Service Agents and Recommended Repairers in the United Kingdom and also from our Overseas Agents and Representatives in various parts of the world. A list of these is contained in Instruction Book No. 56·6 or later issue.

21. **Timing of Valves and Fuel Injection.**—With the exception of the **Fuel Injection Timing,** the valve timing diagram on page 56 of LW Instruction Book No. 56·6 is correct for all marine engines.
The correct timing of Fuel Injection at maximum speed for all LW marine engines is given in the following table:—

For Engines set to Maximum Speed of:	All Engines Bearing Serial Nos. up to and including 83848	All Engines Bearing Serial Nos. after 83848
1,200 r.p.m.	26° 24′ before T.D.C.	25° 24′ before T.D.C.
1,300 r.p.m.	—	25° 48′ ,, ,,
1,500 r.p.m.	27° 48′ before T.D.C.	26° 48′ ,, ,,
1,700 r.p.m.	29° ,, ,,	28° ,, ,,

If there is any doubt as regards the timing of fuel injection it is always advisable to refer to the figures stamped on the Injection Control Plate. Please also refer to paragraph 104 of Instruction Book No. 56·6 for further details.

22. **Hand and Rotation of Engines.**—We can offer Handed Rotation LW Marine Propulsion Engines to all clients who may require a twin set of 4LW, 5LW or 6LW engines with rotation to suit left hand and right hand propellers.
In a single screw installation, the LW marine engine crankshaft rotates in an **anti-clockwise** direction when viewed from the flywheel end and, if specially ordered, the 4LW to 6LW marine engines can be supplied for twin screw installations with the twin engine having a **clockwise crankshaft** rotation when viewed from the flywheel end.
The external form of LW marine engines with Handed Rotation has not changed in any way, both engines appearing identical, and an example of such engines is shown on pages 4 and 6 of this book. It will be observed that these engines, as supplied to the Royal National Life-Boat Institution, are fitted with reducing gears and the propellers will, of course, therefore revolve in the opposite direction to the crankshaft.
It should be mentioned in passing that the special nature of the component parts required to embody non-standard rotation compels us to increase the cost of any engines so arranged. Prices in this respect may be readily obtained from our Head Office and Branch Offices.

23. **Lubricating Oil Coolers.**—All Gardner marine engines are fitted with means to cool the lubricating oil. With heat exchanger or keel cooler systems, the oil is passed through an indented cupro-nickel tube encased in a gun-metal jacket through which the cooling water passes. Thus heat passes from the oil into the water so controlling oil temperature to a figure not exceeding 155° F. approx.
In the oil cooler jacket is fitted a ferrous wasting strip, consisting of a full length longitudinal ribbon of sheet steel, the function of which is to provide corrosion protection for the non-ferrous components.
In time, dependent on the varying water quality, the ferrous wasting strip will corrode away and it is recommended that renewal be effected every twelve months or at more frequent intervals under adverse conditions.
When the oil cooler is dismantled for inspection, the water jacket and indented oil cooler pipe should be thoroughly cleaned of any silt and scale which has accumulated, in order to ensure maximum conduction of heat from the oil. It will be noted that one end of the indented tube is brazed into a circular flange plate whilst at the other end, the water joint is made by a rubber ring to permit endwise movement created by expansion.
The oil flow through the cooler is provided by one of the following arrangements:—

All 2LW and 3LW engines — The engine pressure pump draws its oil from the sump and delivers via the oil cooler to the engine system.

4LW, 5LW and 6LW engines with ram type water pumps	Oil circulated as described above but with the addition of a spring-loaded relief valve to by-pass oil around the cooler at low temperature when, due to higher oil viscosity, cooler resistance is high.
4LW, 5LW and 6LW engines with centrifugal type water pumps	A second oil pump is fitted to the fuel pump cam box. This pump draws oil from and returns via the oil cooler direct to the sump. A valve is incorporated in this oil pump cover thus allowing oil to re-circulate in the pump when cooler resistance is high as mentioned above.

24. **Cooling of Lubricating Oil.**—On engines equipped with a heat exchanger for water cooling, the raw water is piped through the engine oil cooler before reaching the heat exchanger.
In a keel cooler system, however, a small auxiliary engine-mounted pump or separate inboard mounted belt-driven pump, provides a circulation of raw water through the engine oil cooler.
Where the engine water is cooled by means of a radiator and engine-driven fan, the oil is cooled by passing it from the oil cooler pump through a small auxiliary radiator, mounted in front of the main radiator and returning it to the engine sump.

25. **Interlocking Speed and Reversing Control.**—A manual speed control is mounted on all marine engine units and consists of a permanently loaded cork-lined friction disc which will remain in any selected speed position.
This control can be connected to one or more control stations and does not require any additional locking device. The speed control can thus be effected from either the engine room or from a remote station such as the bridge or wheel house.
To prevent engagement of the Reverse Gear Ahead and Astern clutches at high engine speed, the engine speed and reverse gear controls are suitably interconnected. This allows maximum engine revolutions only when the reverse gear lever is in the position Ahead or Astern and the return of the gear lever to Neutral position automatically reduces the engine speed.
The idling speed adjusting screw is fitted to the Speed Control Plate and the interlocking speed control is so arranged that, when changing from Ahead to Astern or vice versa, the engine speed is automatically reduced to 770 r.p.m. when the gear lever is returned to the Neutral position.
In the event of the adjustment between the Speed Control Interconnection Forked Eye and Interconnecting Link being disturbed it must be re-set so that the speed in the Neutral position is limited to 770 r.p.m. There is, however, no reason to interfere with this setting which is interconnected with other intimate engine speed adjustments. Where necessary, certain adjustments are permanently set and suitably sealed before the engine is passed off test.

26. **Hydraulic Remote Control System for Engine Speed.**—This equipment can be fitted to new engines or to existing engines already in service and installation drawings will be supplied upon request. Very little servicing is necessary as there are practically no working parts which are subject to wear.
The speed control arrangement comprises a hand-lever-operated master hydraulic unit connected by copper piping to a "slave" unit bolted to a support bracket mounted on the reverse gear casing. The "slave" unit is connected by rod and lever to the standard friction disc speed control. Any movement of the hand-lever is therefore instantaneously transmitted to the "slave" unit which is connected to the engine speed control.
The hydraulic system must be initially primed by a priming unit consisting of a small hand-operated plunger type pump complete with hydraulic fluid tank of one gallon capacity. No further attention is required after the initial priming unless, of course, the piping, etc. has been dismantled for any reason.
It is not anticipated that it will be necessary for the priming pump, etc., to be supplied with each set of speed control equipment. If a number of vessels belonging to one owner are operating from one port, it would only be necessary to utilise one priming pump and the question of the number of priming units required in other cases would have to be considered on their merits. We shall be glad to advise in this matter whenever necessary.
Installation details and the general arrangement of this system are shown in Drawing No. 14015 on page 29.

27. **"Teleflex" Remote Speed Control.** This control system may be supplied with a new engine or for installation on an existing marine unit. When installing this remote control system the following instructions should be carefully observed to ensure smooth, light and positive control of engine speed. Installation details are shown in Drawing No. 13540 on page 30.

Installation.—At the operating end secure the swivel assembly to the board in the position shown on drawing. Similarly, at the engine end, the swivel body should be secured to a bracket bolted on the reverse gear casing.

Two fork assemblies are provided. Each fork body should be unscrewed from its tube and plug, and inside the fork bodies will be found a lock spring; these should be removed from the bodies and retained. The outer slide tubes of these fork assemblies should then be pushed on to the slide tubes of the swivel assemblies.

Having secured the end fittings, the run of conduit can now be arranged. This should be as direct as possible with the minimum number of bends, and no bend should exceed 90°. If the run requires a bend, it is preferable that the main length of conduit is straight, with the bend at the ends, rather than have a continuous curve all the way.

Before using any conduit a length of cable should be pushed through to verify that the conduit has not been dented or distorted.

It is preferable to pre-set the conduit wherever bends are involved to avoid straining the ends when connecting them together. Always make a bend by using the circular former supplied. A length of cable inserted in the conduit when making the bend, will act as a flexible mandrel and maintain the bore of the conduit during this operation. The ends of the conduit should be faced off square before bellmouthing. When installed, the conduit should be secured by the clips provided, and these should be fitted about 3 ft. apart.

Assembly of the conduit can be commenced from either end. Unscrew the nipple from the swivel and slide it over the end of the first length of conduit. This end should then be bellmouthed with the special drift provided. Inserting the end in the swivel body, screw home the nipple and the joint is made.

If the length of run exceeds 10 ft. a connector will be necessary for each additional length, and the same procedure applies for connectors as for the swivels. Proceed until the whole run is installed.

Having completed the run, the cable should be pushed through the conduit from one end until about 2 in. is projecting beyond the plug and slide tube at the remote end. Proceed at this end by screwing the lock spring anti-clockwise on to the end of the cable until there are two helices of the cable visible beyond the end of the lock spring. Push the cable and lock spring into the fork body and screw the plug and outer slide tube in tightly. The end of the cable is now positively locked within the fork body.

Remove the pin and split pin from the fork and connect the fork to the remote lever. Set this lever to its extreme travel, either full open or shut and at the other end set the friction disc lever in the **same relative position** as the remote lever. With the levers so positioned, fit the fork body to the friction disc lever. The cable must now be cut to length so that, when the lock spring is screwed on the cable and the body of the fork is screwed to its slide tube, any movement of one lever will operate the other without backlash.

It might be noted that if the cable has been cut too long, all that need be done is to screw the lock spring further along the cable and cut off a corresponding length from the end. The cable however, cannot be lengthened after cutting, as it is essential that two turns of the cable helix must protrude beyond the end of the lock spring.

Teleflex cables can be easily cut with a fine hacksaw and the ends will not unravel. It is preferable to grind the end of the cable to a conical point to assist in screwing on the lock spring.

When the cable is inserted in the conduit, it should be liberally greased with an anti-freeze grease.

Check after assembly, to ensure that the run is free, that the two levers synchronise throughout their range of movement, and that there is no backlash. Finally, go over each connection and see that all nipples, etc. are tight.

28. **Hydraulic Remote Control System for Reversing Gear: Installation.**—The following installation instructions should be read in conjunction with Drawing No. 12553 on page 28.