig. 31.

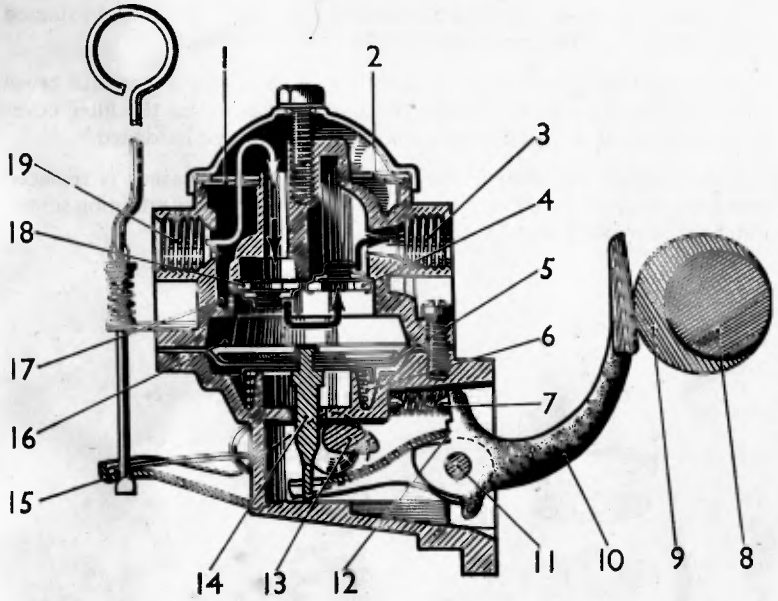


Fig. 30

A section through the fuel pump

As the engine camshaft (8) revolves, the eccentric (9) lifts the pump rocker arm (10), which is pivoted at (11). The rocker arm pulls the pull-rod (14) downwards, together with the diaphragm (5), against the pressure of a spring (6), thus creating a vacuum in the pump chamber (16).

Fuel is drawn from the tank and enters at (19) into the sediment chamber (17) through the filter gauze (1), the suction valve (18), and into the pump chamber (16).

On the return stroke the pressure of the spring (6) pushes the diaphragm (5) upwards, forcing fuel from the pump chamber (16) through the delivery valve (4) and port (3) to the main fuel filter.

When the main fuel filter is full pressure is created in the pump chamber (16) which holds the diaphragm (5) downwards against the pressure of the spring (6), and it will remain in this position until the main filter requires a further supply of fuel. The rocker arm (10) operates the connecting link by making contact at (12), and this construction allows idling movement of the rocker arm when there is no movement of the fuel pump diaphragm.

batteries should be kept clean and dry; care should be taken not to spill water on them when adjusting the level of the electrolyte or when taking specific gravity readings.

Storage

If the equipment is laid by for more than a month the batteries must be given a small charge from an independent source about once a fortnight in order to obviate any permanent sulphation of the plates. In no circumstances must the electrolyte be removed from the batteries and the plates allowed to become dry, as certain chemical changes take place which result in loss of capacity.

Testing the condition of the batteries

It is advisable to complete the inspection by measuring the specific gravity of the acid, and this gives a very good indication of the state of charge of the batteries.

A hydrometer of the type illustrated should be employed for the purpose. Voltmeter readings of each cell do not provide a reliable indication of the condition of the batteries unless special equipment is used.

When measuring the specific gravity of the electrolyte with a hydrometer ensure that the float is free and take the readings at eye level. Avoid taking a reading immediately after topping up the cells with distilled water.

The readings of all cells should be approximately the same.

If one cell gives a reading very different from the rest it may be that the electrolyte has spilled or leaked from the particular cell, or there may be an internal fault. In this case we advise the owner to have his batteries examined by a Lucas Service Depot to trace the cause and prevent the trouble from developing.

The specific gravity readings are: 1·280 to 1·300 when fully charged, about 1·210 when half-discharged, and about 1·150 when fully discharged. These figures are given assuming the temperature of the electrolyte is about 60° F. (16° C.).

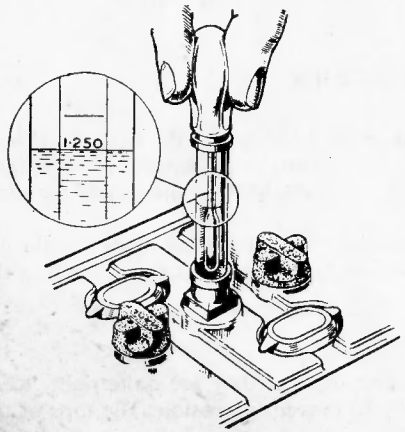


Fig. 29
The correct use of the hydrometer is shown here

When first inserting the diaphragm assembly into the pump body the locating 'tab' on the outside of the diaphragm should be at the 11 o'clock position. After turning the diaphragm assembly a quarter-turn to the left the 'tab' should be at the 8 o'clock position. These positions are shown in Fig. 32.

The two sub-assemblies of the pump are now ready for fitting together, and this is carried out as follows:

Push the rocker arm (20) towards the pump until the diaphragm is level with the body flanges.

Place the upper half of the pump into the proper position as shown by the mark made on the flanges before dismantling.

Install the set screws and lock washers and tighten only until the heads of the screws just engage the washers.

Release and push the rocker arm away from the pump so as to hold the diaphragm at the top of the stroke and, while so held, tighten the set screws diagonally and securely.

Refitting to the engine

Reverse the procedure outlined for removal from the engine. Ensure that the rocker arm is correctly positioned against the eccentric on the camshaft as there is a possibility of inadvertently getting the rocker arm under the eccentric or to one side, when damage will result on tightening the bolts. After refitting to the engine the pump should be run for a short time and pipe unions and pump examined for the possibility of fuel leakage.

Testing the fuel lift pump

Disconnect the fuel outlet pipe from the pump and crank the engine, when there should be a well-defined spurt of fuel from the pump outlet at every working stroke of the pump, namely, once every two revolutions of the engine.

Reconnect the fuel pipe and bleed the fuel system. Finally, run the engine for a short period and check for leaks. After correcting any leaks the fuel system must be re-bled.

FUEL INJECTION PUMP AND INJECTOR NOZZLES

Removal and replacement of the C.A.V. fuel injection pump

Disconnect the fuel feed pipe, the four fuel delivery pipes, and the engine stop control from the injection pump.

Detach the main and auxiliary vacuum pipes from the pneumatic governor; disconnect the breather pipe from the air cleaner and remove the inlet manifold in accordance with the instructions on page 33.

Unscrew the four bolts which secure the injection pump to its mounting

bracket; withdraw the pump rearwards to disengage it from the drive coupling and lift it clear of the engine.

Replacement is a reversal of the above procedure but it will be necessary to set the injection timing in accordance with the instructions below. If the pump is a replacement or has been dismantled the camshaft chamber must be filled with engine oil (see page 28) and a tablespoonful of thin engine oil added to the governor via the breather orifice (see page 28).

It is imperative when reconnecting the stop control to the lever on the governor housing (see Fig. 14) that the lever is in its maximum forward position. This will mean that there is approximately ½ in. (13 mm.) free travel on the stop lever, which is necessary to allow the excess fuel device to operate.

Fig. 33
The arrows indicate two of the four decompressor screws

Timing the fuel injection pump

Before fitting the injection pump to the engine it is necessary to set the engine for injection timing with No. 1 piston on its compression stroke set at 28° B.T.D.C. This can be accomplished as follows:

(1) Slacken off the decompressor screws in the cylinder head (see Fig. 33) to permit the engine to be cranked more easily.

(2) Remove the valve rocker cover for observing the valve action.

(3) Turn the crankshaft slowly in its normal direction of rotation until the exhaust valve (No. 1) of No. 1 cylinder is just closing and the inlet valve (No. 2) of the same cylinder is just opening. This indicates that No. 1 piston is commencing to move downwards on its suction stroke.

Servicing the dynamo

Apart from lubricating the commutator end bearing every 150 hours, the dynamo is designed to give trouble-free service for long periods without attention.

At major overhauls, however, the dynamo should be dismantled and the brush gear and commutator checked and cleaned. Access to the brush gear is gained by unscrewing and removing the two through-bolts and withdrawing the commutator end bracket. Worn brushes must be renewed and the commutator may be cleaned with superfine sand-paper and afterwards wiped with a petrol- (gasoline-) damped rag. New brushes are preformed, so that bedding to the commutator is unnecessary.

To check the brush spring tension the yoke must be completely withdrawn from the armature and the commutator end bracket refitted to the shaft. Refit the brushes with the springs in position on top. A spring scale, if available, should be used to check the tension, which should be 20 to 25 oz. (567 to 709 gm.). Fit a new spring if the tension is low.

When reassembling the dynamo the brushes must first be held clear of the commutator in the usual way, i.e. by partially withdrawing the brushes from their brush boxes until each brush is trapped in position by the side pressure of its spring. The brushes can be released onto the commutator with a small screwdriver when the end bracket is assembled to within about half an inch of the yoke. Before closing the gap between the end bracket and yoke see that the springs are in correct contact with the brushes.

Voltage regulator and cut-out

The voltage regulator controls the dynamo charging rate and the cut-out automatically closes the charging circuit as soon as the dynamo voltage rises sufficiently above that of the batteries. When the dynamo voltage falls below that of the battery the cut-out opens and thereby prevents the battery from discharging itself through the dynamo.

The combined voltage regulator and cut-out are accurately set before leaving the Works and they must not be tampered with. Any attention to this unit should be entrusted to a Lucas Service Depot.

BATTERIES

Topping up

At least once a month the vent plugs in the top of the batteries should be removed and the level of the electrolyte examined. If necessary, distilled water should be added to bring the level to the top of the plate separators.

It is important when examining the cells that naked lights should not be held near the vents on account of the possible danger of igniting the gas coming from the plates.

Terminals

Examine the battery terminals and see that they are quite tight. Keep them smeared with petroleum jelly to prevent corrosion. The tops of the

Support the dynamo, completely remove the securing bolts, and lift it clear of the engine.

Replacement is a reversal of this procedure.

Adjusting the dynamo driving belt

The belt tension is adjusted by slackening the four bolts securing the dynamo and the adjusting link to the engine, moving the dynamo by hand

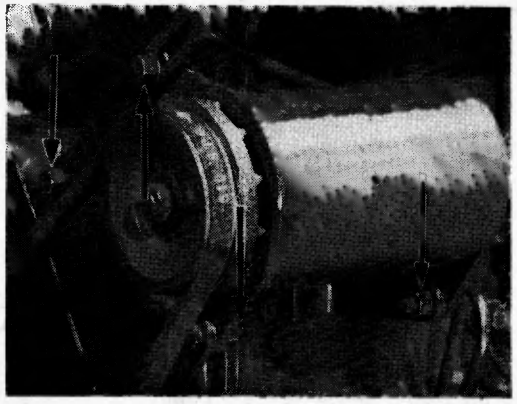


Fig. 27

The arrows indicate the four bolts which have to be slackened when adjusting the tension of the dynamo drive belt

away from the cylinder block the required amount, and retightening the bolts.

Do not overtighten the belt, otherwise undue strain will be thrown upon the dynamo bearings.

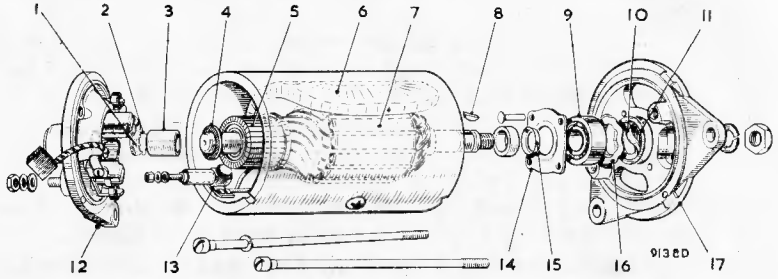


Fig. 28

The components of the dynamo

1. Felt pad.
2. Aluminium disc.
3. Porous bronze bush.
4. Fibre washer.
5. Commutator.
6. Field coils.
7. Armature.
8. Shaft key.
9. Bearing.
10. Felt washer.
11. Oil-retaining washer.
12. Commutator end bracket.
13. Field terminal post.
14. Bearing retaining plate.
15. Cup washer.
16. Corrugated washer.
17. Driving end bracket.

(4) Continue to crank the engine slowly until the timing mark 'INJ. PUMP 1, 4' on the flywheel coincides with the pointer on the flywheel housing (see Fig. 34). No. 1 piston is now set at 28° B.T.D.C. on its compression stroke.

The injection pump can now be fitted to the engine in the following manner:

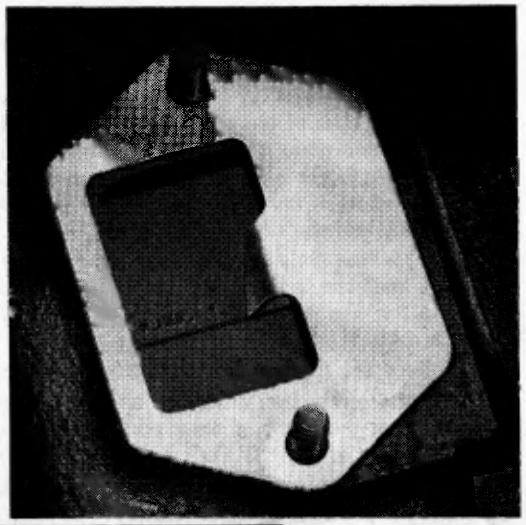


Fig. 34

The injection pump 1 and 4 timing marks opposite the T.D.C. pointer on the flywheel housing

Fig. 35

A view of the injection pump coupling showing the 3° divisions and one of the adjustment bolts

(5) Turn the pump coupling flange by hand until the line on the boss of the coupling is in line with the mark on the pump body end plate and place the pump on its mounting bracket.

(6) Place the coupling centre disc between the pump flange and the

drive flange and secure the pump to its mounting bracket, ensuring that a clearance of between ·005 and ·010 in. (·127 and ·254 mm.) exists between one side of the centre disc and either the driving or driven flange. Adjust by slackening the driving flange clamp bolt and moving the flange along the drive shaft. The pump flange will probably be moved during the process, thus disturbing the timing; this will be rectified later during the timing procedure.

Set the injection pump timing as follows:

(7) Slacken the two set bolts securing the drive flange adjustment to the claw plate.

(8) Turn the injection pump coupling flange by hand until the line on the boss of the coupling is in line with the mark on the pump body end plate. During the above procedure it is essential that the driving flange is not moved. The amount of adjustment is measured by means of the graduations, each division representing 3° on the pump camshaft (see Fig. 35).

Tighten the two set bolts to secure the driving flange adjustment. A final check should be made to ensure that No. 1 piston is still in the correct timing position of 28° B.T.D.C. on its compression stroke.

(9) Bleed the fuel system as described on page 58.

The timing procedure described above automatically sets the injection pump so that the point of 'inlet port closure' (spill cut-off) occurs when the pistons are at 28° B.T.D.C. on their compression strokes.

If for any reason there is no marking on the pump coupling flange or the end plate the point of 'inlet port closure' will have to be found to accomplish the timing procedure.

The term 'inlet port closure' (spill cut-off) refers to the instant when the flow of fuel through the barrel inlet port from the spill gallery is cut off by a pump plunger on its upward stroke and corresponds to the theoretical commencement of injection from that element of the pump. The flow of fuel to each element is cut off at two points during one complete revolution of the pump camshaft—one on the upward stroke, the other on the downward stroke, of the pump plunger. The correct cut-off point for timing is the one on the upward stroke of the plunger.

IMPORTANT.—For the purpose of standardization elements on all C.A.V. injection pumps are counted in numerical order, reading from left to right looking on the inspection cover.

The fitting of the injection pump to this engine is such that No. 4 element supplies fuel to No. 1 cylinder, No. 3 element supplies fuel to No. 2 cylinder, No. 2 element supplies fuel to No. 3 cylinder, and No. 1 element supplies fuel to No. 4 cylinder.

To set the injection timing in this manner proceed as follows:

(1) Set the engine with No. 1 piston at the position of 28° B.T.D.C. on its compression stroke as described previously.

(2) Before fitting the injection pump to the engine, set its approximate timing position by removing the pump inspection cover to observe the plunger action and turning the camshaft until No. 4 plunger

(9) The fitting of the solenoid unit to the drive end bracket can be facilitated by easing the drive assembly forward along the armature shaft. It must be fitted so that the copper link between the solenoid and the starter is connected to the solenoid terminal marked 'STA'.

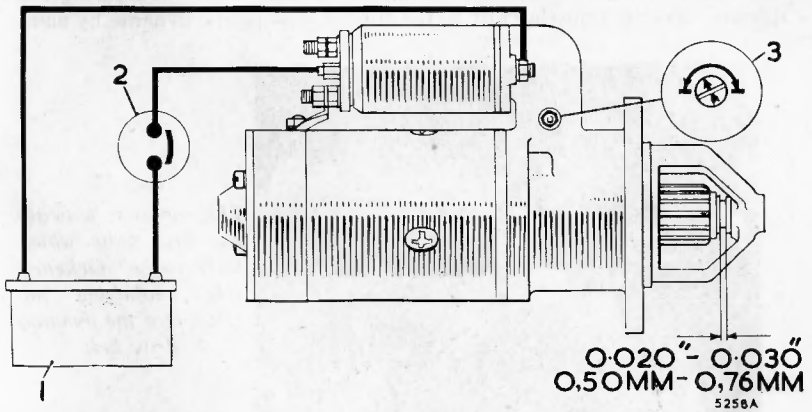


Fig. 26

Setting the starter pinion movement limit

1. 6-volt battery.
2. Starter switch.
3. Eccentric pivot pin.

(10) With the starting motor completely assembled, but before tightening the engagement lever pivot pin locknut, set the pinion movement as follows:

Connect the small centre terminal on the solenoid unit by way of a switch to a 6-volt supply and connect the other side of the supply to one of the solenoid fixing bolts (see Fig. 26).

Close the switch (this throws the drive assembly forward into the engaged position), and measure the distance between the pinion sleeve and the washer on the armature shaft extension. This measurement must be made with the pinion pressed lightly towards the armature to take up any play in the engagement linkage.

To adjust, rotate the eccentric pivot pin until the correct setting of between ·020 and ·030 in. (·508 and ·760 mm.) is obtained. It should be noted that the arc of the pivot pin adjustment is 180°, and the head of the arrow marked on the pivot pin must be set only between the heads of the arrow on the drive end bracket casting (see Fig. 26).

Removal and replacement of the dynamo

Disconnect the dynamo leads from the terminals. Slacken the three bolts securing the dynamo to the engine and the bolt securing the adjusting link to the cylinder block. Move the dynamo towards the cylinder block as far as possible and remove the belt from the dynamo pulley.

$\frac{7}{8}$ in. (22·22 mm.) in length and 16 lb. (7·26 kg.) to compress the spring to $\frac{1}{2}$ in. (12·7 mm.) in length.

(2) Check the slipping torque of the clutch as follows:

Fit the drive assembly onto the splined armature shaft and, using soft-metal jaw plates, clamp the armature in a vice.

Apply an anti-clockwise torque to the pinion with a suitable torque wrench fastened to the pinion teeth. The clutch should slip between 800 and 950 lb. in. (9·2 and 10·9 kg. m.). If the clutch slips at too low a torque figure dismantle it and add shims, or conversely, if the clutch does not slip when the maximum torque is applied remove shims until a figure within the above limits is obtained.

(3) The assembled clutch unit and lever mechanism must be capable of being pushed to the full extent of the set travel and it must move along the armature shaft extension smoothly and freely but without slackness.

(4) Before fitting the drive assembly lightly smear the armature shaft and pack the space between the bearings inside the helical splined sleeve with a bentonite-based grease such as Ragosine Bentone. If at any time the operation of the drive assembly becomes sluggish it should be removed and the bearings cleaned and lubricated as above.

(5) Lubricate the intermediate bracket bearing with Ragosine Molypad molybdenized non-creep oil.

(6) Check the brushes for wear and freedom of movement in their holders. If the brushes are worn to, or approaching, $\frac{5}{16}$ in. (8 mm.) in length they must be renewed. Two of the brushes are connected to the brush boxes on the commutator end bracket and two are connected to tappings on the field coils.

To renew the brushes disconnect the flexible connectors by unsoldering and secure the connectors of the new brushes in their place by soldering. The brushes are preformed so that bedding to the commutator is unnecessary.

A brush which is inclined to stick in its holder can be freed by cleaning its sides with a petrol- (gasoline-) moistened cloth.

(7) Clean the commutator with a petrol- (gasoline-) moistened cloth. If the commutator is burned or pitted spin the armature and polish the commutator with superfine glass-paper; remove all abrasive dust with a dry air blast. **Do not undercut the insulators between the commutator segments.**

In the event of the commutator being badly worn, return the armature to your B.M.C. Marine Dealer for servicing.

(8) Check the bearings for excessive side-play, and if necessary, return the starter to your B.M.C. Marine Dealer and have the bearings renewed.

is just commencing to rise. With the pump set in this position connect the drive coupling and secure the pump to its bracket.

(3) Disconnect the pressure pipe from No. 4 delivery valve holder. Unscrew the valve holder and remove the delivery valve, spring, and peg.

(4) Reconnect the delivery valve holder and fit spill test pipe 18G501 (see Fig. 36).

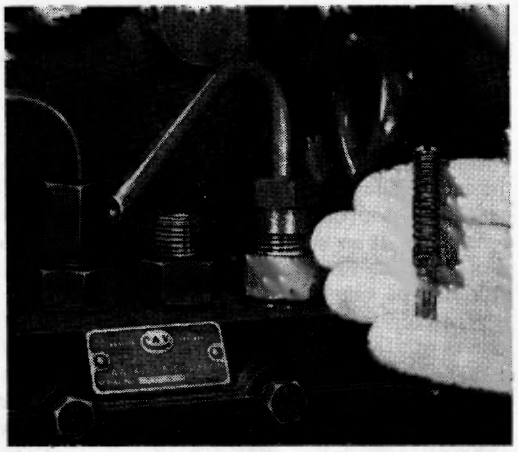


Fig. 36
The spill test pipe in position with the delivery valve, spring, and peg removed

(5) If any of the engine controls are connected ensure that the engine stop control is right home in the normal starting position so that the injection pump control rod is in the full power position. If the controls are not connected the governor spring will automatically position the control rod in the required position.

(6) Slacken the two set bolts securing the drive flange adjustment to the claw plate.

(7) Prime the fuel system by using the priming lever on the lift pump and bleed the filter and the injection pump of air (see page 58).

(8) Continue to operate the fuel lift pump priming lever, and as the fuel flows from the test pipe turn the injection pump coupling flange slowly by hand in its direction of rotation. No. 4 element plunger will now commence to rise from its B.D.C. position, and as the element inlet port is progressively closed by the rising plunger the fuel issuing from the test pipe will gradually diminish. Turn the pump flange very slowly in the final stages; the instant of 'inlet port closure' (spill cut-off) will be observed when there is no drip for a period of 14 to 15 seconds.

During the above procedure it is essential that the drive flange is not moved.

Tighten the two set bolts securing the driving flange adjustment.

A final check should be made to ensure that the flywheel is still in its injection timing position.

(9) Remove the test pipe and the delivery valve holder and replace the delivery valve, spring, and peg after washing them in clean fuel oil. Refit the delivery valve holder and reconnect the pressure pipe union.

(10) The coupling flange is graduated in 3° divisions (see Fig. 35); a line may be scribed across the coinciding graduations for use if the pump is removed again, as this will be the correct position for reassembly.

(11) Connect the controls and bleed the system as described on page 58.

Removal and replacement of an injector nozzle and sleeve

Disconnect the injector feed pipe and remove the fuel leak-off pipe from the injectors and the fuel filter.

Remove the two securing bolts and spring washers, withdraw the injector nozzle from the cylinder head, using remover 18G491, and remove the cup washer and water seal ring. The hole in the cylinder head should be plugged immediately to prevent ingress of foreign matter.

NOTE.—If an injector is to be stored for any length of time precautions must be taken to prevent the entry of foreign matter via the fuel feed and leak-off pipe unions.

When replacing, renew the water seal rings and ensure that the injector sleeves in the cylinder head are free from burrs and scores and will make a gastight joint. If necessary, renew the sleeves, using tap and wrench 18G213A to provide an anchorage for remover 18G213 by cutting a thread inside the sleeve, and install new sleeves with replacer 18G213B.

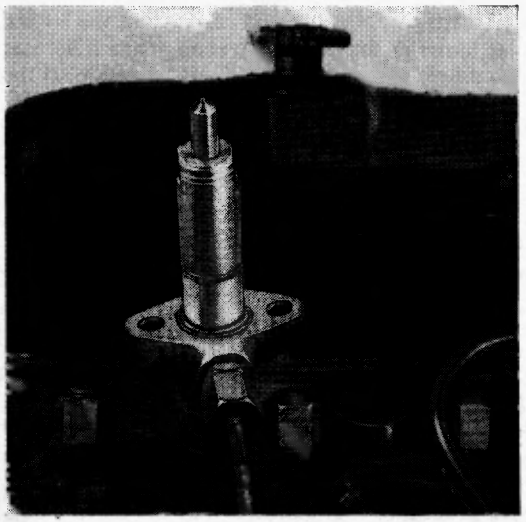


Fig. 37
A fuel injection nozzle, refitted facing away from the engine, ready for testing

Testing an injector nozzle

Under normal operating conditions injector nozzles should be tested every 450 running hours. However, owing to varying conditions under

Unscrew the two through-bolts and withdraw the commutator end bracket and the yoke. Extract the rubber seal from the drive end bracket; slacken the engagement lever pivot pin locknut and unscrew the pin. The drive end bracket can now be withdrawn.

Remove the washer from the end of the armature shaft extension and slide off the drive assembly complete with engagement lever. The intermediate bracket and brake assembly can be withdrawn from the armature shaft extension after its retaining ring has been removed.

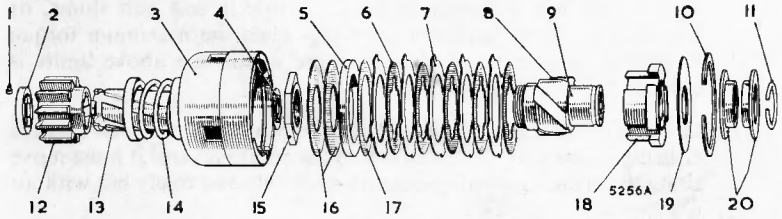


Fig. 25
The components of the starter drive assembly

1. Rivet.
2. Pinion retaining ring.
3. Barrel unit.
4. Thrust washer.
5. Backing ring.
6. Clutch plates (inner).
7. Clutch plates (outer).
8. Helical splines.
9. Driving sleeve.
10. Circlip.
11. Lock ring.
12. Pinion.
13. Helical splined sleeve.
14. Cushion spring.
15. Ring nut.
16. Pressure plates.
17. Shim.
18. Moving member.
19. Retaining washer.
20. Engagement bush.

To dismantle the drive assembly remove the lock ring from the driving sleeve and withdraw the two halves of the engagement bush. Extract the clutch retaining circlip from the barrel unit and withdraw the driving sleeve with clutch unit. The clutch assembly can now be dismantled by removing all the remaining parts, with the exception of the two pressure plates, from the driving sleeve.

To remove the two pressure plates, which are secured to the driving sleeve by a ring nut, slide the driving sleeve onto the splined armature shaft and, using soft-metal jaw plates, clamp the armature in a vice. File away the peened rim; unscrew the ring nut and withdraw the pressure plates.

When reassembling fit a new ring nut and peen the rim over the notch in the driving sleeve to lock the nut in position.

Finally, punch out the rivet which secures the pinion retaining ring to the helically splined sleeve and withdraw the retaining ring, pinion, and cushion spring with cup washers.

Reassembly of the starter motor is a reversal of the above procedure, but the following points must be noted:

(1) Check the tension of the cushion spring. The tension is correct if a load of 11 lb. (5 kg.) is required to compress the spring to

ELECTRICAL EQUIPMENT

Removal and replacement of the starter

Disconnect the batteries and remove the starter and solenoid switch cables.

Unscrew the three bolts securing the starter motor flange to the flywheel housing and withdraw the motor and distance piece. Replacement is a reversal of this procedure.

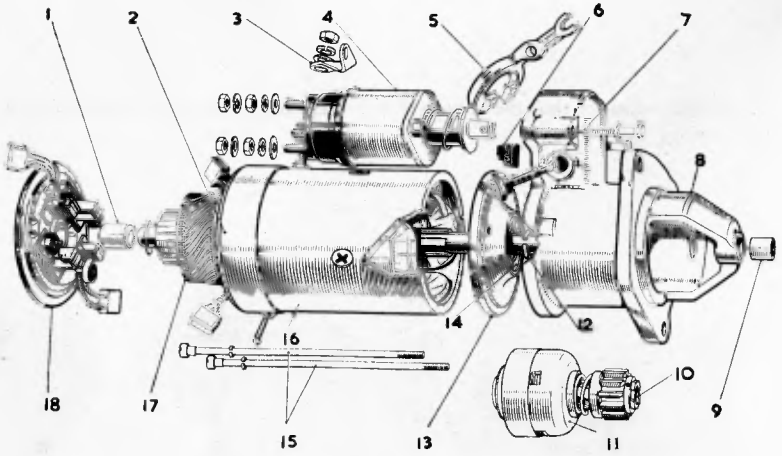


Fig. 24

The components of the starter motor

1. Bearing bush.
2. Cover band.
3. Copper link.
4. Solenoid.
5. Engagement lever.
6. Rubber seal.
7. Eccentric pivot pin.
8. Drive end bracket.
9. Bearing bush.
10. Pinion sleeve bearing.
11. Drive assembly.
12. Retaining ring.
13. Intermediate bracket.
14. Centrifugal brake-shoes.
15. Through-bolts.
16. Yoke.
17. Armature.
18. Commutator end bracket.

Servicing the starter motor

The starter motor requires no routine maintenance except at major overhauls, when the unit may be dismantled, cleaned, and checked.

Before dismantling the starter motor test with a spring scale the tension of the brush springs, which must be 30 to 40 oz. (850 to 1134 gm.). If the tension is low new springs must be fitted.

To dismantle, disconnect the copper link from the lower terminal on the solenoid and the yoke of the starter motor. Unscrew the two bolts with the spring washers securing the solenoid to the starter driving end bracket and withdraw the solenoid, carefully disengaging the solenoid plunger from the starter drive engagement lever.

Remove the cover band, hold back the brush springs, and withdraw the brushes from their holders.

which engines operate faulty injection may be experienced before this time has elapsed, therefore the period must be reduced accordingly.

It is often possible to locate a faulty injector by slackening the feed pipe union nut of the suspect injector sufficiently to allow the fuel to leak past the union whilst the engine is running slowly. If no change can be detected

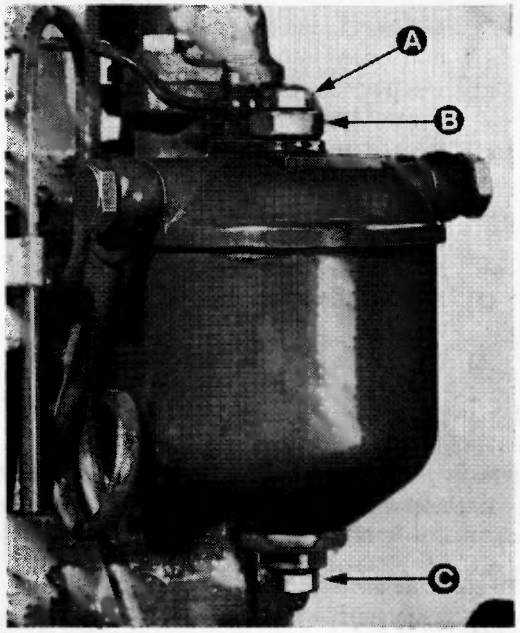


Fig. 38

The C.A.V. fuel filter

A. Air bleed plug.
B. Cap nut.
C. Drain plug.

in the performance of the engine it is reasonable to assume that the injector nozzle is faulty.

In the absence of special testing equipment the injector nozzles can be tested on the engine as follows:

Remove the suspect injector nozzle from the engine and refit it to its feed pipe so that it faces away from the engine. Now motor the engine at idling speed and observe the spray. If the spray does not atomize but 'hose-pipes' or is weak or if the nozzle dribbles it must be replaced by a clean and tested nozzle. The faulty nozzle should be returned to your nearest B.M.C. Marine Dealer for servicing.

WARNING.—Great care must be taken to prevent the hands coming into contact with the spray as the working pressure is sufficient to cause the fuel oil to penetrate the skin with ease.

Removal and replacement of the C.A.V. fuel filter element

The filter element, which is of the paper type, should only need renewing every 450 running hours if clean, filtered fuel has been used and the necessary precautions taken when handling any components of the fuel

system. If, however, the engine misfires or runs erratically owing to fuel starvation due to a choked element, the element must be renewed irrespective of the hours run.

NOTE.—Paper elements are not intended to be cleaned, and when choked they must be renewed.

To renew the filter element proceed as follows:

(1) Release the filter bowl drain plug (see Fig. 38) and drain the fuel in the bowl into a suitable receptacle.

(2) Unscrew the cap nut (see Fig. 38) and withdraw the bowl and element complete.

(3) Discard the element, thoroughly wash out the bowl in petrol (gasoline), and allow it to dry.

(4) Install a new element in the filter bowl with the perforated end facing downwards, ensuring that the rubber sealing washer is in good condition and correctly positioned in the filter head.

(5) Refit the filter bowl and element and tighten the cap nut and drain plug.

(6) Bleed the fuel system (see below).

Removal and replacement of the C.A.V. fuel filter

Disconnect the fuel inlet and outlet pipes and the injector leak-off pipe from the filter and remove the two bolts which secure it to its bracket.

Replacement is a reversal of the above but it is essential that all air is eliminated from the fuel system by bleeding (see below).

To eliminate air from the fuel system (bleeding)

Failure to start or erratic acceleration can be the result of air in the fuel system. This can be caused by a fuel tank being allowed to become empty, by a leaking joint, or by the dismantling of any part of the fuel system.

If this condition is suspected, and after any occasion when part of the fuel system has been dismantled, it will be necessary to bleed the fuel system of air as follows:

First bleed the C.A.V. fuel filter interposed between the fuel lift pump and the fuel injection pump. Slacken the bleed plug on the filter head (see Fig. 38) and operate the hand priming lever on the fuel lift pump until the fuel flowing from the bleed plug is free from air bubbles, then retighten the bleed plug.

Secondly, bleed the injection pump. Slacken the bleed plugs on the injection pump (see Fig. 14) and operate the hand priming lever on the fuel lift pump until the fuel flowing from the bleed plugs is free of air bubbles. Retighten the bleed plugs immediately.

Finally, bleed each fuel delivery pipe in turn. Start the engine. (Should the engine refuse to start, slacken all four decompressor screws (see Fig. 33) and motor the engine with the starter.) Slacken the union nut at the injector nozzle end of the pipe, and as soon as the fuel flows free from air bubbles retighten the union nut.

As this cannot be observed accurately the rocker adjustment is more easily carried out in the following order, and this also avoids turning the engine over more than is necessary:

Adjust No. 1 rocker with No. 8 valve fully open.
" " 3 " " " 6 " " "
" " 5 " " " 4 " " "
" " 2 " " " 7 " " "
" " 8 " " " 1 " " "
" " 6 " " " 3 " " "
" " 4 " " " 5 " " "
" " 7 " " " 2 " " "

NOTE.—Ensure that the engine stop control is in operation before turning the engine.

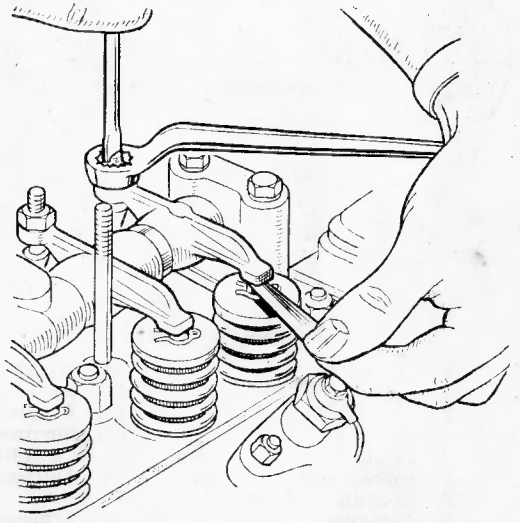


Fig. 23
Setting the valve rocker clearance with a screwdriver and feeler gauge

cylinder head nuts as detailed above, and re-check and adjust the valve rocker clearances.

Before replacing the rocker cover check the cork gasket for damage. If it is found to be faulty fit a new one, or oil leaks may result.

Valve rocker adjustment

If the engine is to give its best performance and the valves are to retain their maximum useful life it is essential to maintain the correct valve clearance.

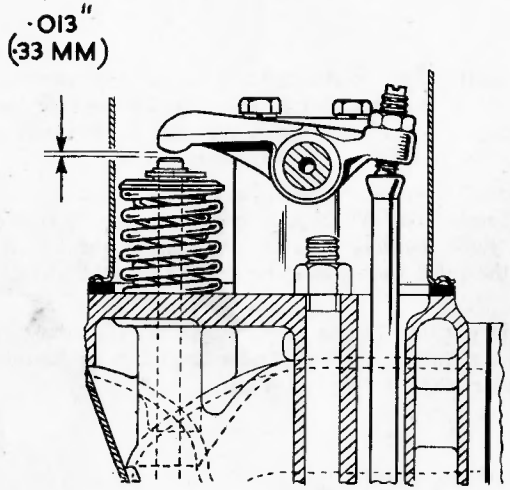


Fig. 22
The correct valve rocker clearance is illustrated here. It must not be departed from

After grinding the valves in it is essential that the valve clearance be reset. The correct clearance for both the inlet and exhaust valves is ·013 in. (·33 mm.) either hot or cold. The engine has been designed to operate with this clearance and no departure from it is permissible.

Provision for adjusting the valve clearance is made in the rocker arm by an adjustable screw and locknut.

The rocker adjusting screw is released by slackening the hexagon locknut with a spanner while holding the screw against rotation with a screwdriver. The valve clearance can then be set by carefully rotating the rocker screw while checking the clearance with a feeler gauge. This screw is then re-locked by tightening the hexagon locknut while again holding the screw against rotation.

It is important to note that while the clearance is being set the tappet of the valve being operated upon is on the back of its cam, i.e. opposite to the peak.

Removal and replacement of the venturi

Disconnect the injection pump governor vacuum pipes from the venturi and the accelerator control from the throttle lever. Unscrew and remove the two nuts with spring and plain washers which secure the venturi to the induction manifold and remove the venturi and its gasket.

The throttle lever is provided with maximum fuel and slow-running stops. These are carefully and accurately set before leaving the Works and must not be altered.

Replacement is a reversal of the above procedure.

OVERHAULING

Removing the engine from the boat

Remove the engine hatch, if fitted, or sufficient of it to enable the engine to be lifted out of the boat comfortably.

Drain all water from the engine and exhaust manifold. Remove the coupling bolts between the engine driving flange and the propeller shaft. Move the shaft aft a sufficient distance to be well clear of the driving flange.

All external connections to the engine, such as the exhaust pipe, water pipes, fuel connections, leads to the dynamo, and starter, should be uncoupled.

Slacken and remove the nuts from the engine securing bolts and remove the bolts.

Attach a suitable lifting sling to the lifting plates provided and carefully lift the engine from its mountings and transfer to a suitable stand for dismantling.

Immediately the engine is on the stand drain all oil from the sump, the reverse gearbox, and the reduction gear, if fitted.

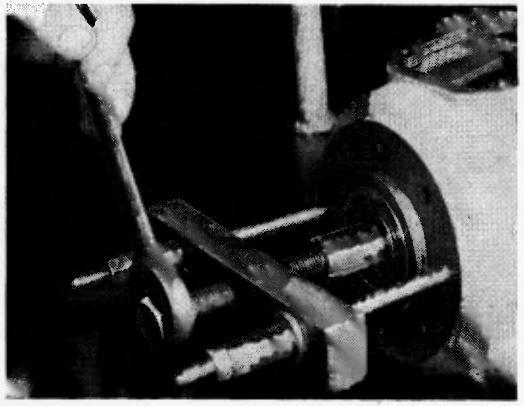


Fig. 39
Withdrawing the reverse gear housing with the aid of an extractor

Dismantling the reduction gear unit

Extract the split pin, unscrew the coupling nut from the secondary shaft, and withdraw the coupling flange. Next remove the eight bolts attaching the oil seal housing to the reduction gear housing, which will allow the removal of the housing and the bearing clamping washer.

Remove the series of bolts attaching the two halves of the reduction gear housing together and withdraw the rear portion.

The gears themselves are now exposed, and after the split pin, nut, and bearing have been removed from the mainshaft they can be withdrawn in mesh complete with the secondary shaft and its front bearing.

When dismantling three-gear-type units care must be exercised when removing the idler gear not to lose the 40 needle-roller bearings on which the gear runs.

face and turning the valve about one turn on its seat; the marking should be completely reproduced on the valve seat. A final rub, using oil only, is recommended.

Reassembly

Before reassembly, which is a reversal of the dismantling procedure, all working components must be smeared with engine oil. This will obviate the possibility of sticking before adequate lubrication from the oiling system reaches them. Also the following points should be carefully noted and adhered to.

Valves

Fit a new oil seal to each valve; on the exhaust valves they must be fitted with the chamfered side downwards (see Fig. 20). **Do not refit the old seals or oiltightness may be lost.** The oil seals are more easily fitted if they have been soaked in engine oil for a short while before use.

When replacing the inlet valves insert the valve into its guide so that the small flat on the valve stem (see Fig. 20), just above the retaining cotter groove, faces the valve guide locating peg. This will allow the key to engage the large flat on the valve stem and so permit the thimble to lock the key in its position.

With the valves held in position by their springs, ensure that the top faces of the valve heads are flush with the cylinder head face or 'standdown' to a depth not greater than ·010 in. (·254 mm.).

Cylinder head and rocker shaft assembly

Make sure that both the surfaces of the cylinder head and cylinder block are clean; coat both sides of the gasket with engine oil and replace it with its plain side downwards.

If there is any doubt as to the condition of the cylinder head gasket fit a new one, plain side downwards. **Do not forget to replace the two cylinder head locating dowels before installing the cylinder head.**

Tighten the 16 cylinder head nuts, a quarter of a turn at a time, to a torque wrench figure of 100 lb. ft. (13·8 kg. m.) in the order given in Fig. 19.

Insert the push-rods into the positions from which they were taken and replace the rocker shaft assembly. First tighten the front, centre, and rear brackets with a torque spanner set to 180 lb. in. (2·07 kg./m. and then the intermediate bracket bolts to a torque figure of 350 lb. in. (4·03 kg./m.).

Check and adjust the valve rocker clearances as outlined on pages 38 and 39 and replace the rocker cover.

Start the engine and allow it to run just above idling speed until it is thoroughly warm. Then switch off, remove the rocker cover, retighten the

DECARBONIZING

Keep the valves in their relative positions when removed from the engine to ensure replacement into their original valve guides.

Decarbonizing

If special equipment is not available for decarbonizing it will be necessary to scrape the carbon deposit from the piston crowns, cylinder block, and cylinder head, using a blunt scraper. An odd length of copper tubing with the end flattened and filed up makes an ideal scraping tool which will not scratch.

A ring of carbon should be left round the periphery of the piston crown and the ring of carbon round the top of the cylinder bore should not be removed. To facilitate this an old piston ring can be sprung into the bore so that it rests on top of the piston.

The cylinder head is next given attention. Clean off the carbon deposit from the valves, valve ports, and the cylinder head. Remove all traces of carbon dust with compressed air, or by the vigorous use of a tyre pump, and then thoroughly clean all parts with paraffin (kerosene) and dry off.

Any accumulation of carbon in the valve guides can be removed by dipping the valve stem in petrol (gasoline) or paraffin (kerosene) and moving the valve up and down in its guide until it is free.

Grinding the valves and valve seatings

Each valve must be cleaned thoroughly and carefully examined for pitting. Valves in a pitted condition should be refaced with a suitable grinder or new valves should be fitted.

If a valve seat shows signs of pitting or unevenness it should be trued by the use of finishing cutter 18G28 (inlet) or 18G174 (exhaust) with pilot 18G230 and handle 18G27. When using the cutter care must be exercised to remove only as little metal as is necessary to ensure a true surface.

When grinding a valve onto its seating the valve face should be smeared lightly with fine carborundum paste and then lapped in with a suction grinder. Avoid the use of excessive quantities of grinding paste and see that it remains in the region of the valve seating only.

A light coil spring placed under the valve head will assist considerably in the process of grinding. The valve should be ground onto its seat with a semi-rotary motion and occasionally allowed to rise by the pressure of the light coil spring. This assists in spreading the paste evenly over the valve face and seat. It is necessary to carry out the grinding operation until a dull, even, matt surface, free from blemish, is produced on the valve seat and face valve.

On completion, the valve seats and ports should be cleaned thoroughly with a paraffin- (kerosene-) soaked rag, dried, and then thoroughly cleaned by compressed air. The valves should be washed in paraffin (kerosene) and all traces of grinding paste removed.

Seatings can be checked by using a spot of 'marking blue' on the valve

The bolts attaching the reduction gear housing to the reverse gearbox can now be removed, allowing the remaining half of the housing and the support arm to be withdrawn.

Reverse gear unit—removal of the reverse gear housing

Remove the reduction gear (see page 60), or in the case of engines not fitted with a reduction gear remove the coupling flange, and unscrew the eight bolts attaching the oil seal housing to the reverse gear housing, which will allow the oil seal housing and distance piece to be removed.

Disconnect the suction pipe from the hand-operated drain pump and reverse gear housing.

Remove the inspection cover complete with filler plug and the eight bolts attaching the reverse gear housing to the flywheel housing. A special extractor is then placed in position and attached to two of the oil seal housing bolt holes.

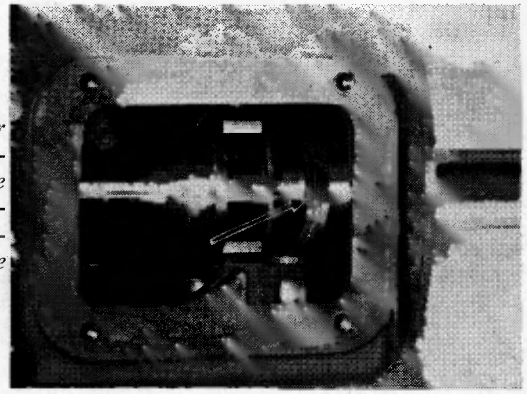


Fig. 40
The mainshaft rear bearing collar and circlip which must be removed before completing the withdrawal of the reverse gear housing

With the reversing lever in the neutral position withdraw the reverse gear housing until the mainshaft rear bearing collar and retaining circlip are observed to be clear of the rear inner face of the housing. Remove the two halves of the collar by detaching the circlip and complete the withdrawal of the reverse gear housing with reversing lever and brake band mechanism attached.

Removal of the reverse gear unit

With the reverse gear housing removed the unit itself may be easily withdrawn from the end of the primary shaft. Should any difficulty be experienced, refit the coupling flange to the end of the mainshaft, together with the plain washer and nut. Gently tap the flange rearwards with a raw-hide mallet until the reverse gear unit is free.

OVERHAULING

Dismantling the reverse gear unit

Remove the reverse gear case end cover by extracting the split pins and unscrewing the nuts from the four long bolts passing right through the reverse gear assembly. This permits the withdrawal of the end cover and releases the pinions, which can then be withdrawn from their shafts.

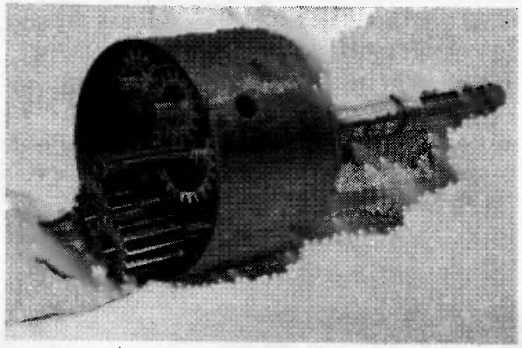


Fig. 41
Withdrawing the reverse gear pinions

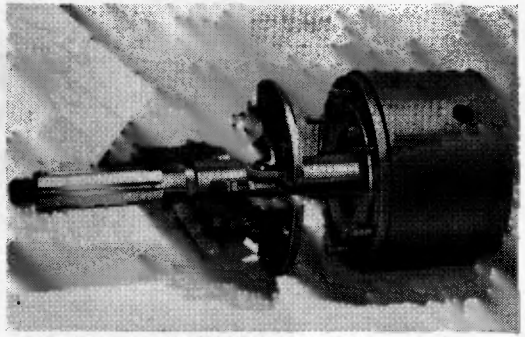


Fig. 42
Withdrawing the clutch cover-plate and toggle levers

To gain access to the clutch plates extract the split pins and unscrew the two remaining nuts on the face of the clutch cover-plate. Remove the cover-plate complete with toggle levers and withdraw the clutch pressure plate and series of clutch plates.

Endeavour to keep the clutch plates in the same order when removed from the housing to facilitate fitting them in their original positions on reassembly. The clutch plates bed down in use, and if disturbed may not run so sweetly.

Should it be necessary to remove the gear case from the mainshaft knock back the lock washer and unscrew the nut securing the reverse gear pinion, the gear case, and the clutch plate hub and withdraw them from the forward end of the mainshaft.

If it is desired to remove the brake band this is released by removing the support plug in the base of the reverse gear housing and unscrewing

DECARBONIZING

Unscrew the two cylinder head locating dowels from the cylinder block; carefully remove the cylinder head gasket and plug the waterways in the cylinder block with clean rag.

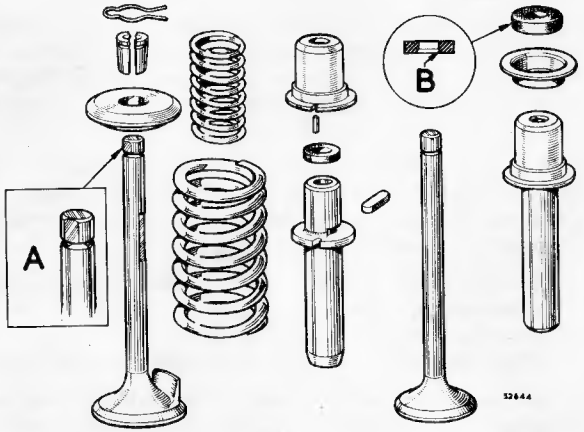


Fig. 20
Components of the engine valves. Inset (A) *shows the flat on the inlet valve stem and inset* (B) *the chamfer on an exhaust valve oil seal*

Removing the valves

To remove the exhaust valves compress each valve spring, using special valve spring compressor 18G106, and remove the circlip and the two cap retainers. Release the valve spring and remove the compressor, valve spring collar, oil seal, oil seal retainer, inner and outer valve spring, and valve.

To remove the inlet valves remove the valve springs as described in the preceding paragraph. Lift the valve thimble clear of its locating peg and withdraw it complete with oil seal from the valve stem. Remove the valve key from the valve guide and withdraw the valve from its guide.

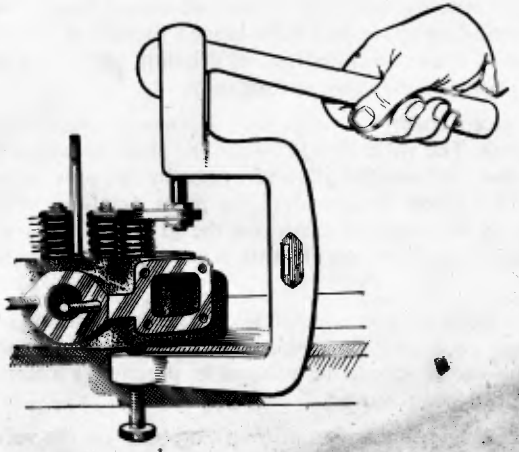


Fig. 21
Using tool 18G106 *to compress the valve springs*

(9) Release the union nut and separate the two halves of the external valve rocker oil feed pipe. Press back the copper tab washers; unscrew the two bolts from the banjo unions and remove the upper half of the pipe from the cylinder head.

(10) Unscrew the hand nuts with fibre washers and remove the valve rocker cover and cork gasket.

(11) Ensure that the main fuel tap is turned off and disconnect the supply and delivery pipes from the fuel filter. Unscrew the four bolts with plain and spring washers and remove the fuel filter and its bracket from the cylinder block.

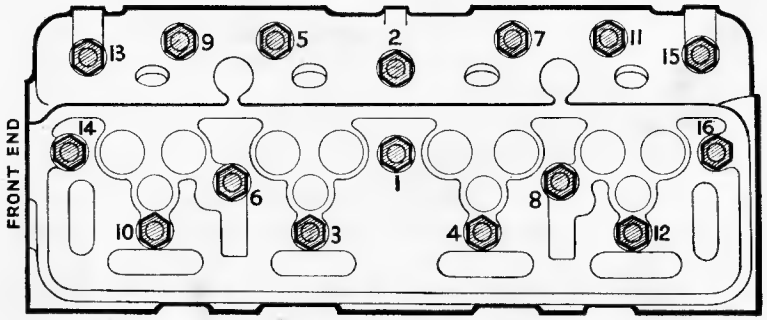


Fig. 19
The correct order of slackening and tightening the cylinder head retaining nuts

Removing the rocker shaft and cylinder head

Slacken all the rocker adjusting screws until all of the valves are in the closed position.

Unscrew the nine rocker shaft bracket fixing bolts with spring washers and remove the rocker shaft assembly complete with brackets and rockers. Withdraw the eight push-rods, storing them carefully so that they may be replaced in the same positions. One way of doing this is to punch eight small holes in a piece of cardboard, number the holes, and insert each push-rod into its corresponding hole in the card.

The cylinder head is secured by 16 nuts, and if they are not slackened evenly distortion of the cylinder head may result, causing water to find its way from the cooling system into the cylinders and sump after the engine is rebuilt. Therefore the nuts must be unscrewed gradually, a turn at a time, in the order shown in Fig. 19 until all load has been released.

The cylinder head may now be removed. To facilitate breaking the cylinder head joint tap each side of the head with a hide mallet or a hammer with a piece of wood interposed to take the blow. When lifting the head a direct pull should be given so that the head is pulled evenly up the studs.

the square-headed adjusting bush on the starboard side of the reverse gear housing until the brake band is free enough to be withdrawn.

Reassembly is a reversal of the above, but when rebuilding the clutch it is important to see that the clutch plates are replaced in their correct order. The plates are alternately of steel and bronze, and it is important

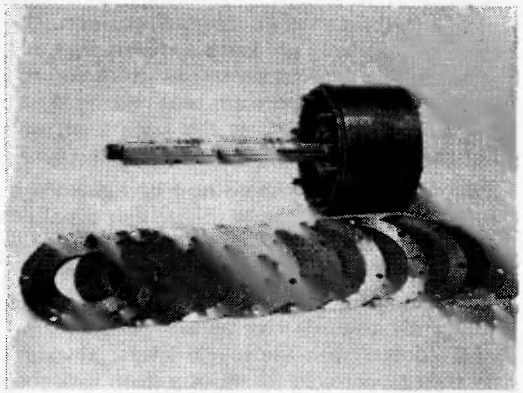


Fig. 43
The series of clutch plates

to ensure that a steel plate goes on first, followed by bronze and steel plates alternately, finishing up with a bronze plate for the thick pressure plate to bear against.

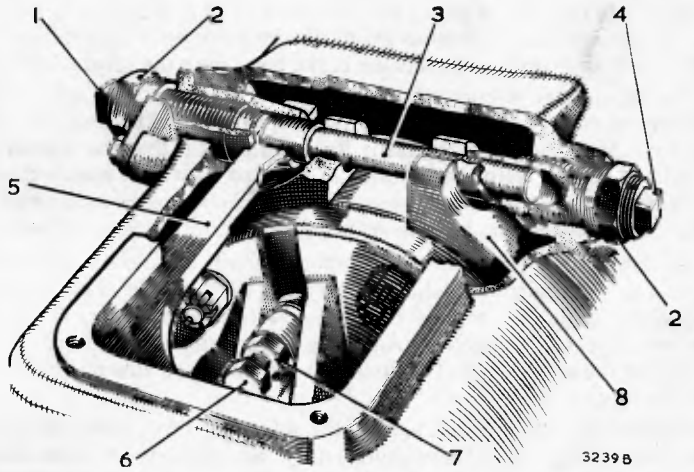


Fig. 44
The reverse mechanism, showing the components for adjusting the clutch and brake band

1. Adjusting bolt.
2. Locknut.
3. Plunger.
4. Adjusting bush.
5. Wedge bar.
6. Toggle lever adjusting screw.
7. Locknut.
8. Brake band.

OVERHAULING

Adjusting the reverse unit and clutch

If there is an indication that clutch slip is taking place under full-load conditions the adjustment of the clutch unit should be checked and adjusted. Correct adjustment is indicated if a certain amount of force is required to push the control lever right home into the 'ahead' position. (This must not be confused with the initial effort required to release the lever from the centre or 'neutral' position.) If the lever can be pushed home easily (feeling no resistance whatever), remove the inspection cover by unscrewing the four set screws which secure it in position. Slacken off the locknuts on the pressure pins passing through the short arms of the three operating toggles, at the same time preventing the pressure pins from turning by holding a spanner on the hexagon head.

The pressure pins should now be tightened up **equally** (approximately half a turn), taking care to ensure that equal pressure is exerted by each. This is very necessary, since vibration due to slack pressure pins may cause considerable damage to the clutch and the reverse gear unit.

Slackness of a pressure pin may be located by moving the operating lever gently towards the 'ahead' position until the operating cam just makes contact with the toggle levers. Slackness in any particular lever may then be detected by rocking them with the fingers.

In order to test whether the adjustment is correct move the lever slowly into the 'ahead' position. When the cam strikes the toggle levers a little force should be required to push the lever right home into position.

When the lever is put into the 'astern' position a brake band is operated which holds the reverse gear case stationary. The brake band is actuated by a wedge bar which is connected to the reversing lever internally via the clutch fork and which contracts the brake band onto the reverse gear case.

The adjustment is correctly set at the Works, and only after a considerable period of use should any further adjustment be necessary. The usual symptom indicating necessity for adjustment is that the reverse gear is inclined to slip. Before adjustment is effected, however, ensure that the cause is not due to the lever fouling some obstruction, such as the decking, which is preventing the lever from being pushed to the limit of its travel.

On both sides of the reverse unit housing will be found a locknut on the end of the brake band adjusting bolt and bush. Under normal circumstances the adjusting bolt on the port side (wedge bar side) is the only one which requires attention. Again, however, after a lengthy period of operation the adjustment of the bush on the starboard side of the housing may be checked as follows:

Slacken the locknut and tighten the adjusting bush until the reverse gear casing is prevented from turning by the brake band. **Then slacken the adjusting bush until the gear drum can be rotated freely.** Tighten the locknut, taking care not to disturb the setting.

The brake band is supported by a plug in the base of the housing directly below the brake band. This plug is provided with an adjustment and should be so set that when the brake band is free it is permitted to fall just clear of the reverse gear drum. **It is correctly set at the Works and under normal conditions should never need attention.**

DECARBONIZING

The diesel engine rarely needs the periodical decarbonizing that is accepted as a matter of course with a petrol engine. After a period of time there may be loss of compression, and starting may become difficult and performance generally poor. This is an indication that the valve seats require attention and at the same time decarbonizing should be carried out.

Preparation

(1) Disconnect the leads from the battery.

(2) Ensure that the sea cock is turned off, then drain all the water from the engine by means of the engine and exhaust manifold drain taps (see Figs. 15 and 16).

(3) Disconnect the thermometer from the cylinder head, the accelerator control from the lever on the venturi, and the exhaust pipe from the exhaust manifold.

(4) Release the water by-pass pipe from the thermostat housing and the water pipe connecting the cylinder head to the exhaust manifold at the manifold end. Unscrew the two bolts with spring washers which secure the thermostat housing to the cylinder head and remove the housing complete with water outlet pipe and thermostat.

(5) Support the exhaust manifold, unscrew the six brass nuts which secure it to the cylinder head, and remove the manifold and its three gaskets.

(6) Disconnect the suction pipes from the engine sump and reverse gearbox drain pump. Slacken the hose clip and disconnect the breather pipe from the air cleaner. Unscrew the four nuts with spring washers and remove the breather pipe, sump and reverse gearbox drain pump, and the engine rear lifting plate with gasket from the cylinder head.

(7) Release the fuel delivery pipes from the injection pump and injectors and remove them complete with clamps. Disconnect and remove the main and auxiliary vacuum pipes from the venturi and pneumatic governor. Support the inlet manifold; unscrew the four bolts with spring and plain washers which secure it to the cylinder head and remove the manifold complete with venturi and air cleaner.

(8) Remove the fuel leak-off pipes, which are secured to the injectors and fuel filter by five union bolts, taking care not to lose any of the copper joint washers which are positioned on each side of the banjo-type unions. The injectors can be withdrawn (see page 56) after removing the eight bolts with spring washers which secure them to the cylinder head.

Immediate steps must be taken to prevent the ingress of foreign matter into the fuel sustem. The injection pump outlet unions should be sealed off with sealing caps 18G216 and the injectors wrapped in clean greaseproof paper.

MAINTENANCE ATTENTION

Give the reduction gear coupling flange (if fitted) greaser **one** turn; replenish with grease to Ref. C, page 89.

Drain the fuel injection pump camshaft chamber of excess oil, using the level tap provided (see Fig. 14).

Every month

When the boat is not in frequent use remove the batteries and have them fully charged from an independent source.

Every 150 running hours

Drain the engine sump while the engine is warm and refill with fresh oil.
Renew the external lubricating oil filter element.
Clean the fuel lift pump filter gauze and bleed the fuel system.
Clean and re-oil the air cleaner.
Add distilled water to the batteries if necessary.
Add a few drops of oil to the lubricator hole in the dynamo commutator end bearing.
Check the dynamo driving belt tension.
Inspect all nuts and bolts on the engine and installation, and tighten if necessary.
Give the tachometer drive (if fitted) greaser **one** stroke of a grease gun filled with grease to Ref. C, page 89.

Every 300 running hours

Check valve rocker clearances, and adjust if necessary.
Drain the reverse gearbox and (if fitted) reduction gear, and refill with fresh oil.

Every 450 running hours

Renew the two C.A.V. fuel filter elements and bleed the fuel system.
Test the injectors for spray.

Every 600 running hours

Clean out the water passages.
Remove and clean the sump and floating oil strainer and pick-up.

Every 1,200 running hours

Give the fresh-water pump (when fitted) lubricator two strokes of an oil gun filled with oil to Ref. B, page 89.

OVERHAULING

Finally, place the reverse lever in the 'astern' position and tighten the adjusting bolt on the port side of the housing until moderate resistance is felt and the reverse gear casing is firmly held by the brake band. Tighten the adjusting bolt locknut, taking care not to disturb the adjustment.

Should the reverse gear slip when the engine is under load, it is now only necessary to tighten slightly the adjusting bolt until the slip is cured.

Provision is made on the reverse unit clutch fork shaft to allow the operating lever to be fitted on either the port or starboard side of the unit. In addition, by removing the operating lever from the shaft splines the lever may be repositioned to allow a full range of movement to suit most installations.

Removal and replacement of the reverse gear oil pump

The oil pump is attached to the rear face of the reverse gear housing adaptor plate by four bolts and spring washers. To facilitate its removal support the lower end of the pump body against the pressure of the pump plunger spring while unscrewing the securing bolts.

Replacement is a reversal of the above procedure.

Dismantling the reverse gear oil pump

Withdraw the oil pump plunger complete with its ball valve and seat and remove the gauze strainer, which is a push-fit on the base of the pump body.

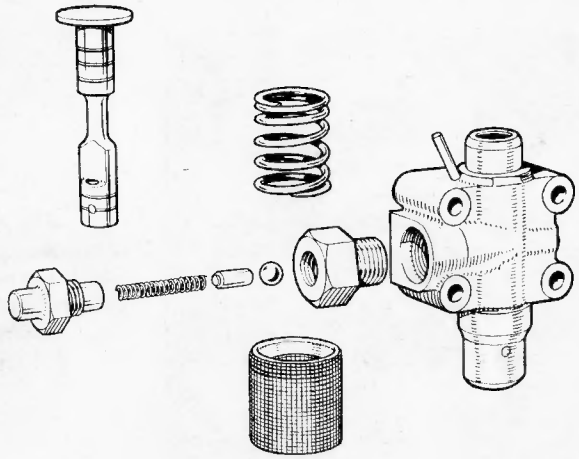


Fig. 45
The components of the reverse gear oil pump

OVERHAULING

The pressure relief valve, which is situated on the port side of the pump, is removed by detaching the locking wire from the small hexagon and unscrewing with a suitable spanner on the large hexagon. With the relief valve clamped in a vice, unscrew the relief valve plug and remove the spring, pad, and ball. After reassembly, which is a reversal of the above procedure, check the operation of the pump by immersing the base of the pump in oil and continuously depressing and releasing the plunger until oil emerges from the delivery port in the front face of the pump and the small oil feed pipe situated on the head of the pump.

The operation of the oil relief valve can be checked by closing the delivery port and the oil feed pipe with firm pressure of the thumb and fingers; continuous operation of the plunger will open the pressure relief valve and oil will emerge from the relief valve ports situated on the port side of the pump body.

Removal and replacement of the reverse gear adaptor plate and the flywheel housing

Remove the starter, reverse gear, and reverse gear oil pump (see pages 40, 61, and 65).

Press back the lock washer, unscrew the reverse gear primary shaft pinion nut, and withdraw the primary shaft pinion, the primary shaft rear bearing, and the reverse gear oil pump operating cam. Extract the oil pump cam key from the primary shaft and withdraw the reverse gear adaptor plate complete with the primary shaft front bearing.

The flywheel housing, which is located by two dowels, can be withdrawn after the removal of the 10 set screws with spring washers which secure it to the cylinder block and rear mounting plate.

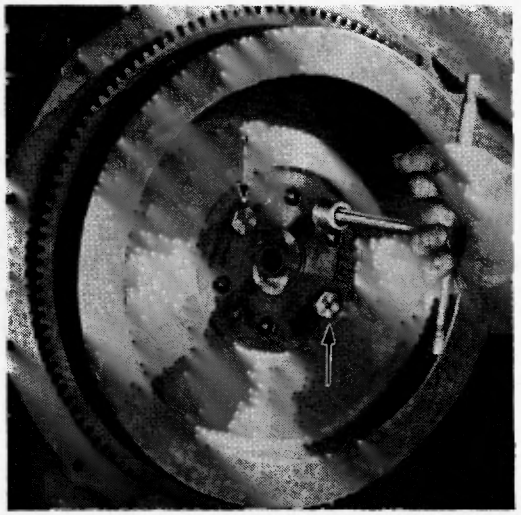


Fig. 46
Withdrawing the flywheel. The two arrows indicate the support bolts

MAINTENANCE ATTENTION

A regular plan of routine maintenance should be adopted and carried out at set times, thus making it easy to remember and reducing the risk of any item being overlooked. For this purpose the schedule on these pages has been compiled, and particular attention should be paid to the daily routine maintenance tasks which, though few in number and simple to perform, assist in reducing to a minimum any breakdown possibility.

Initial servicing—after 25 running hours

During the early life of the engine the oil picks up numerous minute particles of foreign matter which it is impossible to eliminate during the course of manufacture. At the same time the working parts of the engine settle down, with the result that certain clearances and adjustments will require checking and, if necessary, resetting.

The following items of maintenance should be carried out as soon as the engine has completed 25 running hours, and it will be appreciated that this attention, given during the critical period in the life of the engine, will make all the difference to its subsequent life and performance.

Drain oil from engine, reverse gearbox, and, if fitted, reduction gear and refill with fresh oil.

Tighten manifold nuts.

Tighten valve rocker shaft bracket bolts.

Tighten cylinder head nuts to the recommended torque figure (see page 37).

Check valve rocker clearances, and reset if necessary.

Check dynamo driving belt tension, and adjust if necessary.

Check pneumatic governor suction pipe unions, and tighten if necessary.

Check all water pipe unions, and tighten if necessary.

Examine batteries and top up to the proper level with distilled water or diluted acid as may be required. Clean and tighten terminals.

Check all nuts and bolts on engine and installation, and tighten if necessary.

Every day

Check the oil levels in the engine sump and reverse gearbox; top up if necessary.

Give the water pump and stern tube greasers half a turn; replenish with grease to Ref. C, page 89, when necessary.

Check the contents of the fuel tank; replenish if low.

Clean out the engine tray.

Check the water level in the 'Keel Cooler' header tank (when fitted).

Every week

Clean the sea cock filter. Examine the system for leaks.

Examine the fuel cocks and pipes for leaks.

Check the oil level in the reduction gear if fitted; replenish if necessary.

Oil all controls and fairleads.

LUBRICATION

Dynamo

Every 150 running hours add a few drops of oil to Ref. D, page 89, to the lubricating hole in the commutator end bearing. Avoid over-lubrication.

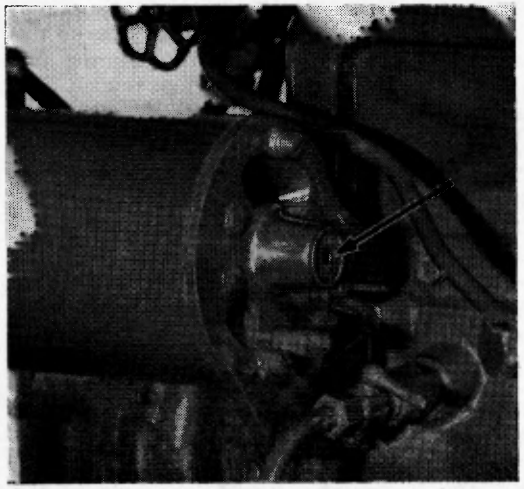


Fig. 18
The dynamo commutator end bearing lubricator hole

Cleaning and re-oiling the air cleaner

The air cleaner is of the oil-wetted gauze type and every 150 running hours it must be serviced as follows:

Unscrew and remove the central nut and withdraw the element from the body of the cleaner. Wash the element in paraffin, drain, and allow to dry thoroughly. Wet the element with engine oil and allow to drain before replacing.

Do not run the engine with the air cleaner removed (or with an air cleaner of the wrong type fitted) as the fuel injection pump pneumatic governor is tuned with the air cleaner in position.

Controls

Give all engine controls a quota of lubricant once a week, especially at control pivots and fairleads. Lubricate the accelerator linkage to the venturi.

OVERHAULING

When reassembling, which is a reversal of the above procedure, ensure that the shouldered side of the primary shaft pinion faces towards the flywheel.

Removal and replacement of the reverse gear primary shaft and the flywheel

Remove the starter, reverse gear, reverse gear oil pump, reverse gear adaptor plate, and flywheel housing (see pages 40, 61, 65, and 66).

The reverse gear primary shaft, which is located by two dowels, can be withdrawn after unlocking and removing the six bolts which secure both the primary shaft and the flywheel to the crankshaft flange.

To withdraw the flywheel screw two $\frac{3}{8}$ in. UNF bolts into the tapped holes provided in the flywheel until they bear against the crankshaft flange, then tighten them a turn at a time until the flywheel is free of the crankshaft flange (see Fig. 46). It is advisable to provide a support for the flywheel to prevent it from falling as it becomes free of the crankshaft flange. This can be accomplished by partially inserting two of the flywheel bolts into their normal positions (see Fig. 46).

To ensure correct reassembly the flywheel locating dowels have been spaced unevenly. This spacing allows the flywheel to be assembled to the crankshaft in one position only, thus ensuring that the timing marks on the flywheel are in relation to the throws of the crankshaft.

When reassembling, tighten the flywheel bolts, in diagonal sequence, with a torque spanner set at 1,200 lb. in. (13·8 kg. m.).

After reassembly check with a dial gauge that the primary shaft runs true to within ·001 in. (·025 mm.).

Removal and replacement of the rear mounting plate

With the flywheel and the flywheel housing removed (see page 66 and above) the rear mounting plate, which is located by three dowels, can be removed by unscrewing the 11 set screws with spring washers which secure it to the cylinder block.

When replacing, ensure that the gasket is sound and will make an oil-tight joint and that the plate is true and free from burrs.

Dismantling the rocker shaft assembly

Remove the rocker shaft assembly (see page 34).

Slide the outer and intermediate rocker brackets, the valve rockers, and the spacing washers from the rocker shafts. At the same time, to assist when reassembling, note the positions of the large and small spacing washers (see Fig. 48).

Unscrew the two locating screws which secure the rocker shafts to the centre bracket and withdraw the rocker shafts.

Remove the plugs from the outer ends of the rocker shafts and clean out the oilways. The oilways in the intermediate rocker brackets should also be cleaned out. To do this remove the pressure relief valve from the front bracket by releasing the copper tab washer, unscrewing the relief valve

plug, withdrawing the spring, seat, and ball, and unscrewing the relief valve body.

On the rear bracket remove the brass plug with copper washer.

When reassembling smear all working surfaces with engine oil, examine the relief valve seat and ball for wear, and check the tension of the relief valve spring.

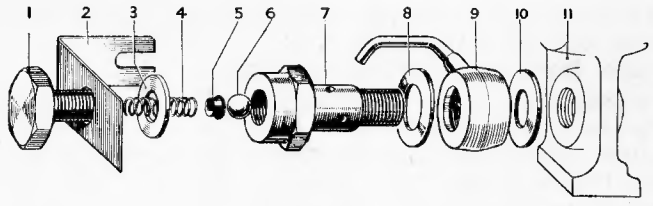


Fig. 47

The valve rocker oil pressure relief valve

1. Plug.
2. Tab washer.
3. Washer.
4. Spring.
5. Seat.
6. Ball.
7. Body.
8. Washer.
9. Drain pipe.
10. Washer.
11. Rocker bracket.

The seat should be smooth and the ball free from scores.

To check the tension of the spring measure its free length, which must be not less than $\frac{3}{4}$ in. (19 mm.), and ensure that a load of 3 oz. (85 gm.) is required to compress it to its fitted length of $\frac{5}{8}$ in. (15·9 mm.).

If necessary, fit a new ball, valve body, and spring.

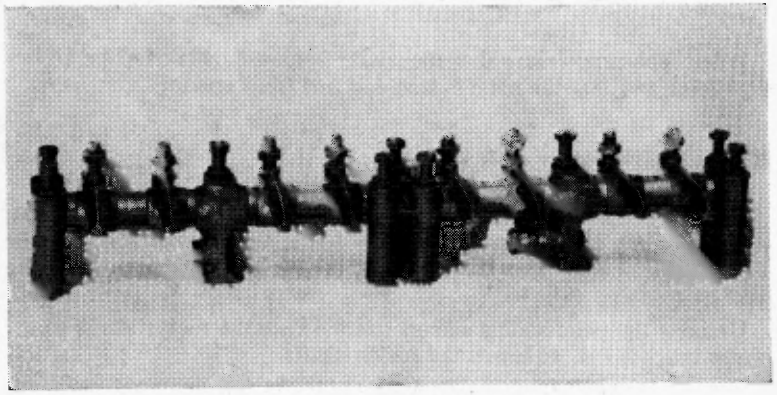


Fig. 48

The valve rocker shaft assembly

The oil level indicator rod is on the starboard side of the clutch and reverse gear and is marked to indicate both high and low levels.

A plunger and ball-type oil pump incorporating a non-adjustable pressure release valve is located on the reverse gear housing adaptor plate and is operated by a cam mounted on the primary shaft.

Oil drawn through a gauze strainer fitted on the base of the pump is delivered by way of drilled passages in the housing adaptor plate to the inside of the primary shaft, lubricating the mainshaft front bearing and then via drillings in the mainshaft, mainshaft pinion, and reverse gear case to the clutch cover and reverse gear pinion bearings. A pipe situated on the head of the pump body supplies oil to the operating cam and pump plunger head.

The reverse gear should be drained and filled with fresh oil after the first 25 running hours. Thereafter the oil should be changed every 300 running hours. Drain the oil after the engine has been running, when the oil will flow more readily, using the hand-operated pump situated on the port side of the engine. **Do not forget to turn the two-way cock on the pump to the correct position for draining the reverse gear.**

Reduction gear

After the first 25 running hours drain off the old oil and refill with fresh oil to Ref. B, page 89. Thereafter the oil should be changed every 300 running hours. With the 2 : 1 ratio gear 1 pint (·57 litre) and with the 3 : 1 ratio gear $1\frac{1}{2}$ pints (·85 litre) of oil is required in the reduction gear-box after it has been drained for the oil to be at its correct level.

To fill, remove the filler plug and the level plug and fill with oil until it emerges from the level plug orifice. The oil is now at its correct level. Replace the plugs.

The coupling flange greaser should be given one turn each week and kept filled with one of the greases to Ref. C, page 89.

Sea- or river-water pump, stern tube, and (when fitted) tachometer drive

The water pump and stern tube greasers should be given half a turn each day and kept filled with one of the greases to Ref. C, page 89.

Do not overgrease, in particular, the water pump. Excess grease from the drive shaft bearing can block up the water drain slots and reduce the efficiency of the water thrower. Keep these parts free of excess grease so that if the water pump should develop a slight leak water will be flung clear and not find its way into the engine.

The tachometer drive greaser should be given **one** stroke of a grease gun filled with one of the greases to Ref. C, page 89, every 150 running hours.

Fresh-water pump (when fitted)

Every 1,200 running hours give the lubricating nipple on the water pump pulley two strokes of an oil gun filled with oil to Ref. B, page 89.

LUBRICATION

Surplus oil from the valve rockers and the pressure relief valve returns to the sump via the push-rod apertures, thus lubricating the tappets and the cams of the camshaft.

Oil is fed to the timing chain from the main oil gallery via a drilled passage across the front of the cylinder block and a pipe mounted in the timing chain case. From this passage oil is also fed to the automatic timing chain tensioner.

In the event of the external oil filter element becoming blocked a by-pass valve situated in the filter head allows unfiltered oil to be fed throughout the engine.

Draining the engine sump

The sump on new and reconditioned engines must be drained and filled with new oil after the first 25 running hours and then at intervals of every 150 running hours. The oil must be changed when hot, in which condition it will flow more readily and any sediment present will still be held in suspension, not having had time to settle.

To empty the sump the hand-operated pump (see Fig. 17) on the port side of the engine should be employed.

A two-way cock is provided on the pump to enable the oil from either the engine sump or the clutch and reverse gear to be drained.

At every engine oil change or every 150 running hours a new external oil filter element should be fitted. For details of removal see page 72.

Fuel injection pump

No lubrication attention during service is required by the fuel injection pump as the mechanism is lubricated by the leakage of fuel oil from the pump elements.

Every week any surplus oil in the camshaft chamber must be drained off by means of the level tap (see Fig. 14).

If a new or reconditioned pump is fitted to the engine initial lubrication must be provided by removing the inspection cover and filling the camshaft chamber with engine oil until it emerges from the level tap.

Pneumatic governor

When fitting a new or reconditioned fuel injection pump remove the governor breather (see Fig. 14) and add one tablespoonful of oil to Ref. D, page 89, which will provide initial lubrication for the governor diaphragm. Further lubrication during service is unnecessary as adequate lubrication is provided by oil mist from the pump finding its way to the governor via a groove in the injection pump control rod bush.

Clutch and reverse gear

The oil supply for the clutch and reverse gear is quite independent of the engine lubrication system and oil to Ref. A, page 89, should be used.

OVERHAULING

Removal and replacement of the valve guides

Remove the cylinder head and the appropriate valve and spring (see page 34).

Support the cylinder head and drive the valve guide outwards from the exhaust or inlet port, using special valve guide remover and replacer 18G228.

The valve guides are provided with a shoulder, and when replacing, the guide must be driven into the port, using 18G228, until the shoulder butts firmly against the top face of the cylinder head.

Before replacing the inlet valve guide, line up the slot in the valve guide shoulder with the guide locating peg in the cylinder head.

Finally, with the guides in position, ream them to between ·3460 and ·3465 in. (8·788 and 8·801 mm.), using special reamer 18G229.

Removal and replacement of the sea- or river-water pump

The water pump is driven from the forward end of the fuel injection pump drive. It is removed by disconnecting the outlet pipe (the inlet pipe will have been disconnected when the engine was removed from the boat) and then unscrewing the three set screws which secure the pump body to its adaptor on the timing chain cover.

Replacement is a reversal of the above procedure.

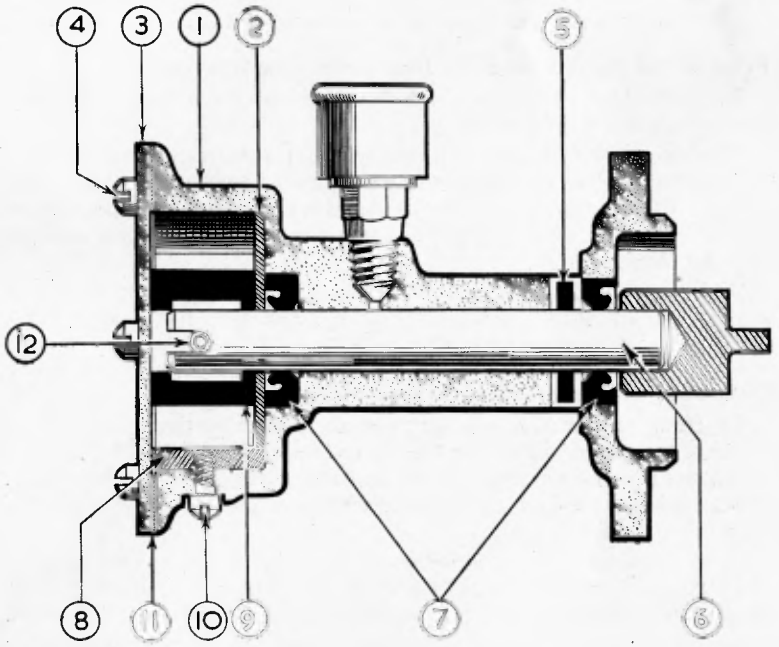


Fig. 49

A section through the sea- or river-water pump

OVERHAULING

Dismantling and reassembling the sea- or river-water pump

Referring to Fig. 49, unscrew the six securing screws (4), remove the end cover (3) and the end cover gasket (11). Withdraw the impeller (9) complete with set screw (12) from the pump shaft (6) and remove the impeller wear plate (2) from the pump body (1).

The pump shaft (6) can now be withdrawn rearwards from the pump body (1) but care must be taken not to damage the two seals (7) and the water slinger (5). With a suitable tool carefully remove the two seals (7). Finally, unscrew the cam retaining screw (10) and remove the cam (8).

Reassembly is a reversal of this procedure but the following points must be noted and adhered to:

(1) Sub-assemble the pump shaft, the rear seal, and the water slinger before replacing them in the pump body.

(2) Ensure that the two seals fit flush with the seal bore faces in the pump body, and that the lip of the front seal faces towards the impeller and the lip of the rear seal faces towards the drive coupling.

(3) If the impeller wear plate is worn it may be reversed to bring the smooth face against the impeller.

(4) Before the cam is replaced smear its outer diameter, its rear face, and the cam retaining screw hole with a water-resisting sealing compound, and after reinstalling be sure to remove any excess sealing compound from the pump body bore.

(5) Ensure that the end cover gasket covers the cam.

Removal and replacement of the fresh-water pump (when fitted)

Drain the cooling system of water and remove the dynamo and water pump drive belt (see page 44).

Disconnect the hoses from the water pump, remove the five bolts and one nut with spring washers securing the pump to the cylinder block, and withdraw the pump. To assist when reassembling note the position of the two steel packing washers between the impeller housing and the cylinder block.

When replacing, which is a reversal of the above procedure, fit new gaskets and adjust the water pump and dynamo drive belt in accordance with the instructions on page 44.

Dismantling and reassembling the fresh-water pump

Unscrew the four nuts with spring washers securing the pump body to the impeller housing and withdraw the housing and its gasket. Support the pump and prevent movement of the impeller without risk of damaging it. Extract the split pin from the spindle securing nut and withdraw it together with the plain washer.

Press the spindle to the rear, taking care not to damage the threads, until the spindle circlip behind the end cover is hard against the bearing support and prevents further movement. Remove the end cover and shims.

On later pumps the spindle circlip is deleted and the spindle diameter is reduced for a short distance to provide an abutment for the end cover. Withdraw the key and circlip from the spindle.

LUBRICATION

Engine lubrication system

The oil supply is carried in the cast-iron sump below the cylinder block, the capacity being 20 pints (11·4 litres), and the filler cap is fitted to the rocker cover.

The oil level indicator rod is on the port side of the engine and is marked to indicate both high and low levels.

An eccentric rotor, non-draining-type oil pump is mounted on the under side of the crankshaft front main bearing cap and is driven from the front of the crankshaft by a spur gear. Oil is drawn into the pump through a floating gauze strainer and is delivered via a feed pipe and drilled passages in the crankcase to the renewable-element-type external oil filter. A non-adjustable pressure relief valve is mounted on the outlet flange of the oil pump.

From the external filter oil is fed under pressure to an internal horizontal oil gallery on the port side of the crankcase and then through drilled passages direct to the crankshaft main and camshaft bearings.

The connecting rod big-end bearings are supplied with oil from the crankshaft main bearings via drilled passages in the crankshaft. Lubrication of the cylinder walls is effected by surplus oil flung from the crankshaft.

An external pipe feeds oil from the main oil gallery to the valve rockers via drilled passages in the cylinder head, intermediate rocker brackets, and rocker shafts. A relief valve in the front intermediate valve rocker bracket reduces the oil pressure to this mechanism.

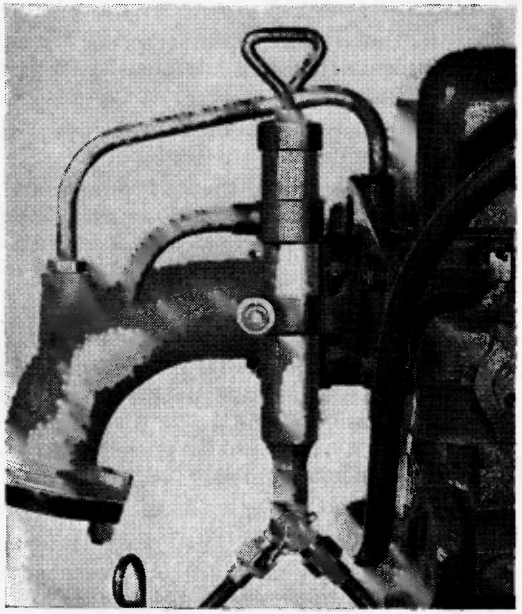


Fig. 17

The engine sump and reverse gearbox drain pump. A two-way cock is provided at the base of the pump for independent draining of either unit

(3) After draining, run the engine for a timed minute.

(4) Remove the plug from the base of the silencer.

When a 'Keel Cooler' is fitted either drain the cooling system as follows:

(1) With the engine hot open the water drain taps situated on the port side of the cylinder block and the rear end of the exhaust manifold (see Figs. 15 and 16).

When draining the cooling system it is imperative to release the header tank filler cap to permit air to enter and allow a free flow of water.

(2) Drain the hoses connecting the exhaust manifold and the water pump to the 'Keel Cooler' by releasing the clips and disconnecting them at the 'Keel Cooler' end.

(3) After draining, run the engine for a timed minute.

Or, better still, an anti-freezing solution may be used in the cooling system.

We recommend owners to use Bluecol, Filtrate Nevafreze, or Mobil-Permazone non-erosive anti-freeze in order to protect the cooling system during frosty weather and reduce corrosion to a minimum.

The correct percentages of anti-freeze for different degrees of frost resistance in the B.M.C. Commodore Marine Engine are:

Down to 7° *F.* (−14° *C.*)	*Down to* 0° *F.* (−18° *C.*)
15 per cent. solution	20 per cent. solution

If temperatures below 0° F. (−18° C.) are likely, solutions of 25 per cent or more must be employed. Consult your local Dealer for the correct proportions.

Before introducing anti-freeze mixture it is advisable to clean out the cooling system thoroughly by swilling out the water passages with a hose inserted into the filler cap opening, keeping the drain taps open.

Only top up when the cooling system is at its normal running temperature in order to avoid loss of anti-freeze due to expansion.

Make sure that the cooling system is watertight and examine all joints, replacing any defective rubber hose with new.

Do not remove the impeller from the spindle unless the spindle is to be renewed.

Unscrew the three set bolts with spring washers securing the bearing support to the pump body and press the water seal out of the body.

Remove the retaining circlip from the front end of the bearing support, draw off the water pump pulley complete with bearings, bearing distance piece, and oil seal, and withdraw the bearing distance collar. Extract the sealing ring from the bearing support and press out the spindle bush.

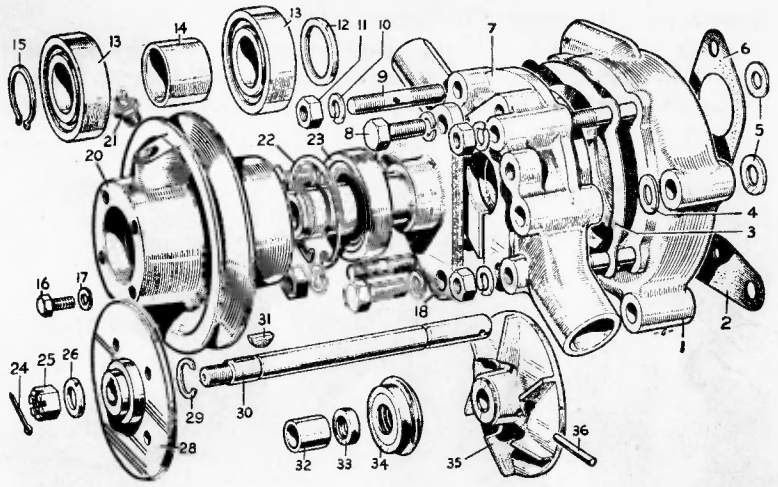


Fig. 50

The components of the fresh-water pump

1. Impeller housing.
2. Gasket.
3. Gasket.
4. Gasket.
5. Distance pieces.
6. Gasket.
7. Pump body.
8. Set bolt.
9. Stud.
10. Spring washer.
11. Nut.
12. Distance collar.
13. Bearings.
14. Distance piece.
15. Circlip.
16. Set bolt.
17. Spring washer.
18. Bearing support.
20. Pulley.
21. Lubricating nipple.
22. Circlip.
23. Oil seal.
24. Split pin.
25. Nut.
26. Plain washer.
28. End cover.
29. Lock ring.
30. Spindle.
31. Spindle key.
32. Bush.
33. Sealing ring.
34. Water seal.
35. Impeller.
36. Taper pin.

Finally, withdraw the bearing oil seal and bearing circlip from the pulley body and press out the two bearings.

When reassembling renew the gasket and seals; ensure that the bearing distance collar is replaced with its countersunk bore facing the shoulder of the bearing support, and before replacing the impeller housing check that a clearance of ·010 in. (·25 mm.) exists between the impeller blades and the pump body. If necessary, adjust by adding or removing shims from between the end cover and the pulley.

After reassembly lubricate with a grease gun filled with oil to Ref. B (page 89).

OVERHAULING

Removal and replacement of the engine oil filter

Remove the two stud nuts with plain and spring washers which secure the filter to the cylinder block and withdraw the filter.

When replacing ensure that the faces of the filter and cylinder block are clean and free from burrs. Fit a new gasket; run the engine until it is warm and check for oil leaks.

Removal and replacement of the engine oil filter element

Release the filter bowl by unscrewing the central bolt which secures it to the filter head and withdraw the bowl complete with element. Remove the element, wash out the bowl in paraffin (kerosene), and allow to dry.

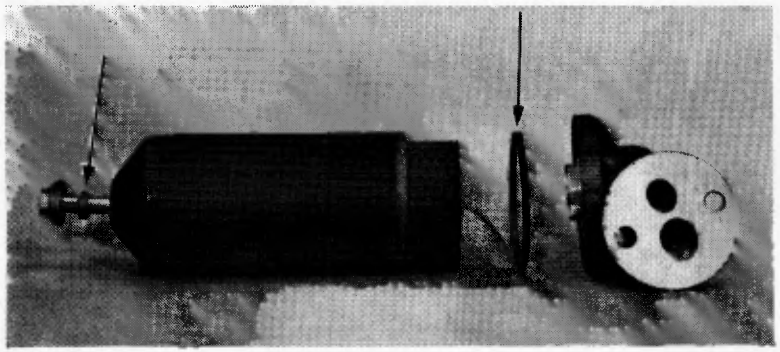


Fig. 51

A partially exploded view of the engine oil filter. The arrows indicate the two sealing washers

Insert a new element into the filter bowl, ensure that the sealing washer between the filter bowl and head is correctly positioned, and reassemble.

After reassembly, which is a reversal of the above procedure, run the engine until the oil is warm and then check for oil leaks.

Removal and replacement of the sump

Disconnect the drain pump suction pipe from the sump. Remove the 18 set screws which secure the sump to the crankcase and detach the sump and its gasket from the engine.

If the gasket is in good condition it may be used again, but it is advisable to fit a new one.

Before fitting a new gasket remove all traces of the old one from the crankcase and sump faces.

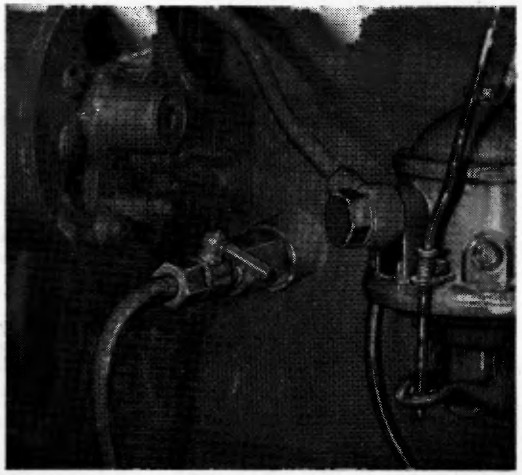
FROST PRECAUTIONS

During frosty weather, unless frostproof accommodation is available, the following precautions must be taken to prevent damage to the cylinder block and cooling system:

(1) With the engine hot, close the sea cock and completely drain the cooling system by opening the drain taps situated on the port side of the cylinder block and the rear end of the exhaust manifold (see Figs. 15 and 16).

Fig. 15

The cylinder block water drain tap



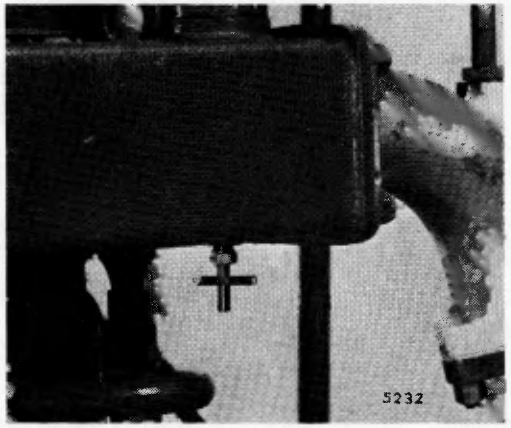


Fig. 16

The exhaust manifold water drain tap. Turn the tap in an anti-clockwise direction to open it

(2) Drain the water from the sea cock and the pipe connecting it to the water pump by unscrewing the union nut and disconnecting the pipe from the sea cock.

RUNNING INSTRUCTIONS

On engines not fitted with a 'Keel Cooler' the discharge overboard, via the exhaust pipe, of the cooling water must now be checked, and if after the engine has reached its normal running temperature the flow of water cannot be observed, it is an indication that the sea cock has become fouled and immediate action must be taken to remove the obstruction.

Check the oil pressure. With the engine warm the gauge should give a steady reading of between 35 and 40 lb./sq. in. (2·46 and 2·81 kg./cm.²) at normal speed and 10 and 15 lb./sq. in. (·7 and 1·05 kg./cm.²) when idling.

Extensive flickering of the oil gauge needle when the engine is warm is an indication of an irregularity in the lubricating system, which should be checked immediately.

Check also the dynamo output, which should be in the region of 8 amps. immediately after starting. The reading may drop considerably after a short time if the batteries are in a good state of charge.

Should the ammeter show a heavy discharge reading and there is virtually no electrical equipment in use immediate attention to the electrical system is indicated.

Stopping the engine

All that is necessary to stop the engine is to pull out the engine stop control to its fullest extent. This stops the engine by cutting off the fuel supply to the injector nozzles.

Before leaving the boat always turn off the main fuel cock and the sea cock.

NOTE.—Failure to turn off the sea cock has frequently led to the boat filling with water and ultimately sinking, due to a leak in the cooling system.

Running-in period

The treatment given to a new engine during the first 25 to 50 running hours will have an important bearing upon its subsequent performance. During this period the speed must be restricted so that racing of the engine does not occur. The engine speed must be increased gradually and progressively until at least 50 running hours have been completed.

Labouring by the engine must also be avoided.

OVERHAULING

Removal and replacement of the floating oil strainer and pick-up

With the sump removed release the two set bolts with spring washers which secure the oil suction pipe to the base of the oil pump and withdraw the suction pipe complete with the floating oil strainer and pick-up.

Remove the split pin; separate the oil strainer from the suction pipe and clean the strainer with paraffin (kerosene), using a stiff brush—never use rag.

When reassembling ensure that the oil strainer pivots freely in the suction pipe and the joint faces of the suction pipe and oil pump are clean and free from burrs. Fit a new gasket.

Removal and replacement of the oil pump

Remove the sump (see page 72) and detach the oil delivery pipe flange from the cylinder block by removing the two securing bolts with spring washers. Unscrew the two securing bolts with spring washers and withdraw the oil pressure relief valve complete.

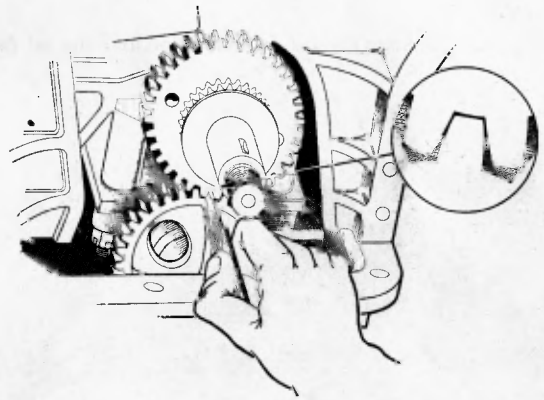


Fig. 52

Checking the backlash of the oil pump driving gears

Withdraw the split pins and unscrew the two nuts which secure the oil pump to the base of the front main bearing cap. The oil pump can now be withdrawn from the bearing cap studs complete with gear and delivery pipe. Finally, remove the two hollow dowels and the adjusting shims.

When reassembling fit new gaskets between the pressure relief valve and the pump cover and between the oil delivery pipe flange and the cylinder block. Also ensure that shims of the same thickness are replaced between the pump and the bearing cap as were found when dismantling. In the event of new crankshaft or oil pump components being fitted it will be necessary to add or remove shims to ensure that a backlash of ·004 in. (·102 mm.) is present between the teeth of the oil pump driving gears (see Fig. 52).

OVERHAULING

Dismantling and reassembling the oil pump

Disconnect the oil delivery pipe by removing the two set screws with spring washers which secure it to the oil pump cover.

Remove the split pin and nut from the end of the oil pump shaft; withdraw the driving gear, using special remover 18G2 with thrust pad 18G231E, and remove the gear key.

The pump cover is located by two dowels and secured to the pump body by five set bolts with spring washers. Removal of the set bolts will permit the withdrawal of the pump cover, the outer rotor, and the inner rotor with driving shaft.

Reassembly is a reversal of the above procedure but care must be taken to ensure that the outer rotor is installed in the pump body with its chamfered end (see Fig. 53) facing towards the driving gear end of the pump body.

Fit a new gasket between the oil delivery pipe and the oil pump cover.

Fig. 53

An exploded view of the oil pump and pressure relief valve. The arrow indicates the chamfered end of the outer rotor

RUNNING INSTRUCTIONS

Starting the engine

Check the level of the oil in the engine and fuel in the tank and replenish if necessary.

NOTE.—Do not allow the fuel tank to become empty, otherwise it will be necessary to bleed the fuel system (see page 58).

Ensure that the reverse gear is in neutral, the sea cock is open, and the engine stop control is fully home.

Turn on the main fuel tap, slightly open the throttle, and press the starter button on the instrument panel until the engine fires, when the starter button must be released immediately. If the engine does not start within five or six seconds release the starter button and allow a short interval between each attempt to start. This is to ensure that the engine is stationary and to prevent possible damage to the starter motor by overheating.

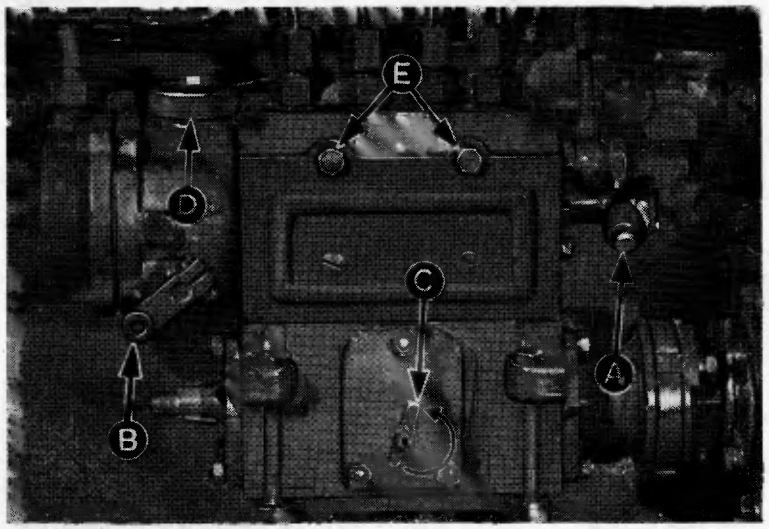


Fig. 14

The fuel injection pump. To open the oil level tap turn in the direction shown by the arrow

A. Excess fuel device.
B. Stop control lever.
C. Oil level tap.
D. Governor breather.
E. Air bleed plugs.

To ensure easy starting in very cold weather an excess fuel device (see Fig. 14) is fitted to the injection pump to provide extra fuel for starting. To start the engine proceed as above, but before pressing the starter button depress the excess fuel button. The button will automatically return to its normal position as soon as the engine starts.

NOTE.—Never start the engine with either of the pneumatic governor suction pipes disconnected or with either the throttle unit (venturi) or inlet manifold removed, as the governor will not operate and the engine will 'race' out of control.

OIL LEVELS

Clutch and reverse gear

The clutch and reverse gear should be filled via the filler plug on the inspection cover with one of the lubricants to Ref. A, page 89. The correct

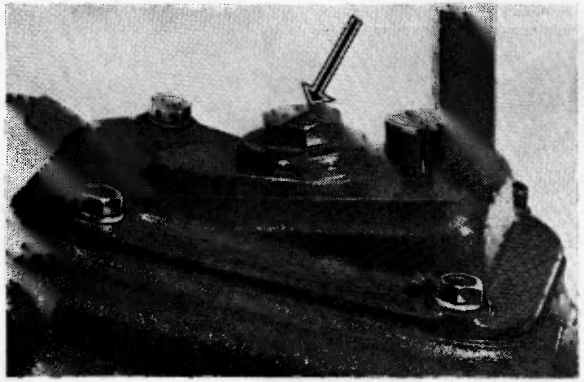


Fig. 12
The clutch and reverse gear oil filler plug

level may be found by withdrawing the dipstick located on the starboard side of the clutch and reverse gear housing. Keep the level of oil up to the 'HIGH' mark on the dipstick.

Fig. 13
The reverse gear oil level dipstick

Reduction gear

An oil filler plug is fitted at the top of the casing and a level plug on the starboard side. Remove both filler and level plugs and add transmission oil to Ref. B, page 89, until it emerges from the level plug orifice. Replace both plugs.

OVERHAULING

Dismantling and reassembling the oil pressure relief valve

Release the locking washer and remove the plug from the valve body. The spring, valve plunger, and ball can now be withdrawn.

Before reassembling examine the valve seat and ball for wear and check the tension of the spring.

The seat should be smooth and the ball free from scores. To check the tension of the spring measure its free length, which must be not less than $2\frac{1}{8}$ in. (53·98 mm.), and ensure that a load of 5 lb. (2·27 kg.) is required to compress the spring to its fitted length of $1\frac{1}{16}$ in. (26·99 mm.).

If necessary, renew the valve seat, ball, and spring.

Removal and replacement of the pistons and connecting rods

As the pistons and connecting rods can only be withdrawn from the top of the cylinder block it will be necessary to remove the cylinder head (see page 34) as well as the sump (see page 72) and the oil strainer and pick-up (see page 73).

Press back the locking washers, remove the big-end bolts, and withdraw the bearing cap, which is located on the connecting rod by two hollow dowels.

Withdraw the piston complete with connecting rod from the top of the cylinder block and refit the bearing cap. To assist when reassembling it should be noted that the cavity in the piston is on the starboard side of the engine.

When replacing the piston and connecting rod, which is a reversal of the above procedure, lubricate all bearing surfaces with engine oil, space the piston ring gaps at 180° to each other, and compress the piston rings, using piston ring compressing tool 18G55A to facilitate the entry of the piston into the cylinder bore.

When used parts are refitted it is essential that they are returned to their original positions. To ensure this, mark each bearing cap and connecting rod with the number of the cylinder from which it was taken.

Dismantling and reassembling a piston and connecting rod

The piston is attached to the connecting rod by a fully floating gudgeon pin and two circlips. Withdrawal of the two circlips from the piston will allow the gudgeon pin to be removed from the piston and connecting rod.

When reassembling ensure that the cavity in the crown of the piston is on the side of the connecting rod opposite to the big-end bearing cap.

If a new gudgeon pin is fitted a certain amount of selective assembly must be used. The gudgeon pin must be a push-fit for three-quarters of its travel and finally tapped home with a raw-hide mallet. This operation must be carried out with the piston and gudgeon pin cold.

Removal and replacement of the big-end bearings

To remove the big-end bearings press back the locking plate, remove the

connecting rod cap set bolts, withdraw the cap, and extract the bearing liners.

Replacement is a reversal of the above procedure, but as the bearings are of the shimless type it is essential that no attempt be made to adjust them. Worn bearings must always be replaced with new parts.

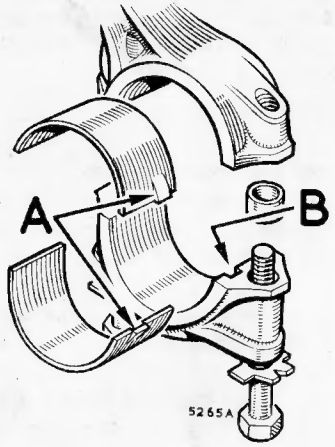


Fig. 54
An exploded view of the connecting rod big-end, showing (A) *the bearing locating tags and* (B) *the grooves*

The bearing liners are located in their housings by a small tag situated on one side of each liner and they must be fitted so that the tags come on the same joint edge of the bearing housing (see Fig. 54).

Removal and replacement of the little-end bush

Remove the old bush from the connecting rod, using a hand press, or if this is not available carefully tap it out, using a suitable drift.

When pressing in a new little-end bush make sure that the oil hole in the bush is in line with the oil hole in the top of the connecting rod. One edge of the connecting rod little-end bore is countersunk to facilitate the pressing in of the bush.

Replacement bushes are supplied finished to size and reaming is not necessary.

Removal and replacement of piston rings

In the absence of a special piston ring expander a smoothly ground hacksaw blade or a disused ·020 in. (·50 mm.) feeler gauge may be used for this operation.

Raise one end of the ring out of its groove. Insert the steel strip between the ring and the piston. Rotate the strip around the piston, applying slight upward pressure to the raised portion of the ring until it rests on the land above the ring grooves. It can then be eased off the piston.

OIL LEVELS

Filling up with oil

Before starting up the engine it is, of course, essential to fill the crankcase of the engine and the reverse gear with the correct quantity of lubricant. We recommend one of the oils indicated on page 89.

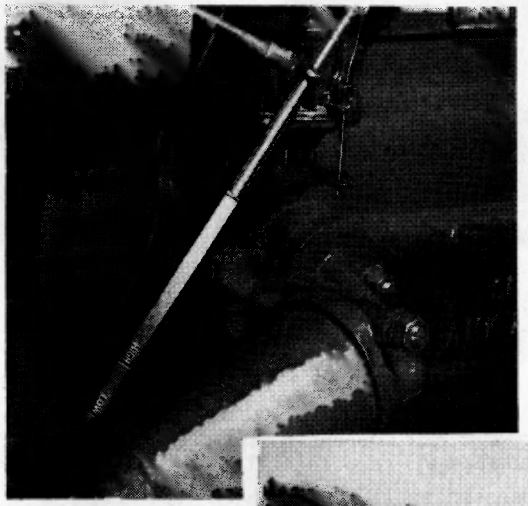


Fig. 10
The engine sump oil level dipstick

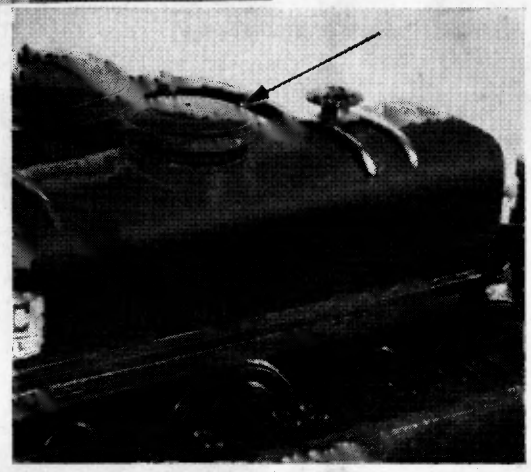


Fig. 11
The engine oil filler cap

Engine

The capacity of the engine sump is 20 pints (11·4 litres) and the correct oil level may be ascertained by withdrawing the dipstick located on the port side of the engine (see Fig. 10). If the oil level is below the 'HIGH' mark on the dipstick, replenish with one of the lubricants to Ref. A, page 89, by removing the quick-release cap (see Fig. 11) on the rocker cover and adding oil until the level is correct. Avoid overfilling the sump.

Do not run the engine for long periods with the oil level below the 'HIGH' mark.

INSTALLATION

EXHAUST SYSTEM

The arrangement of the exhaust piping is of some importance in the case of any marine engine. In the B.M.C. engine the cooling water, after it has completed its circuit of the engine cooling system, is introduced by a special mixing chamber into the exhaust pipe, where it mingles with the exhaust gases and thus reduces their temperature. This method of cooling the exhaust is very effective and has the advantage of greatly reducing the size of the silencer required to attain a given degree of silence.

With this scheme, however, it is important that there should exist, where possible, a reasonable drop between the mixing chamber outlet and the exhaust outlet in the stern of the boat (see Fig. 5), which, incidentally, should be above the normal water line when the boat is under way. The exhaust pipe, in addition, should be free from sharp bends and should have as steady a fall as possible over its entire length.

A sufficient drop in the exhaust pipe is a matter of importance in order to prevent the possibility of water finding its way into the engine when the engine is shut off and the boat is left at moorings. The best safeguard is to drive a slightly tapered wooden plug into the exhaust outlet whenever the boat is left at moorings for any considerable length of time.

The exhaust pipe should be of 2 in. (50·8 mm.) inner diameter reinforced rubber tubing.

NOTE.—When a 'Keel Cooler' is fitted copper exhaust piping must be used unless separate arrangements are made to cool effectively the exhaust system.

The silencer should be firmly attached to the exhaust pipe by the proper unions and also firmly anchored to a suitable part of the boat's structure.

A silencer specially designed for this engine and exhaust piping of the correct specification, together with clips and connections for securing it to the manifold, silencer, and hull fitting, are obtainable from Morris Motors Ltd.

When the engine is installed below water level or so near water level that a fall in the exhaust pipe straight from the exhaust manifold is not possible, a mixing chamber located some distance above the exhaust manifold outlet should be employed. Suitable fittings for this type of installation can be supplied by Morris Motors Ltd. on application.

OVERHAULING

Each piston is fitted with three compression and two 'slotted' oil scraper rings. The periphery of the top compression ring is chromium-plated and the peripheries of Nos. 2 and 3 compression rings are tapered. To ensure correct replacement the top faces of the tapered compression rings are stamped 'TOP'.

Before fitting new rings clean the grooves in the piston to remove any carbon deposit. Care must be taken not to remove any metal, or side-play between the ring and the groove will result, with consequent excessive oil consumption and loss of gastightness.

Test new rings in an unworn part of the cylinder bore to ensure that the ends do not butt together. The best way to do this is to insert the piston into the cylinder bore and push the ring onto the top of the piston and hold it there in order to keep the ring square with the bore. The correct ring gap is ·011 to ·016 in. (·279 to ·406 mm.).

Removal and replacement of the cylinder liners

The cast-iron cylinder liners are located in the cylinder block by a flange at the top of each liner. This flange, together with the cylinder head gasket, forms an effective water seal at the top of the cylinder block. The bottom water seal is formed by a synthetic rubber sealing ring located in a groove in the cylinder block and compressed against the outside of the cylinder liner.

To withdraw a cylinder liner first remove the sump (see page 72), the cylinder head (see page 34), and the pistons and connecting rods (see page 76).

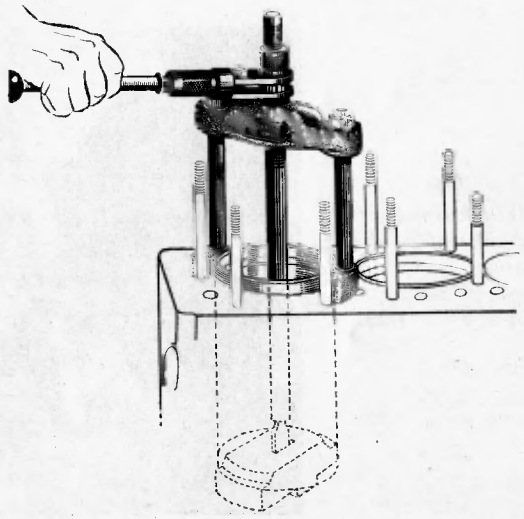


Fig. 55
Withdrawing a cylinder liner, using remover 18G227A

OVERHAULING

Using the special remover tool 18G227A (see Fig. 55), which is designed to engage readily the lower end of the liner, withdraw the liner and remove the water sealing ring.

Before replacing the cylinder liner ensure that the shoulder in the top of the cylinder block is free from burrs and rust accumulation. Clean and smooth off the shoulders and mating surfaces. Do not remove any metal, otherwise leaks are liable to occur.

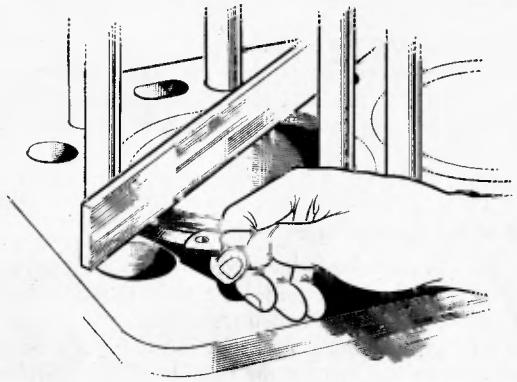


Fig. 56
Checking the standing height of the cylinder liner

Thoroughly clean out the water seal groove in the cylinder block and fit a new seal. Do not refit old seals. To prevent any possibility of the seal being dislodged or damaged when fitting the liner smear the surface of the seal with petroleum jelly.

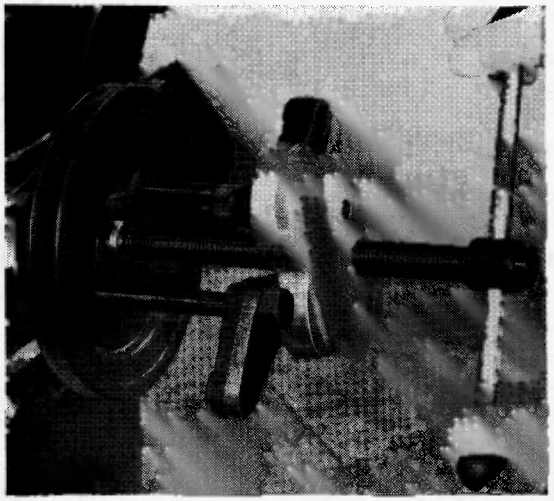


Fig. 57
Withdrawing the crankshaft pulley, using special remover 18G231 *with adaptors* 18G231*A*

INSTALLATION

The tubing must be suitably coiled at the engine end to prevent fracture due to vibration.

A fuel tank of ample capacity fitted, if working conditions permit, as far as possible away from the engine is ideal for reasons of safety. The filler orifice must be arranged for convenient filling but steps must be taken to prevent the entry of water.

NOTE.—It is imperative that the fuel is clean and free from foreign matter at all times, and the two C.A.V. fuel filters, together with a filter gauze and sediment chamber, which are incorporated in the fuel lift pump, are quite adequate under normal conditions.

ELECTRICAL EQUIPMENT

The batteries should be positioned as close to the engine and switchboard as possible and firmly secured to prevent any possibility of them coming adrift in rough weather. They should be fixed in a position where they are readily accessible for the purpose of checking the electrolyte, and in such a manner that they are readily removable for charging from an independent source when necessary. When employing a strap type of fixing it is advisable to interpose rubber strips between the strap and the battery cases to reduce the possibility of damaging the cases and also to help absorb any vibration to which the batteries may be subjected.

The batteries should be connected in accordance with the wiring diagram on page 88, using cables of good quality for the purpose. It is false economy to use doubtful wiring.

INSTRUMENT PANEL

A wooden panel is available to contain all the instruments supplied. The panel should be positioned where it is easily referred to by the pilot and as near his normal line of sight as possible. It should be adequately sheltered.

The switches and ammeter should be wired up in the manner set out in the wiring diagram (page 88), using cables of the correct specification, particularly for the starter connections.

The oil gauge pipe should be connected to the union situated on the port side of the engine at the rear of the cylinder block and liberally coiled whenever it is likely to be subjected to vibration.

The connection for the thermometer is situated in the forward end of the cylinder head on the port side. To absorb engine vibration two vertically disposed coils 2½ in. (63 mm.) diameter by 1 in. (25 mm.) pitch must be formed at each end of the capillary tube. It is important that the coils at the bulb end of the tube 'spring' with the flexing movement of the engine.

NOTE.—The capillary tube must not run direct from the instrument to the bulb.

INSTALLATION

Copper tubing of ½ in. (12·7 mm.) outside diameter and 18 gauge (1·25 mm.) should be employed for connecting the pump to the sea cock. The best place for the water intake is approximately amidships and as near the keel as practicable. To avoid fracture due to vibration it is recommended that suitable coils, horizontally disposed, should be made in the length of the piping between the engine and the sea cock.

Filling the cooling system when fitted with a 'Keel Cooler'

Remove the filler cap from the header tank and fill the system with fresh water (preferably soft) until the correct level is reached, i.e. about 1½ in. (3·8 cm.) from the top of the tank. Then run the engine until it is hot to disperse any air that may have been trapped in the system and add water as necessary to bring the surface to the correct working level.

Approximately 3¼ gallons (15·1 litres) of water are required to fill the system but this is dependent upon the length of the piping connecting the water pump and the exhaust manifold to the 'Keel Cooler'. Therefore, when initially filling the system a note should be made of the exact quantity so that the correct proportion of anti-freeze can be added during frosty weather as the 'Keel Cooler' cannot be completely drained by the cooling system drain taps.

NOTE.—As this system is pressurized care must be taken when removing the filler cap if the system is hot. It is advisable to protect the hands against escaping steam and then turn the cap slowly anti-clockwise until the resistance of the safety stop is felt. Leave the cap in this position until all pressure is released, then press the cap downwards against the spring to clear the safety stops and continue turning until it can be removed.

FUEL SUPPLY

An A.C. mechanical lift pump operated by the engine camshaft supplies fuel to the C.A.V. injection pump, which meters and delivers it under high pressure via the injection nozzles into the combustion chambers.

Two C.A.V. fuel filters which have renewable paper elements are supplied; one is inserted in the pipe line connecting the fuel lift pump to the injection pump and the other is supplied loose for insertion in the pipe line connecting the fuel tank to the lift pump.

The loose C.A.V. fuel filter should be connected to the fuel tank and lift pump with copper tubing of $\frac{5}{16}$ in. (8 mm.) outside diameter. To avoid fracture due to engine vibration it is advisable to arrange coils at each end of the pipe connecting the fuel filter to the lift pump. The coils should be disposed horizontally to avoid the formation of air locks. To assist the flow of fuel under all conditions the filter should be mounted as near as possible to the engine or in a similar warm place.

The injector nozzle fuel leak-off pipe union on the top of the secondary fuel filter should be connected to the union on the top of the fuel tank with $\frac{3}{16}$ in. (4·76 mm.) outer diameter copper tubing.

OVERHAULING

To replace the liner insert it into the cylinder block and press it into position until the flange of the liner butts against the shoulder of the cylinder block. Place a piece of wood across the top of the liner and with both hands press the liner fully home.

Before replacing the water seal insert the liner into the cylinder block and check the standing height of the liner from the top face of the cylinder block (see Fig. 56), which should be between ·002 and ·005 in. (·051 and ·127 mm.). Adjustment is carried out by adding shims (see page 4) between the flange of the liner and the recess in the cylinder block.

Removal and replacement of the crankshaft pulley

Remove the dynamo driving belt (see page 44), press back the lock washer, and with special spanner 18G97 unscrew the crankshaft nut. The pulley, which is keyed to the crankshaft, can now be withdrawn, using special remover 18G231 with adaptors 18G231A (see Fig. 57).

Replacement is a reversal of the above procedure.

Removal and replacement of the timing chain case cover

Remove the dynamo (see page 43), the water pump (see page 69), and the crankshaft pulley (see above).

Release the 21 bolts with spring washers which secure the engine front support bracket and the timing chain case cover to the engine and remove the support bracket, the dynamo adjusting link, the dynamo front support bracket, and the engine front lifting plate. Withdraw the four bolts securing the sump to the chain case cover; slacken the remaining sump bolts a turn or two and remove the chain case cover complete with oil seal, oil seal housing, and distance collar. Cover the open end of the sump to prevent the ingress of foreign matter.

When replacing, which is a reversal of the above procedure, fit a new gasket between the cover and the chain case. If the sump gasket shows any signs of damage this must also be renewed.

Removal and replacement of the crankshaft oil seals

Remove the crankshaft pulley and the timing chain case cover (see above), unscrew the four screws with spring washers which secure the oil seal housing to the timing chain case cover, and withdraw the housing complete with oil seals and the crankshaft distance collar. Withdraw the crankshaft distance collar and press out the oil seals.

When reassembling ensure that the oil seals are fitted into their housing with the sealing lips facing away from each other and insert the crankshaft distance collar through the oil seals from the front of the housing with its slow-tapered end foremost. To assist assembly and prevent damage to the sealing lips smear both the oil seals and the distance collar with engine oil.

Removal and replacement of the timing chain

Remove the timing chain case cover (see above) and to assist when replacing the timing chain turn the engine until the 'O' marks on the

injection pump, camshaft, and crankshaft chain wheels are in the positions shown in Fig. 58. It should be noted that the tooth on the crankshaft chain wheel bearing the 'O' mark is adjacent to the chain wheel keyway, and as the 'O' mark, when it is in its correct position, will be covered by the timing chain, the keyway may be used in lieu.

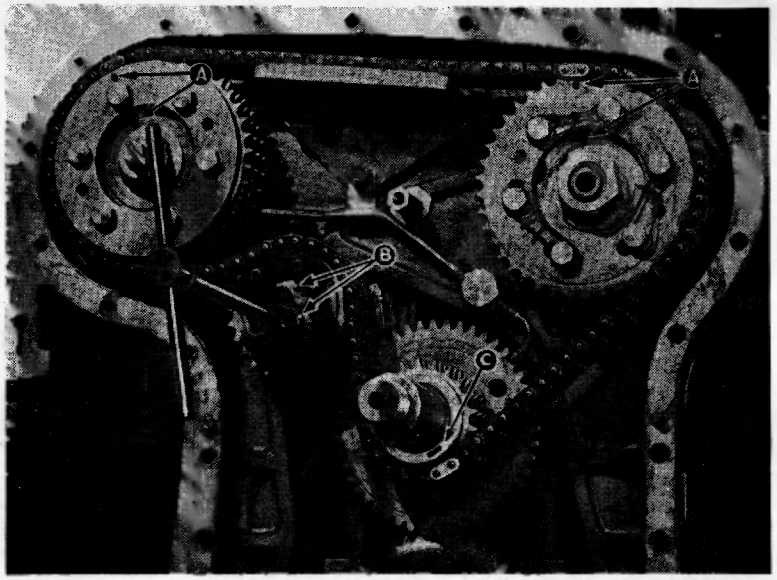


Fig. 58

A. 'O' marks on the chain wheels and hubs.
B. Chain tensioner pawl pins.
C. Crankshaft chain wheel keyway.

Press back the lock washer and remove the bolt and two copper sealing washers from the chain wheel oil feed pipe banjo-type union. Unscrew the three bolts with spring washers which secure the timing chain guide bracket and remove the oil feed pipe and the guide bracket.

Release the tension from the timing chain by squeezing together the chain tensioner pawl pins (see Fig. 58) and pushing the tensioner chain wheel over as far as possible to compress the spring; wedge the chain wheel in this position by inserting the positioning tool 18G241 (see Fig. 58).

Cut the locking wires; remove the six set bolts securing the injection pump chain wheel and ease the chain wheel off its hub. Withdraw the injection pump chain wheel from the timing chain and lift the chain clear of the remaining chain wheels.

With the timing chain removed neither the crankshaft nor the camshaft may be rotated unless all the rocker adjusting screws are completely released

cleaned from inside the boat. Quotations for suitable sea cocks and strainers of this nature are supplied by Morris Motors Ltd., and illustrated below is a combined strainer and sea cock of the type recommended.

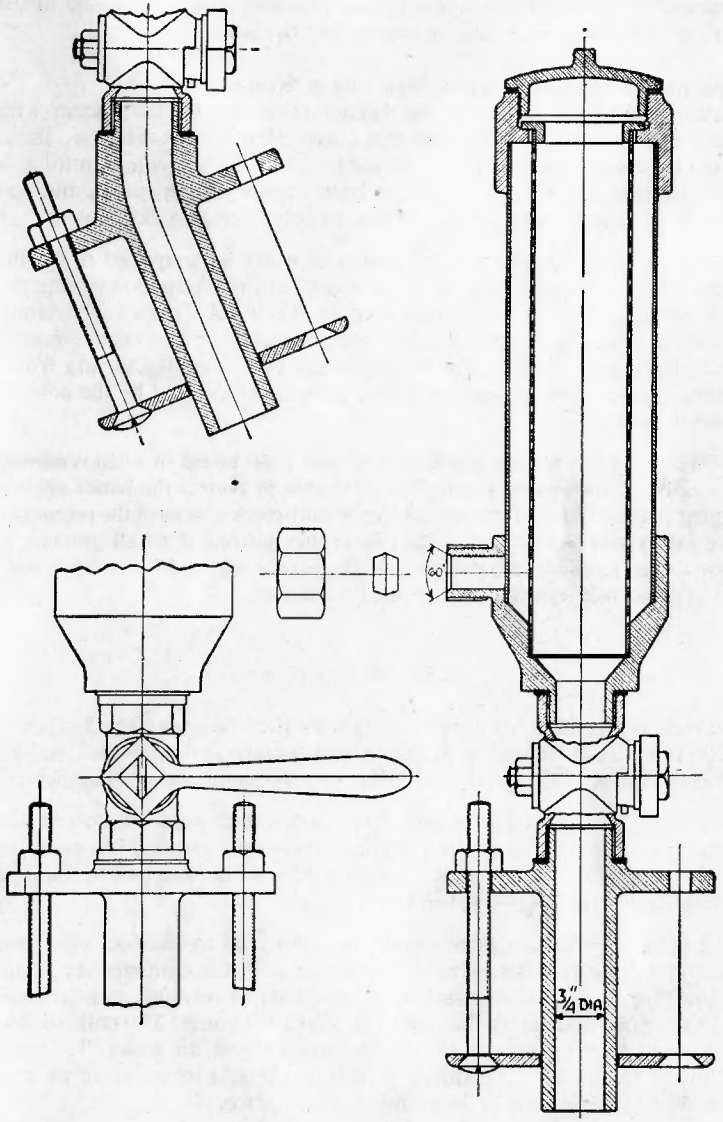


Fig. 9

The illustrations provide an indication of the approved type of sea cock and strainer. The top left illustration depicts the angular type of intake

finally reaching the cylinder head water outlet at the forward end of the cylinder head. Having reached the correct temperature, the thermostat opens and the cooling water is discharged overboard via the jacketed exhaust manifold and the exhaust system, where it assists in cooling and silencing the exhaust gases, thus improving the efficiency of the engine. Prior to the thermostat opening, the cooling water is recirculated by means of an external by-pass pipe which connects the cylinder head water outlet to the water pump suction pipe.

NOTE.—To ensure correct circulation the 'T' junction connecting the by-pass pipe to the water pump suction pipe must be installed as far below the water line and as near as is possible to the sea cock.

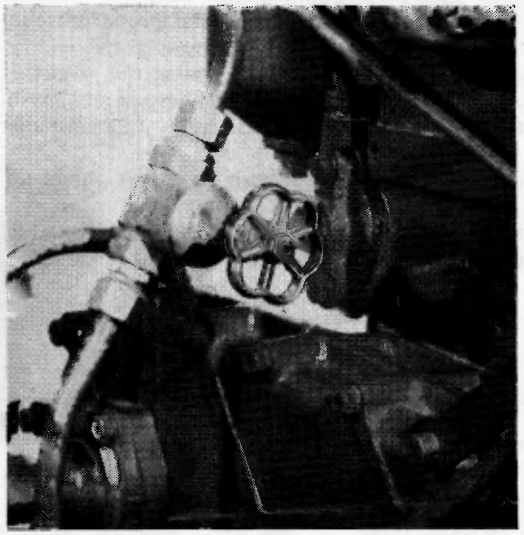


Fig. 8
The water by-pass gate valve

In circuit with the by-pass pipe is an adjustable gate valve which must be adjusted to maintain an engine running temperature of 70° C. (158° F.) at normal cruising speeds.

The pump intake must be connected with a suitable sea cock and strainer situated in the hull so that the intake is well below the water line.

The need for a sea cock becomes immediately apparent when the boat is left at moorings and there is a leak of any description in the water piping. Without a sea cock the continual dripping may be sufficient to fill and sink the boat. This also indicates the necessity for shutting off the sea cock whenever the boat is moored. The greatest trouble encountered in connection with strainers and sea cocks is occasioned by weeds becoming sucked up and choking the strainer gauze or sea cock passage. It is therefore imperative to employ a sea cock and strainer which can easily be

to allow all the valves to be in the closed position. If this is not carried out the valves will foul the tops of the pistons and cause serious damage.

Replacement of the timing chain is a reversal of the above procedure, but to facilitate retiming, the injection pump chain wheel hub and one tooth of each chain wheel, with the exception of the tensioner chain wheel, are marked with an 'O'. The 'O' marks on the injection pump chain wheel and its hub must line up with each other and the three 'bright links' in the timing chain must correspond with the 'O' marks on the chain wheel teeth (see Fig. 58). The 30 pitches between the 'bright links' are positioned between the camshaft and injection pump chain wheels and the 34 pitches between the 'bright links' are positioned between the camshaft and crankshaft chain wheels.

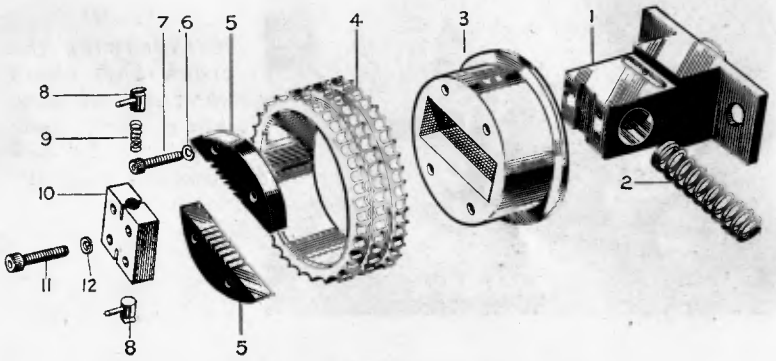


Fig. 59
The components of the timing chain tensioner

Removal and replacement of the timing chain tensioner

Remove the timing chain case cover and the timing chain (see page 79).

Unscrew the eight set screws (7) and (11) which secure the retaining plates (5) and the end plate (10) to the slide block (3) and the shank (1) respectively; care must be taken not to lose the two pawls (8) and the pawl spring (9). It is advisable to mark one of the retaining plates (5) and its mating surface on the slide block (3) to ensure correct reassembly.

Withdraw the chain wheel (4), the slide block (3), and the spring (2) from the shank (1). Knock back the two lock washers, unscrew the nut and set screw which secure the shank (1) to the cylinder block, and withdraw the shank.

Reassembly is a reversal of the above procedure, but it is most important that the retaining plates (5) and the pawls (8) are fitted correctly, that is with the teeth of the ratchets facing in the direction shown in Fig. 59, otherwise the restraint mechanism becomes inoperative.

Removal and replacement of the timing chain wheels and the oil pump driving gear

Remove the timing chain (see pages 79 to 81) and withdraw the crankshaft oil thrower. The crankshaft chain wheel, together with the oil pump driving gear, can now be withdrawn, using special remover 18G231 with adaptors 18G231B (see Fig. 60).

To remove the camshaft chain wheel and hub, press back the lock washer and unscrew the securing nut. During this operation the chain wheel can

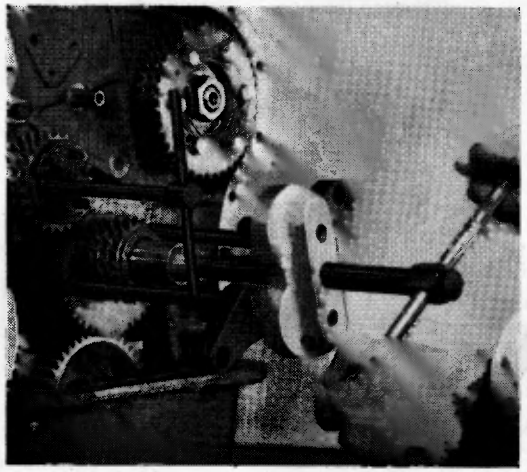


Fig. 60
Withdrawing the crankshaft chain wheel and oil pump driving gear, using remover 18G231 *with adaptors* 18G231B

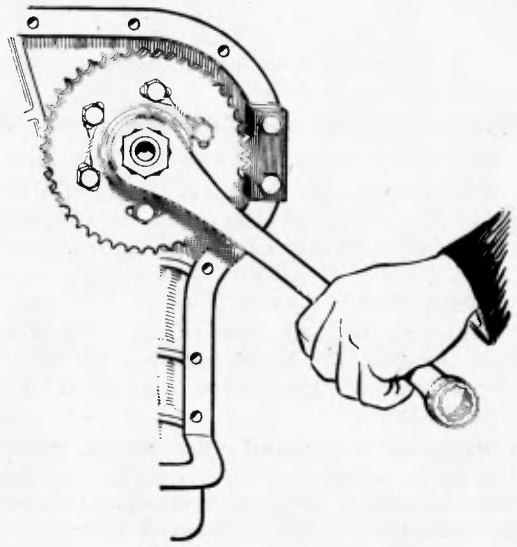


Fig. 61
Illustrating the use of locking fixture 18G232

if they are not it is an indication that the coupling is out of truth or the propeller shaft is bent. Any inaccuracy of this nature must be rectified or satisfactory running will be impossible.

Having satisfied yourself that the alignment of the engine and propeller shaft is correct, the holes in the engine bearers for the securing bolts may be drilled. This is best accomplished by using the holes in the engine bearer arms as guides, taking great care that the engine is not moved during the operation. Now insert the securing bolts and tighten up, using suitable pressure plates beneath the nuts. The alignment of engine and propeller shaft should again be checked to make sure that no movement has taken place while drilling the securing bolt holes or tightening up the bolts themselves. It is absolutely essential that the feeler gauge readings at all points round the coupling should be exactly the same.

When correct alignment has been attained the temporary clamp retaining the propeller shaft may be removed and the propeller shaft slightly withdrawn aft to part the coupling. The coupling spigot should be easily parted and should re-enter its recess squarely when the propeller shaft is returned to its correct working position. If all these points are in order the coupling bolts can be inserted in their holes and carefully tightened up.

See that the reverse lever is properly fitted, with its socket pulled up reasonably tight against the spacing collar.

The engine installation should preferably be enclosed in a suitable structure to prevent water finding its way onto the engine.

WATER CIRCULATING SYSTEM

The B.M.C. Commodore Marine Engine may be supplied with or without a 'Keel Cooler' unit.

Engines fitted with a 'Keel Cooler' unit employ a pressurized closed-circuit cooling system using fresh water.

In this system fresh water from the cooling unit is circulated by an impeller-type pump through the cylinder block and cylinder head. Having reached the correct temperature, the thermostat opens and the water passes into the header tank.

From the header tank the water returns via the jacketed exhaust manifold to the cooling unit, where it is cooled by the surrounding sea or river water. Prior to the thermostat opening the water is recirculated within the cylinder block and the cylinder head by means of a by-pass hose fitted between the cylinder head water outlet connection and the water pump.

Engines not fitted with a 'Keel Cooler' unit use an open-circuit cooling system using sea or river water which is circulated by a vane-type pump driven from the forward end of the fuel injection pump drive.

In this system the pump draws its supply of cooling water through a suitable sea cock in the hull below the water line and delivers it into the base of the cylinder block, where it passes through the cooling passages,

finally reaching the cylinder head water outlet at the forward end of the cylinder head. Having reached the correct temperature, the thermostat opens and the cooling water is discharged overboard via the jacketed exhaust manifold and the exhaust system, where it assists in cooling and silencing the exhaust gases, thus improving the efficiency of the engine. Prior to the thermostat opening, the cooling water is recirculated by means of an external by-pass pipe which connects the cylinder head water outlet to the water pump suction pipe.

NOTE.—To ensure correct circulation the 'T' junction connecting the by-pass pipe to the water pump suction pipe must be installed as far below the water line and as near as is possible to the sea cock.

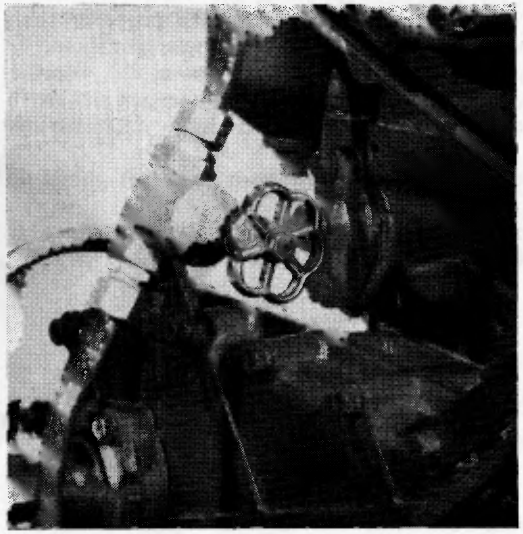


Fig. 8
The water by-pass gate valve

In circuit with the by-pass pipe is an adjustable gate valve which must be adjusted to maintain an engine running temperature of 70° C. (158° F.) at normal cruising speeds.

The pump intake must be connected with a suitable sea cock and strainer situated in the hull so that the intake is well below the water line.

The need for a sea cock becomes immediately apparent when the boat is left at moorings and there is a leak of any description in the water piping. Without a sea cock the continual dripping may be sufficient to fill and sink the boat. This also indicates the necessity for shutting off the sea cock whenever the boat is moored. The greatest trouble encountered in connection with strainers and sea cocks is occasioned by weeds becoming sucked up and choking the strainer gauze or sea cock passage. It is therefore imperative to employ a sea cock and strainer which can easily be

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Replacement of the timing chain is a reversal of the above procedure, but to facilitate retiming, the injection pump chain wheel hub and one tooth of each chain wheel, with the exception of the tensioner chain wheel, are marked with an 'O'. The 'O' marks on the injection pump chain wheel and its hub must line up with each other and the three 'bright links' in the timing chain must correspond with the 'O' marks on the chain wheel teeth (see Fig. 58). The 30 pitches between the 'bright links' are positioned between the camshaft and injection pump chain wheels and the 34 pitches between the 'bright links' are positioned between the camshaft and crankshaft chain wheels.

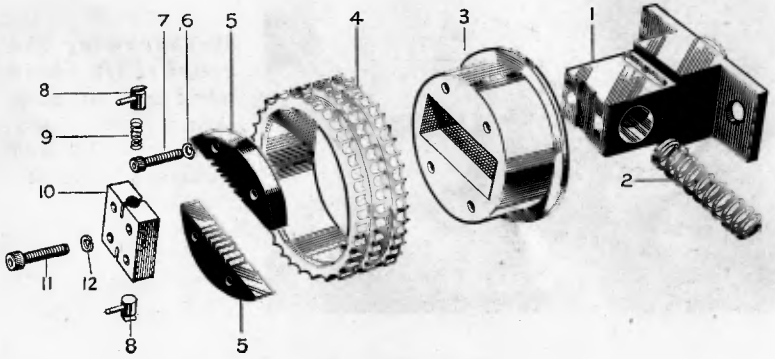

Fig. 59
The components of the timing chain tensioner

Removal and replacement of the timing chain tensioner

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Withdraw the chain wheel (4), the slide block (3), and the spring (2) from the shank (1). Knock back the two lock washers, unscrew the nut and set screw which secure the shank (1) to the cylinder block, and withdraw the shank.

Reassembly is a reversal of the above procedure, but it is most important that the retaining plates (5) and the pawls (8) are fitted correctly, that is with the teeth of the ratchets facing in the direction shown in Fig. 59, otherwise the restraint mechanism becomes inoperative.

Removal and replacement of the timing chain wheels and the oil pump driving gear

Remove the timing chain (see pages 79 to 81) and withdraw the crankshaft oil thrower. The crankshaft chain wheel, together with the oil pump driving gear, can now be withdrawn, using special remover 18G231 with adaptors 18G231B (see Fig. 60).

To remove the camshaft chain wheel and hub, press back the lock washer and unscrew the securing nut. During this operation the chain wheel can

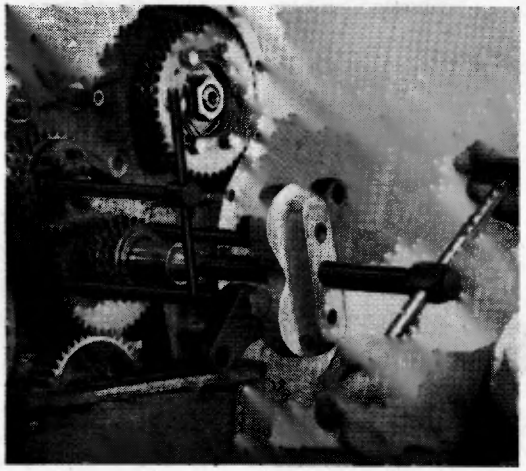

Fig. 60
Withdrawing the crankshaft chain wheel and oil pump driving gear, using remover 18G231 *with adaptors* 18G231B

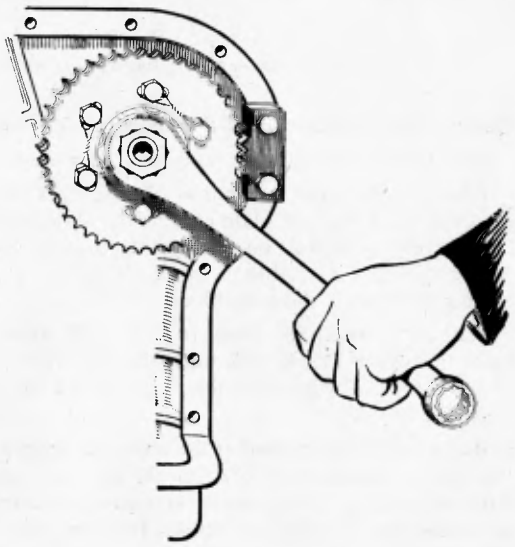

Fig. 61
Illustrating the use of locking fixture 18G232

if they are not it is an indication that the coupling is out of truth or the propeller shaft is bent. Any inaccuracy of this nature must be rectified or satisfactory running will be impossible.

Having satisfied yourself that the alignment of the engine and propeller shaft is correct, the holes in the engine bearers for the securing bolts may be drilled. This is best accomplished by using the holes in the engine bearer arms as guides, taking great care that the engine is not moved during the operation. Now insert the securing bolts and tighten up, using suitable pressure plates beneath the nuts. The alignment of engine and propeller shaft should again be checked to make sure that no movement has taken place while drilling the securing bolt holes or tightening up the bolts themselves. It is absolutely essential that the feeler gauge readings at all points round the coupling should be exactly the same.

When correct alignment has been attained the temporary clamp retaining the propeller shaft may be removed and the propeller shaft slightly withdrawn aft to part the coupling. The coupling spigot should be easily parted and should re-enter its recess squarely when the propeller shaft is returned to its correct working position. If all these points are in order the coupling bolts can be inserted in their holes and carefully tightened up.

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The engine installation should preferably be enclosed in a suitable structure to prevent water finding its way onto the engine.

WATER CIRCULATING SYSTEM

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Engines fitted with a 'Keel Cooler' unit employ a pressurized closed-circuit cooling system using fresh water.

In this system fresh water from the cooling unit is circulated by an impeller-type pump through the cylinder block and cylinder head. Having reached the correct temperature, the thermostat opens and the water passes into the header tank.

From the header tank the water returns via the jacketed exhaust manifold to the cooling unit, where it is cooled by the surrounding sea or river water. Prior to the thermostat opening the water is recirculated within the cylinder block and the cylinder head by means of a by-pass hose fitted between the cylinder head water outlet connection and the water pump.

Engines not fitted with a 'Keel Cooler' unit use an open-circuit cooling system using sea or river water which is circulated by a vane-type pump driven from the forward end of the fuel injection pump drive.

In this system the pump draws its supply of cooling water through a suitable sea cock in the hull below the water line and delivers it into the base of the cylinder block, where it passes through the cooling passages,

If the boat has not already been fitted with a stern tube the next procedure is to attend to this necessary equipment. Great care should be taken to see that the stern tube is fitted in proper alignment with the engine bearers or difficulty may be encountered in lining up the engine. If you have not previously had experience of stern tube fitting this is a matter which is best placed in the hands of a competent boat builder.

The after portion of the propeller shaft coupling should now be removed from the engine and fitted to the forward end of the propeller shaft, taking special care to see that the keyway is of the correct size and accurately made, also that the key itself is a good fit. It is also essential that the propeller shaft should have a hole into which the bolt in the coupling boss has been properly fitted, since this carries the propeller thrust. A test of the coupling should be made to check it for truth and any necessary corrections carried out. With this accomplished the propeller shaft may be fitted in the stern tube.

Everything is now in readiness to receive the engine, and it must be remembered that whenever possible the engine should be fitted with the hull afloat. If the craft is not afloat when installing the engine there is a danger of distorting the hull due to insufficient support.

Swing the engine on lifting tackle by the lifting plates provided on the engine, when it can then carefully be lowered onto the engine bearers. The propeller shaft must now be located in its correct position fore and aft by some device that will permit of its rotation by hand but prevent its movement aft. The nature of this device will necessarily vary considerably with different boats, and it should not be outside the scope of the average boat owner to devise a suitable stop of this nature.

The engine should then carefully be moved aft until two halves of the coupling flange come together, with the spigot portion partly engaging in its recess. Raise the engine to the correct height for the two halves to engage easily by the insertion of packing pieces of suitable thickness beneath the bearer arms.

The vertical alignment of the engine should be checked at this stage by inserting a feeler gauge between the two halves of the coupling at the top and bottom positions, that is to say, vertically above and below the coupling centre. When the engine and propeller shaft are in correct alignment the width of the gap between the coupling flanges should be the same at the top and bottom. If any discrepancy exists it should be corrected by the introduction of modified packing pieces beneath the bearer arms.

The lateral alignment of the engine must now be checked in a similar way, the feeler gauge being inserted at either side of the coupling this time instead of at the top and bottom. Correct alignment will again be indicated when the gap on each side is exactly equal, and any inaccuracy should be rectified by moving the engine on the bearers in the desired direction.

As a final check the propeller shaft should be rotated a quarter of a turn at a time through one complete revolution, a test being made with the feeler gauge in four equally spaced positions round the coupling at the end of each quarter-turn. All the readings should be exactly equal;

be prevented from turning by the use of special locking fixture 18G232 (see Fig. 61). The chain wheel and hub can now be withdrawn, using special remover 18G231 with adaptors 18G231C and thrust pad 18G231D (see Fig. 62).

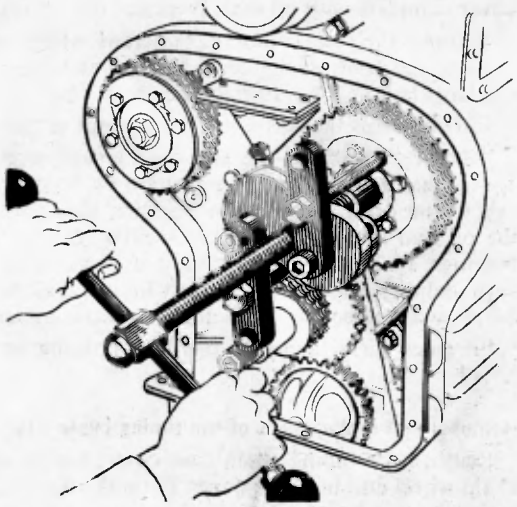


Fig. 62
Withdrawing the camshaft chain wheel, using remover 18G231 with adaptors 18G231C and thrust pad 18G231D

To separate the camshaft chain wheel from its hub, cut the locking wires and remove the series of set bolts.

The injection pump chain wheel and hub is removed in the same manner as the camshaft chain wheel and hub, using special remover 18G231 with adaptors 18G231C and thrust pad 18G231E.

To provide an anchorage for the extractor adaptors it will be necessary to refit the injection pump chain wheel (which was withdrawn during the removal of the timing chain) to its hub.

The removal of the timing chain tensioner is described on page 81. When reassembling, which is a reversal of the above procedure, ensure that the 'O' marks on the injection pump and camshaft chain wheels are in line with the similar marks on their respective hubs, and before tightening the camshaft chain wheel bolts set the valve timing in accordance with the instructions on page 86.

The oil thrower must be replaced on the crankshaft with its bevelled side facing towards the chain wheel.

Removal, dismantling, and replacement of the fuel injection pump drive

Remove the timing chain case cover (see page 79), the timing chain (see pages 79 to 81), the injection pump chain wheel and hub (see above), and the injection pump (see pages 51 and 52).

OVERHAULING

Release the six securing bolts with spring washers and withdraw the housing and drive assembly rearwards from the timing chain case.

Slacken the clamping bolt, withdraw the injection pump coupling driving flange from the drive shaft, and remove the coupling key.

Unscrew the four bolts with spring washers and withdraw the housing cover complete with oil seal. Press out the oil seal.

Remove the four countersunk screws which secure the bearing cover-plate to the front of the drive housing and press out the drive shaft and the large ball bearing. Extract the chain wheel key from the drive shaft.

Finally, press the small ball bearing out of the rear of the housing.

When reassembling, use new countersunk screws to secure the bearing cover-plate and lock them in position by peening, fit the chain wheel hub key to the drive shaft before inserting the shaft into the housing, press the oil seal into the end cover so that its sealing lip faces towards the bearings, make the joint between the end cover and the drive housing with sealing compound, and freely lubricate all working parts with engine oil to ensure adequate lubrication until the engine oil is circulated.

Fit a new gasket between the drive housing and the timing chain case.

Removal and replacement of the timing chain case

Remove the timing chain case cover, timing chain, and the camshaft chain wheel and hub (see pages 79 to 83).

The timing chain case is secured to the cylinder block by the chain case cover distance piece and four set bolts with spring washers. Before releasing these scribe a line across the injection pump coupling flanges to assist when reassembling. The chain case, which is located on the cylinder block by two dowels, can now be withdrawn complete with the injection pump drive.

When reassembling, which is a reversal of the above procedure, fit a new gasket between the timing case and the cylinder block, coating the joint face of the cylinder block only with sealing compound. Ensure that the scribed marks on the injection pump coupling flanges are in line.

Removal and replacement of the tappets

Remove the valve rocker cover; unscrew the breather pipe clip securing nut from the rear of the cylinder head and detach the breather pipe from the air cleaner and the tappet cover.

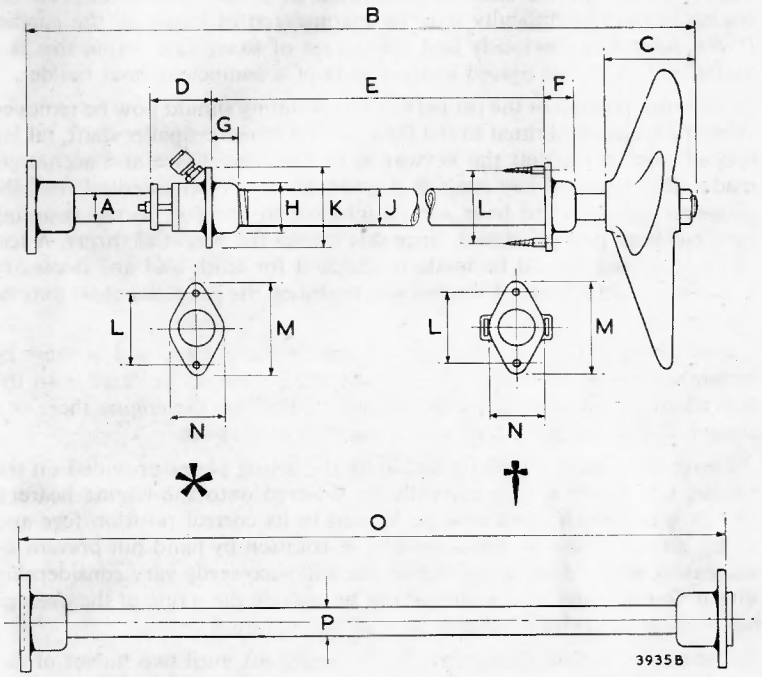
Fully slacken the valve rocker adjusting screws and withdraw the push-rods, storing them carefully to ensure their replacement onto the same tappets.

Unscrew the 15 set screws with spring washers and remove the tappet and push-rod cover. Lift out the tappets, keeping them in order so that they may be replaced into their respective guides.

New tappets must be fitted by selective assembly so that they just fall into their guides under their own weight when lubricated.

INSTALLATION

STANDARD STERN GEAR DIMENSIONS



B.M.C. COMMODORE

	DIMENSIONS									
	A	B	C	D	E	F*	F†	G	H	J
in.	1½	90	4⅝	3	36	1½	7½	1½	2⅜	2
mm.	38	2288	117·47	76·2	914·4	38	190·5	38	60·3	50·8
	K	L*	M*	N*	L†	M†	N†	O	P	
in.	4¼	3½	4⅜	2⅝	4¼	5¼	3½	72	1½	
mm.	107·95	88·9	111·1	66·67	107·95	133·35	79·38	1828·8	38	

* White-metal bearing. † Water-lubricated bearing.

Manganese-bronze propeller shafting is supplied for engines with direct drive; if stainless steel propeller shafting is used the Ministry of Transport will authorize a reduction in the shaft diameter in many cases. We will be pleased to advise on application. The propeller shafting supplied for engines with 2 : 1 or 3 : 1 reduction is of stainless steel.

When ordering the stern tube dimension (E) must be specified. When ordering the propeller shaft dimension (B) must be specified.

An unsuitable propeller will, of course, lead to an unsatisfactory engine and boat performance. The Company therefore strongly recommend owners, in their own interests, to consult a qualified naval architect in order to establish the correct dimensions of the propeller to be fitted. The Company will be pleased to assist, from their experience, in the selection of a suitable propeller, but owners are advised, whenever possible, to consult the naval architect who designed the boat.

on the provision of adequate and properly fitted engine bearers. Their lower edges should be shaped to fit snugly on the planking and notched over each timber and, in order to save weight, bearers may, if desired, be tapered off in depth on either side of the engine towards their ends.

It will be appreciated that two bearers of this nature possessing considerable depth will have but little lateral rigidity and will be ill equipped to resist engine vibration unless they are stiffened up laterally in some way. This is usually accomplished by the employment of what are termed 'floors', which consist of comparatively short hardwood timbers of appreciable depth extending from bilge stringer to bilge stringer. These

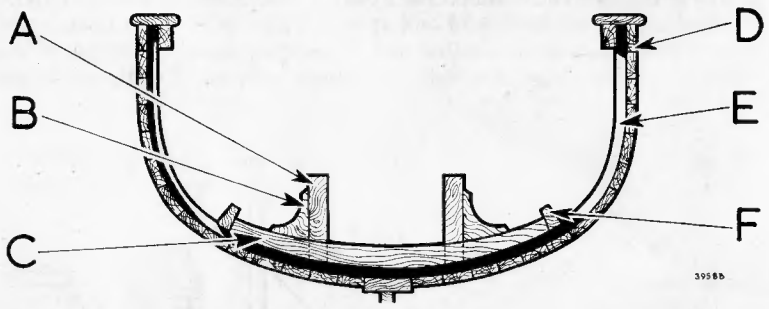


Fig. 7

Diagrammatic section of a typical river boat, illustrating the essential components to good installation outlined in the text

A. Engine bearer.
B. Knee.
C. Floor.
D. Planking.
E. Timber.
F. Bilge stringer.

should be at least 3 in. (76 mm.) deep at the keel, tapering off to the bilge, and should be 1½ in. (38 mm.) thick. These floors should be placed at intervals of 1 ft. (300 mm.) underneath the engine and reverse gear, and at 2-ft. (600-mm.) intervals over the remainder of the bearers.

Oak is generally employed for making these floors, and they are cut, when possible, from selected planks whose natural grain follows as closely as possible the curve of the floor.

The engine bearers may then be braced to the floors by the employment of natural oak 'knees' or 'crooks' in the angle formed between the bearers and the floors, which will result in a foundation of adequate stiffness to carry the power unit.

If the engine is supplied with a **'Keel Cooler'** the installation of the cooling unit on the outside of the boat is the next item to be considered. The cooling unit should be fitted in the most convenient position amidships and as near as possible to the keel and engine.

To accommodate the cooling unit headers (see Fig. 2) it will be necessary to cut in the hull of the boat two holes 1⅜ in. (34·93 mm.) diameter with 6 ft. 1¼ in. (1·86 m.) between their centres. The latter dimension will allow any of the four cooling tubes to be removed without further dismantling of the cooling unit.

It is advisable to fit protective hardwood fairings (see Fig. 2) both fore and aft of the cooling unit.

When reassembling ensure that the tappet and push-rod cover joint is oiltight and adjust the valve rocker clearance in accordance with the instructions on pages 38 and 39).

Removal and replacement of the camshaft and front bearing

Remove the timing chain case cover (see page 79), the timing chain (see pages 79 to 81), the camshaft chain wheel and hub (see page 82), the fuel lift pump (see page 48), and the tappets (see page 84).

Detach the camshaft locating plate, which is secured to the cylinder block by two set bolts with spring washers, and carefully withdraw the camshaft from the cylinder block.

Unscrew the locating bolt with spring washer and withdraw the camshaft front bearing. The two intermediate and rear bearing journals run direct in the cylinder block.

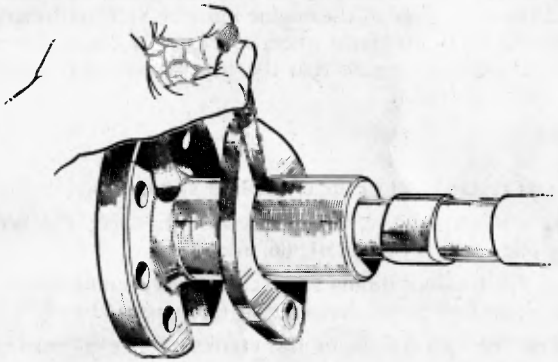


Fig. 63

Checking the camshaft end-float

To install a new camshaft front bearing press it into the bore, plain edge foremost, aligning the two holes in the bearing with the oil hole and locating hole in the cylinder block. When the bearing is in position it can be finally lined up by tapping it round, using a soft drift against the aligning notch. Finally, ream in position with a line reamer to a diameter of between 1·9995 and 2·001 in. (50·787 and 50·825 mm.) and fit the locating bolt.

Before replacing the camshaft check its end-float, which should be between ·002 and ·012 in. (·051 and ·305 mm.). This is accomplished by assembling the chain wheel and hub and the locating plate to the camshaft and measuring the clearance between the locating plate and the front face of the camshaft front bearing journal.

Checking and setting the valve timing

If the camshaft chain wheel has been removed or disturbed on its hub, and after fitting a new camshaft, the valve timing must be checked and, if necessary, reset. This is carried out as follows:

Set the valve rocker clearances in accordance with the instructions on pages 38 and 39. Slacken the decompressor screws (see Fig. 33) and turn the engine until the 1 and 4 T.D.C. mark on the periphery of the flywheel is opposite the pointer on the top of the flywheel housing (see Fig. 34) and No. 1 piston is at the top of its compression stroke. Now turn the engine until the T.D.C. mark on the periphery of the flywheel is 5° A.T.D.C. If the valve timing is correct the exhaust valve of No. 4 cylinder will be just closed. The exact point at which the exhaust valve (No. 8) closes can be determined by mounting a clock gauge on the exhaust manifold rear studs with the indicator on the valve collar.

If the valve timing is not in accordance with the above, slacken the six set bolts securing the camshaft chain wheel to its hub and turn the camshaft by its centre nut clockwise if the valve is closing late and anti-clockwise if the valve is closing early. During this operation the chain wheel and the remainder of the engine must be kept stationary. Carefully tighten up the camshaft chain wheel set bolts; re-check the valve timing as described above to ensure that the correct timing has been obtained and re-wire the set bolts.

Removal and replacement of the crankshaft and bearings

Remove the starter, reverse gear, flywheel housing, flywheel, and rear mounting plate (see pages 40, 61, 66, and 67).

Remove the dynamo, timing chain case cover, timing chain, crankshaft chain wheel, and oil pump driving gear (see pages 43 and 79 to 82).

Withdraw the two halves of the crankshaft thrust washer from the front face of the front main bearing.

Remove the sump, oil pump, and oil strainer (see pages 72 and 73).

Release the decompressor screws (see Fig. 33) to facilitate the turning of the crankshaft and the movement of the connecting rods and pistons and remove the big-end bearings (see pages 75 and 76).

Mark each big-end bearing cap and bearing to ensure that they are reassembled to the correct journal, taking care, in the case of the bearings, that they are not damaged or distorted when marking. A punch should not be used for this purpose.

Unscrew the two bolts securing the two halves of the crankshaft rear oil seal cover to each other and the four bolts securing the bottom half of the cover to the crankcase. Remove the bottom half of the cover, taking care not to damage the gasket. If the gasket is damaged in any way the top half of the cover must be removed and a new gasket fitted.

Remove the remaining eight nuts with split pins securing the main bearing caps (the front main bearing cap nuts will have been removed

While considering the engine installation it is well to remember at the same time that, for the benefit of the stability of the boat, it is always advisable to mount the engine reasonably low down in the hull. The engine bearer arms of B.M.C. marine engines are carried well up and permit the use of engine bearers of ample depth when the sump only just clears the keel.

Special attention, however, must be given to the layout of the exhaust system if the engine is mounted below or near the water line (see Fig. 5).

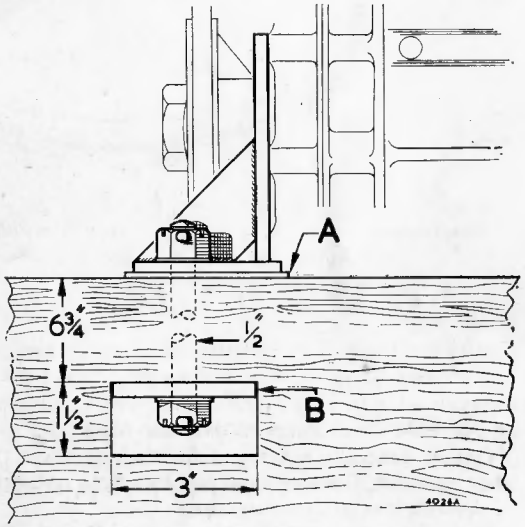
Adequate engine bearers are essential for successful installation; their faulty design, particularly in the matter of insufficient length, may seriously strain the hull and cause unnecessary engine vibration. The engine bearers, which should be of hardwood and at least 2½ in. (63·5 mm.) thick, must be sufficiently deep to ensure that they will not sag under the weight of the engine and thus distort the hull. They must also be of sufficient length

Fig. 6

The method of attaching the engine to the bearers, and the dimensions of the slot for the nut

A. Packing piece to facilitate lining up engine.

B. Pressure plate $\frac{5}{16}$ in. (7·94 mm) thick.



to avoid placing local strains on the hull, and for this reason should extend fore and aft for a considerable distance beyond the limits of the engine itself—in fact, as far as it is found to be practicable on the particular hull under consideration.

The bearers should be spaced so that the distance between their centres is 21 in. (533·4 mm.). The under faces of the engine bearer brackets on the engine are 3 in. (76 mm.) below the centre line of the crankshaft and ½ in. diameter bolts should be used to secure the engine. Provision has therefore to be made for insertion of the securing bolt nuts, and the bearers must be cut with slots at each securing bolt position at least 6¾ in. (17 cm.) below the lower face of the engine bearers and of sufficient length to enable the free use of a spanner on the nuts. The accompanying diagram clearly indicates the nature of these slots.

The whole success of installation depends to a very large extent indeed

ENGINE

The first essential in installing the engine is to see that the boat is fitted with suitable engine bearers set at the correct angle and whose upper surface should be from $\frac{1}{8}$ in. (3 mm.) to $\frac{1}{4}$ in. (6 mm.) lower than the actual final position of the engine bearer arms, so as to permit final location of the engine by the use of packing beneath the bearer arms. It must be remembered when preparing the engine bearers for an engine fitted with reduction gear that the centre line of the coupling is offset from the centre of the crankshaft.

When installing an engine it is to be noted that gear-type reduction gears with clockwise or anti-clockwise rotation are available, enabling handed propellers to be used in twin engine installations.

It must be remembered when considering the installation that the B.M.C. Commodore engine must never make more than 10° with the horizontal when the boat is under way, or lubrication may be seriously affected.

It is advisable to arrange for a watertight galvanized iron tray to be fitted beneath the engine to prevent oil and fuel drippings from entering the bilges. Where the boat is to be used within the jurisdiction of the Thames Conservancy this tray is compulsory.

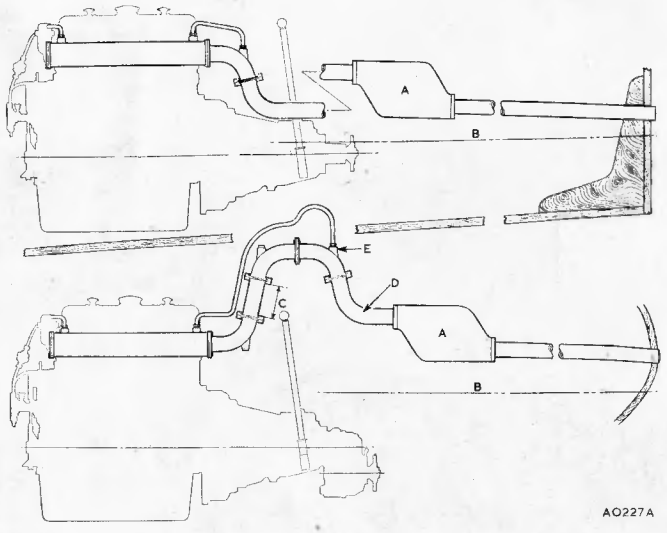


Fig. 5

Installation diagram of the exhaust system. The upper diagram illustrates the type of installation to employ when the engine is mainly above the water line and the lower one when the engine is mainly below the water line

A. Silencer.
B. Water line.
C. Distance may be varied to suit.
D. Exhaust pipe must maintain a constant fall to outlet.
E. Water inlet to exhaust mixing chamber.

when the oil pump was withdrawn), and withdraw the bearing caps, the bearing bottom shells, and the bearing cap hollow dowels. The crankshaft and the remaining two halves of the crankshaft thrust washer can now be removed. It should be noted that the caps are marked on one side to ensure replacement into their original positions. Individual caps with both bearing half-shells must be kept together.

When fitting new bearings no scraping is required as the bearings are machined to give the correct diametrical clearance of between ·002 and ·005 in. (·051 and ·127 mm.).

In the case of a run bearing it is essential to clean out thoroughly all the oilways in the crankshaft and cylinder block, renew the oil filter element, wash out the sump with paraffin (kerosene), and clean the oil pump and strainer to ensure that no particles of bearing metal are left anywhere in the lubricating system.

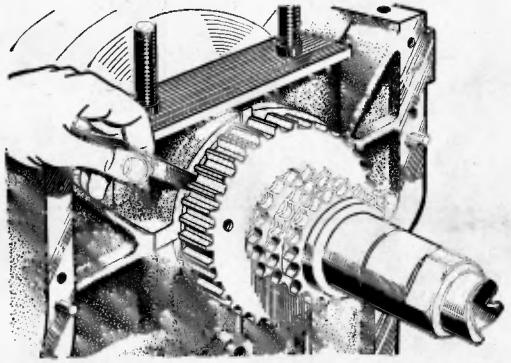


Fig. 64

Checking the crankshaft end-float

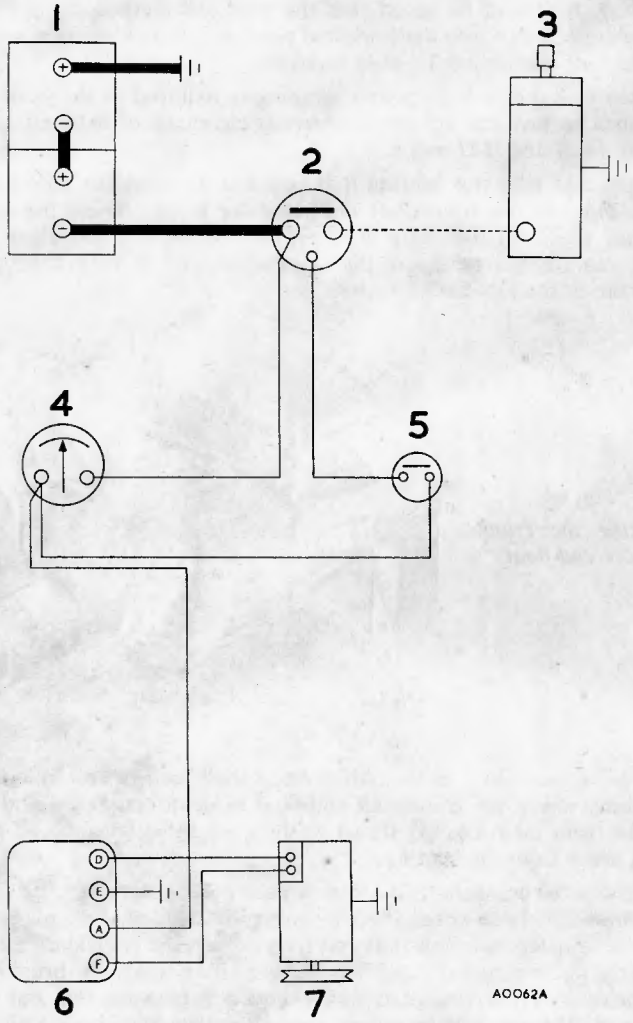
When reassembling fit the half bearing shell with the oil hole into the crankcase; check the crankshaft end-float as described below and ensure that the front main bearing thrust washers are fitted with the oil grooves facing away from the bearing.

To check the crankshaft end-float replace the oil pump driving gear and the crankshaft chain wheel. Place a short piece of tube and a plain washer over the front of the crankshaft and fully tighten the crankshaft nut. With a feeler gauge measure the end-float between the crankshaft thrust washers and the oil pump driving gear, which should be between ·006 and ·010 in. (·152 and ·254 mm.). If necessary, renew the thrust washers, fitting them by selective assembly.

If the top half of the crankshaft rear oil seal cover has been removed it must be centralized round the return thread on the crankshaft. A clearance of between ·007 and ·0085 in. (·178 and ·216 mm.) all round should be maintained between the thread and the cover.

When refitting the bottom half of the rear oil seal cover ensure that its lower face is level with the crankcase surface to which the sump is mounted.

WIRING DIAGRAM



1. Two 6-volt batteries.
2. Solenoid starter switch.
3. Starter.
4. Ammeter.
5. Starter push switch.
6. Control box.
7. Generator.

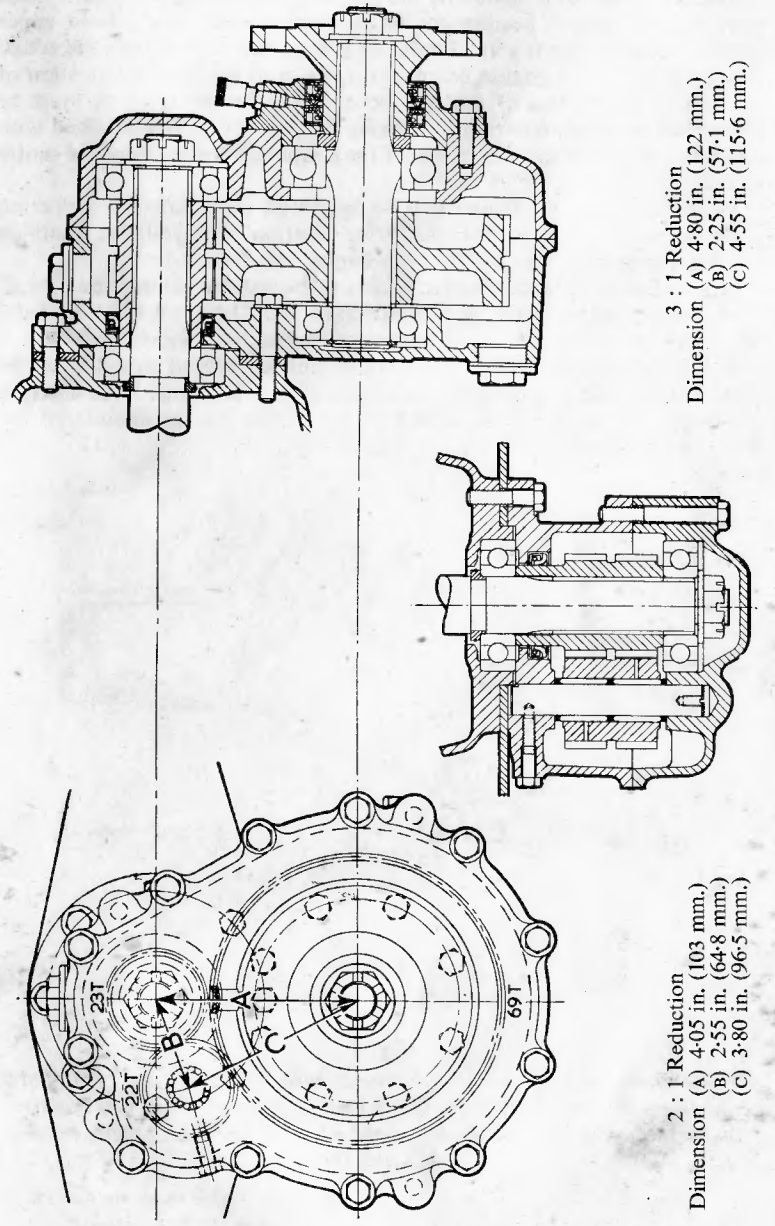
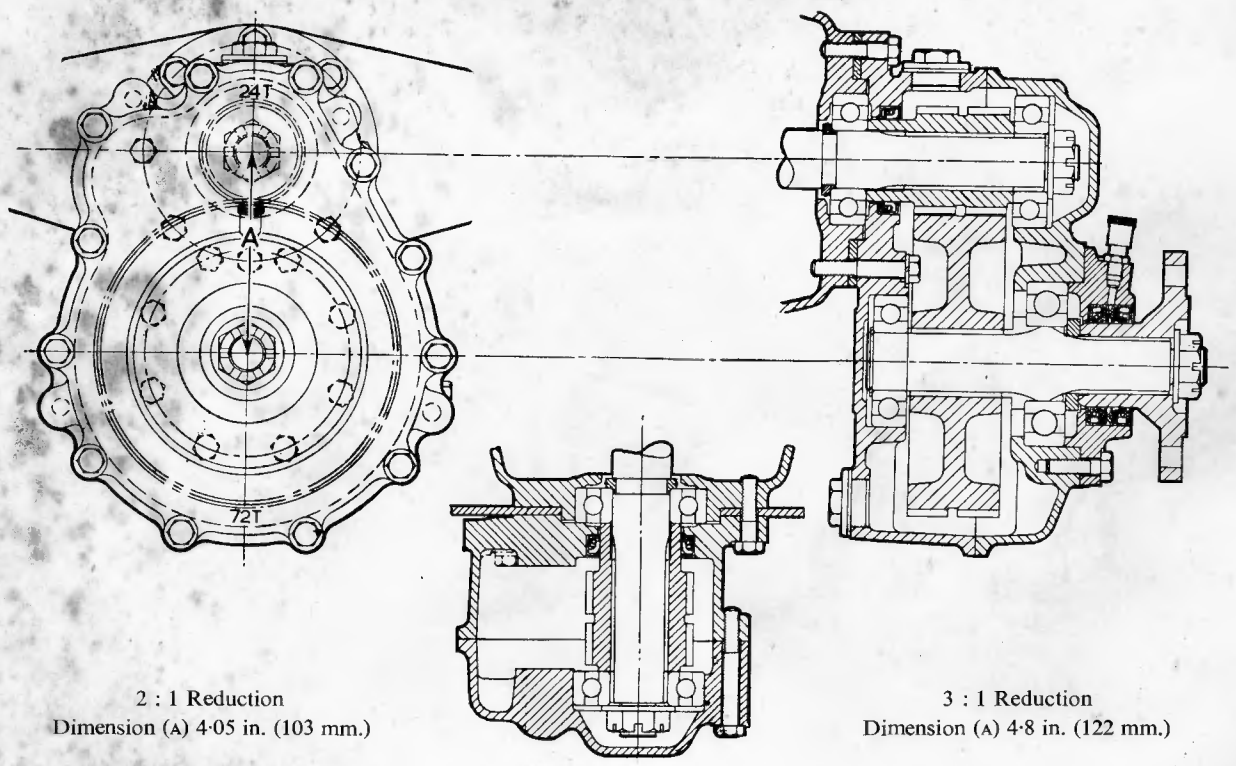


Fig. 4
Reduction gear (three-gear—left-hand rotation)



2 : 1 Reduction
Dimension (A) 4·05 in. (103 mm.)

3 : 1 Reduction
Dimension (A) 4·8 in. (122 mm.)

Fig. 3
Reduction gear (two-gear—right-hand rotation)

KEY TO RECOMMENDED LUBRICANTS

	A		B	C	D
Component	**Engine and Reverse Gearbox**		**(During Service) Reduction Gear and Fresh-water Pump**	**Sea- or River-water Pump, Stern Tube, Reduction Gear Coupling Flange, and Fresh-water Pump (Assembly)**	**Dynamo and Oilcan**
Climatic conditions	**Tropical and temperate—down to 32° F. (0° C.)**	**Cold and extreme cold—down to 0° F. (−18° C.)**	**All conditions**	**All conditions**	**All conditions**
DUCKHAM'S	Duckham's NOL Diesel Thirty	Duckham's NOL Diesel Twenty	Duckham's NOL E.P. 140	Duckham's L.B. 10 Grease	Duckham's NOL Diesel Twenty
ESSO	Essolube H.D. 30	Essolube H.D. 20	Esso Expee Compound 140	Esso Multipurpose Grease H	Essolube H.D. 20
BP ENERGOL	Energol Diesel D S.A.E. 30	Energol Diesel D S.A.E. 20W	Energol E.P. S.A.E. 140	Energrease L. 3	Energol Diesel D S.A.E. 20W
SHELL	Shell Rotella 30	Shell Rotella 20/20W	Shell Spirax 140 E.P.	Shell Retinax A	Shell Rotella 20/20W
MOBIL	Delvac Oil 930	Delvac Oil 920	Mobilube G.X. 140	Mobilgrease M.P.	Delvac Oil 920
CASTROL	Castrol C.R. 30	Castrol C.R. 20	Castrol Hi-Press	Castrolease L.M.	Castrol C.R. 20
FILTRATE	Filtrate Diesel 30	Filtrate Diesel 20	E.P. Filtrate Gear 140	Super Lithium Filtrate Grease	Filtrate Diesel 20
STERNOL	Auto Deso H.D. 30	Auto Deso H.D. 20	Ambroleum E.P. 140	Ambroline L.H.T.	Auto Deso H.D. 20

SERVICE PARTS

Service Parts or technical advice should be obtained from your B.M.C. Marine Engine Dealer or from

MORRIS MOTORS LIMITED

MARINE ENGINE DIVISION

P.O. BOX 20, COVENTRY, ENGLAND

Telephone: Coventry 88051

Telegrams: Morengines, Coventry

When writing either to the Dealer or to

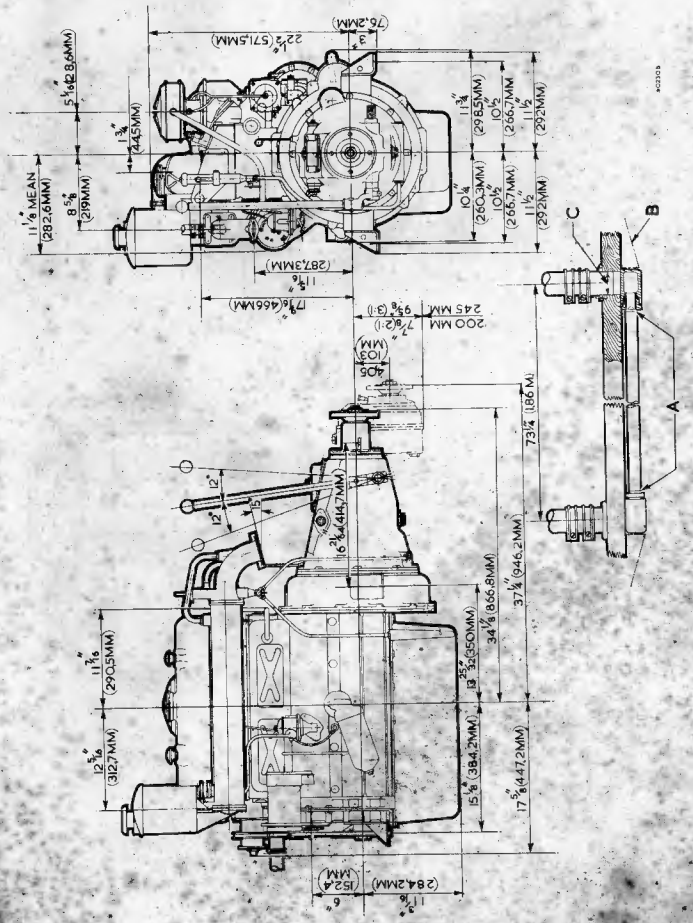
Morris Motors Limited

ALWAYS QUOTE THE ENGINE NUMBER

The engine number is stamped on two plates located on the starboard side of the engine. One plate is located on the cylinder block and the other on the flywheel housing.

It is essential that this number be given in order to avoid needless correspondence and to ensure prompt service.

Commodore D595



A. Painted bands for locating keel cooler pipe.
B. Fairing fitted by boat builder.
C. 1½ in. (34.93 mm.) outside diameter pipe.

Fig. 2

B.M.C. Commodore (with 'Keel Cooler') installation details

INSTALLATION

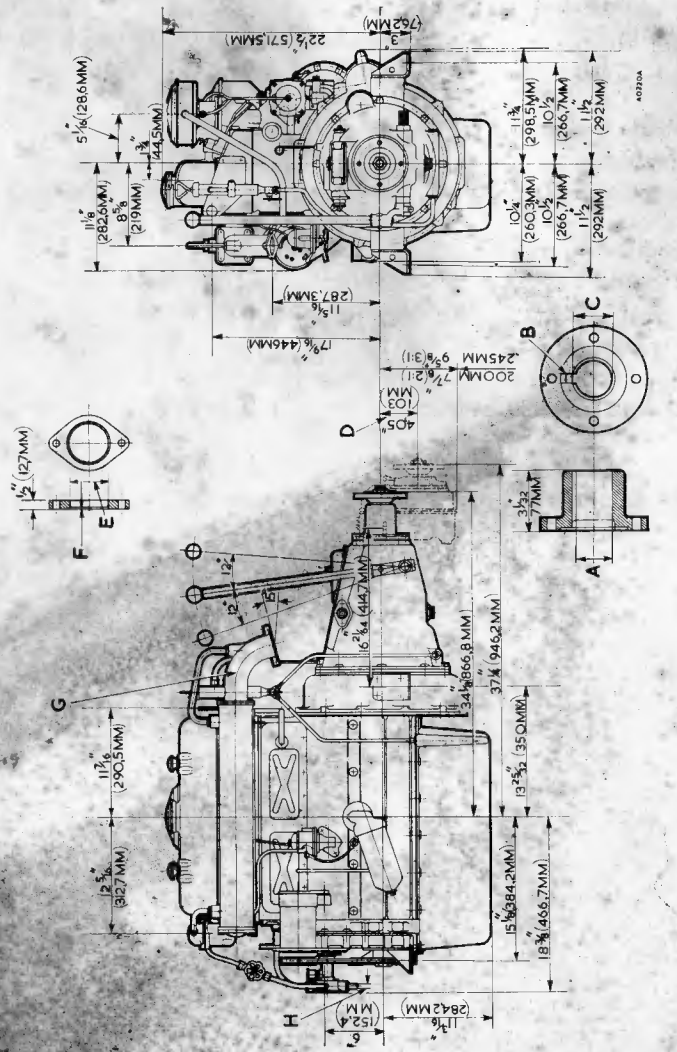


Fig. 1

B.M.C. Commodore (without 'Keel Cooler') installation details. The by-pass pipe must be fitted as near as possible to the sea cock and well below the water line

A. Coupling flange bore diameter
1⅛ in. —·002 in.
(38·1 mm. —·051 mm.
B. Coupling flange keyway
⅜ in. +·000 in.
(9·52 +·000 mm.)
C. Flange bore diameter plus keyway
1⅛ in. +·004 in.
—·000 in.
(42·86 mm. +·102 mm.
—·000 mm.)
D. 2 : 1 reduction gear centres as shown.
3 : 1 reduction gear centres—4·8 in.
(122 mm.).
E. Exhaust pipe flange, inside diameter, 2 in. (50·8 mm.).
F. Exhaust pipe flange chamfer, ⅛ in. (3·18 mm.) at 45°.
G. Exhaust outlet chamber may be fitted at 90° or upside-down at either end of the manifold.
H. Water inlet pipe, outside diameter, 1 in. (12·7 mm.) × 18 SWG.

B.M.C. MARINE ENGINE DEALERS

ENGLAND

BUCKINGHAMSHIRE .. J. G. Meakes Ltd., Bridge Works, **Marlow.**
Telephone: Marlow 4.

CAMBRIDGESHIRE .. H. C. Banham Ltd., Riverside Works, Cam Road, **Cambridge.**
Telephone: Cambridge 3093.

CORNWALL .. .. Taylor's Garage (Falmouth) Ltd., Town Quay, **Falmouth.**
Telephone: Falmouth 475.

DEVON .. .. .. Couch & Stoneman Ltd., South Embankment, **Dartmouth.**
Telephone: Dartmouth 418.
Barton Motor Co. Ltd., Hyde Park Corner, **Plymouth.**
Telephone: Plymouth 62126.

DORSET .. .. .. Parkgates Service Station Ltd., 1 Fernside Road, **Poole.**
Telephone: Parkstone 800; (Stores) Parkstone 2862.

ESSEX .. .. .. Crouch Engineering Co. Ltd., **Burnham-on-Crouch.**
Telephone: Burnham-on-Crouch 2130.
P. G. Page Ltd., Morris House, Crouch Street, **Colchester.**
Telephone: Colchester 2204.

GLOUCESTERSHIRE .. The Bristol Motor Co. Ltd., Ashton Gate, **Bristol 3.**
Telephone: Bristol 64013.
W. Shakespeare, Avon Boatyard, **Tewkesbury.**
Telephone: Tewkesbury 2194.

GUERNSEY, C.I. .. .. Ruette Braye Motors Ltd., Ville-au-Roi, **Guernsey.**
Telephone: Guernsey Central 2610.

HAMPSHIRE .. .. Wadhams Ltd., The Avenue, **Southampton.**
Telephone: Southampton 22991.
Wadhams Ltd., Goldsmith Avenue, Southsea, **Portsmouth.**
Telephone: Portsmouth 31231.
Wadhams Ltd., Northwood, **Cowes** (Isle of Wight).
Telephone: Cowes 1220.

ISLE OF MAN .. .. Athol Garage (1945) Ltd., **Douglas.**
Telephone: Douglas 254.

JERSEY, C.I. .. .. Cleveland Garages Ltd., **Havre-des-Pas.**
Telephone: Jersey Central 4460.

KENT .. .. .. Caffyns Ltd., New Dover Road, **Canterbury.**
Telephone: Canterbury 3288.

LANCASHIRE .. .. Loxhams Morriservices Ltd., Corporation Street, **Preston.**
Telephone: Preston 4247.

B.M.C. MARINE ENGINE DEALERS

LONDON	Stewart & Ardern Ltd., Morris House, The Vale, **Acton,** London W.3. *Telephone:* Shepherds Bush 3130. University Marine Ltd., 7 Hertford Street, **London W.1.** *Telephone:* Grosvenor 4141.
NORFOLK	Herbert Woods Ltd., 'Broads-Haven', **Potter Heigham,** Nr. Great Yarmouth. *Telephone:* Potter Heigham 265.
NORTHUMBERLAND	Chas. G. S. Buist Ltd., St. Mary's Place, **Newcastle upon Tyne 1.** *Telephone:* Newcastle-upon-Tyne 28486.
NOTTINGHAMSHIRE	T. Shipside Ltd., Lower Parliament Street, **Nottingham.** *Telephone:* Nottingham 46771.
SUFFOLK	Lock & Stagg Ltd., Friars Road, **Ipswich.** *Telephone:* Ipswich 53155.
SURREY	Boats and Engines, Marine Works, Thameside, **Kingston-on-Thames.** *Telephone:* Kingston 2052.
SUSSEX	Bailey & Noyce, Marine Works, **Itchenor,** Nr. Chichester. *Telephone:* Birdham 374. William Osborne Ltd., Arun Shipyard, **Littlehampton.** *Telephone:* Littlehampton 96.
WARWICKSHIRE	Birmingham Garages Ltd., Navigation Street, **Birmingham 5.** *Telephone:* Birmingham Midland 1023.
YORKSHIRE	The Paragon (Hull) Motor Co. Ltd., Boothferry Road, **Hull.** *Telephone:* Hull 53155.

IRELAND

IRELAND (Northern)	The Shipyard Co. Ltd., **Bangor,** Nr. Belfast. *Telephone:* Bangor 374 and 805.

SCOTLAND

SCOTLAND	A. & D. Fraser Ltd., 65 Bothwell Street, **Glasgow C.2.** *Telephone:* Glasgow Central 9955.
ORKNEY AND SHETLAND	J. & W. Tait Ltd., **Kirkwall,** Orkney. *Telephone:* Kirkwall 635.

WALES

GLAMORGANSHIRE	C. K. Andrews Ltd., Uplands Garage, **Swansea.** *Telephone:* Swansea 57981.
MERIONETHSHIRE	D. E. Davies Ltd., Green Garage, **Barmouth.** *Telephone:* Barmouth 4.
PEMBROKESHIRE	Vic Morris, St. Bride's Garage, **Saundersfoot.** *Telephone:* Saundersfoot 83.

GENERAL SPECIFICATION

Camshaft bearing clearance:	
No. 1 (bush)	·0015 to ·004 in. (·038 to ·102 mm.)
Nos. 2, 3, 4, and 5	·00275 to ·00475 in. (·0698 to ·1206 mm.)
Static injection timing	28° B.T.D.C.
Injection pressure	175±5 atmospheres
Reduction gear ratio (optional)	2 : 1 and 3 : 1. Left- or right-hand rotation
Oil capacities:	
Sump and filter	20 Imp. pints (11·4 litres)
Reverse gear	4 Imp. pints (2·27 litres)
Reduction gear (2 : 1 ratio)	1 Imp. pint (·57 litre)
Reduction gear (3 : 1 ratio)	1½ Imp. pints (·85 litre)
Maximum variation of engine from horizontal with craft under way	10°
Running temperature	70° C. (158° F.)

Cooling by vane-type pump with water-cooled manifold

GENERAL SPECIFICATION

B.M.C. COMMODORE 3·4-LITRE DIESEL ENGINE

Bore	3·740 in. (95 mm.)
Stroke	4·724 in. (120 mm.)
Number of cylinders	4
Capacity	207·5 cu. in. (3402 c.c.)
Compression ratio	16·5 : 1
Firing order	1, 3, 4, 2
Maximum b.h.p.	52 at 2,400 r.p.m.
Recommended economical maximum b.h.p. for continuous cruising (12-hour rating)	40·5 at 1,600 r.p.m.
Oil pressure relief valve operates	55 lb./sq. in. (3·9 kg./cm.²)
Oil pressure:	
At idling speed	10 to 15 lb./sq. in. (·7 to 1·05 kg./cm.²)
At normal running speed	35 to 40 lb./sq. in. (2·46 to 2·81 kg./cm.²)
Thickness of cylinder liner shims	·003 and ·005 in. (·076 and ·127 mm.)
Crankpin diameter (standard)	2·4360 to 2·4365 in. (61·874 to 61·887 mm.)
Number of main bearings and type	5 shimless, steel-backed, sintered copper and lead lined
Main journal diameter (standard)	3·061 to 3·0615 in. (77·749 to 77·762 mm.)
Camshaft drive (type)	Chain, triple roller
Camshaft chain pitch	$\frac{3}{8}$ in. (9·525 mm.)
Camshaft chain, number of links	112
Valve timing marks	'O' marks on camshaft, crankshaft, and injection pump chain wheels. Bright links in chain. Pointer under cover on flywheel housing and groove in flywheel
Valve seat angle	45°
Inlet valve opens	5° B.T.D.C.
Inlet valve closes	40° A.B.D.C.
Exhaust valve opens	45° B.B.D.C.
Exhaust valve closes	5° A.T.D.C.
Valve rocker clearance	·013 in. (·33 mm.) hot or cold
Valve guides	Renewable
Valve to guide clearance	·002 to ·003 in. (·051 to ·076 mm.)

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FOREWORD

IN presenting the B.M.C. Commodore Marine Engine the British Motor Corporation take the opportunity of drawing attention to the fact that this engine is not merely an automobile engine slightly modified for nautical use, but a specially designed and constructed power unit which has embodied in it all the requirements of a high-class marine engine, and will prove to be of outstanding efficiency and reliability.

It must not be thought from this that there is anything fundamentally different between automobile engines and marine engines. On the contrary, their basic principles remain the same, and experience gained in handling an automobile engine will stand one in good stead when handling its marine counterpart.

The important differences occurring between the two types of power unit are occasioned by the difference in working conditions and requirements, which make the reconsideration of details such as cooling, lubrication, transmission, materials of construction, etc., imperative if lasting service, reliability, and satisfaction are to be ensured.

Naturally the installation of marine engines varies within wide limits according to the design of the boat to which they are fitted, and it is not possible in the pages of a concise publication of this nature to deal with every variation of installation.

The instructions contained within are mainly concerned with the correct operation and maintenance of the engine and its accessories. An effort has been made to present all information and instructions in an order to which they would normally be approached, both for the owner who desires only to know what is absolutely necessary to ensure trouble-free and satisfactory running, and also for the owner who desires more complete information concerning the mechanism and maintenance of the engine.

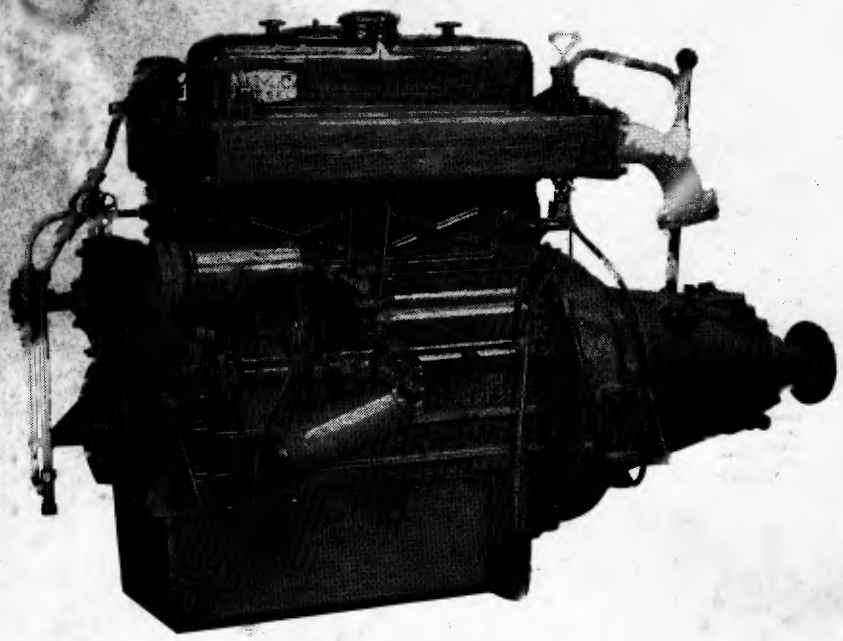
If you encounter trouble get in touch with your nearest B.M.C. Marine Engine Dealer or write to the Company, and always quote the engine number (see page 90).

Note that all correspondence concerning exported engines must be addressed to Nuffield Exports Ltd.

An exchange scheme for many major items and assemblies is run by Morris Motors Ltd., Marine Engine Division, Coventry; ask a Dealer for details.

CLAIMS UNDER WARRANTY

Claims for the replacement of material or parts under Warranty must always be submitted to the supplying Dealer, or when this is not possible to the nearest Dealer, informing him of the Vendor's name and address.



THE B.M.C. COMMODORE MARINE ENGINE (3·4-LITRE DIESEL)

B.M.C.
COMMODORE
MARINE ENGINE
OPERATOR'S HANDBOOK

SECOND EDITION

A copy of this Operator's Handbook is sent out with every B.M.C. Commodore Marine Engine. Additional copies are obtainable only from a B.M.C. Marine Dealer and Part No. AKD794A should be quoted when ordering

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