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# Marine Oil Burning.

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*Fuel oil as usually obtained for bunkers is the residue remaining from the original crude after the more valuable lighter oils have been extracted. Residues have a high calorific value, generally about 18,000 B.T.U.'s per lb. and are an ideal fuel for boilers. They may be heavy and viscous but providing they are dealt with in a proper manner and suitably prepared for burning, no difficulties should be experienced in obtaining excellent results and high boiler efficiencies. When dealing with heavy fuel oils, particularly with mechanical atomising burners, the viscosity is of considerable importance. It should be sufficiently reduced for pumping and the fluidity should be such that fine atomisation is obtainable. Satisfactory conditions will only be secured if suitable pressures and temperatures are used, for which auxiliary equipment of the most modern type should be installed. Oil burning equipment generally is dealt with in the first part of the paper, as no doubt there are some engineers who have not had extensive experience with oil. The latter part of the paper will probably be of greater interest, as it describes the principle and operation of wide range burners, which surprisingly have not been adopted very extensively at sea.*

## Tanks.

One of the greatest advantages of oil is the adaptability for storage in tanks remote from the boiler room or in the double bottoms. With low sea temperatures it is necessary to heat the oil sufficiently to allow transfer to the service tanks. Steam heating coils or grids serve this purpose but they have two disadvantages. Firstly, a faulty joint in the steam heating line may allow oil to find its way back to the hot-well and thence to the boilers with probably disastrous consequences. If other methods can be adopted, steam joints should be excluded from oil spaces. The danger of feed-water contamination cannot be over estimated. Secondly, in trades carrying special commodities it is important that the tank tops should not be overheated, otherwise damage to the cargo may result. Steam grids heat the whole of the tank and the highest temperature is at the top, not where it is required, namely at the suction.

A more satisfactory method is to use a low-pressure heating system employing separate heaters and pumps and with heating compartments fitted in each tank. Hot oil is pumped to the tank where it is diffused over a large area at the bottom of the tank. The contents are heated in this manner to something above the setting point only when necessary, thereby ensuring a flow to the heating compartment where the temperature is raised to reduce the viscosity sufficiently for a free flow to the pump suction.

There are no steam connections in contact with the oil and only that amount which is required at the time is heated, *i.e.* the contents of the heating compartment.

In this way the potential danger of feed-water contamination and the possibility of damage to cargo due to overheating the hold is entirely eliminated.

The service tanks should be of sufficient capacity for at least an eight-hour supply. This period allows any water which may be carried through with the oil from the double-bottom tanks to settle out, although it is necessary to heat the oil to assist separation. For this purpose a continuous length of tubing having welded joints and fitted in the bottom of the tank in the form of a steam heating grid is satisfactory. Any water accumulating in the bottom of the tank may be drawn off and passed through the oil separator for further purification before it is discharged overboard. In cases of emergency it may be necessary to close the duplicate suction valves on the service tanks instantly and for this purpose a quick-closing spring-loaded gate valve is probably the most suitable type. It may be closed from any reasonable distance by means of a steel wire rope attached to the specially-constructed bridge pillars. The action is instantaneous and the wire rope is easier and more reliable in operation than extension spindles with bevel gearing or universal joints.

## Suction Strainers.

Any large particles of foreign matter entrained with the oil should not be allowed to pass through to the pumps and heaters where working parts may become damaged or the heater tubes plugged.

Probably the most satisfactory strainer for suction work is the duplex type fitted with twin baskets of perforated sheet steel. It can be easily examined and quickly cleaned when necessary. The perforations of the baskets should not be too small to offer any appreciable restriction to the flow of oil to the pumps. Holes about $\frac{3}{32}$in. dia. are satisfactory for this purpose.

A pressure gauge of the compound type fitted at the strainer outlet is an important fitting. The reading shown gives an indication of the condition of the strainer basket, *i.e.* if a vacuum reading is shown on the gauge it is most likely due to the basket having become plugged and requiring cleaning.

## Pumps.

There are many different makes and types of pumps suitable for oil burners, both steam- and electrically-driven. In the case of steam-driven pumps the vertical simplex is probably the most suitable for the purpose. This type is usually made with a longer stroke than the duplex pattern which gives it better suction qualities. The valves are of larger diameter and consequently offer less restriction to the flow of viscous oils.

It takes up a minimum of space and all working parts are accessible. Where steady conditions are required a pressure regulator fitted between the steam valve and the valve chest will take care of any slight variations in the steam pressure and will maintain a constant discharge pressure.

This fitting, however, is not required with straight mechanical atomising burners because the output of the burners is regulated by means of the pump steam valve. It is, however, a desirable fitting for the pump if working in conjunction with the modern oil burner of the wide range type.

The oil end of the pump should be of all iron or steel construction and it is important that any parts in contact with the oil should not be made of brass or gun-metal as the sulphur content of the oil has a damaging effect on these materials. They should, therefore, on no account be used.

A spring-loaded relief valve which is normally fitted to these pumps takes care of any high pressure which may develop. The delivery in excess of the working pressure automatically lifts the valve and allows the oil to return through the by-pass to the pump suction.

Working at a normal speed of 16/18 double strokes per minute, the discharge fluctuation should not exceed one per cent. of the working pressure provided an air vessel of adequate volume is installed in the hot oil discharge line. The air vessels normally fitted by pump manufacturers are seldom large enough for the purpose. A snifting valve is a standard fitting on the suction side of the pump valve chest, and is provided for recharging the air vessel. This operation takes only a matter of

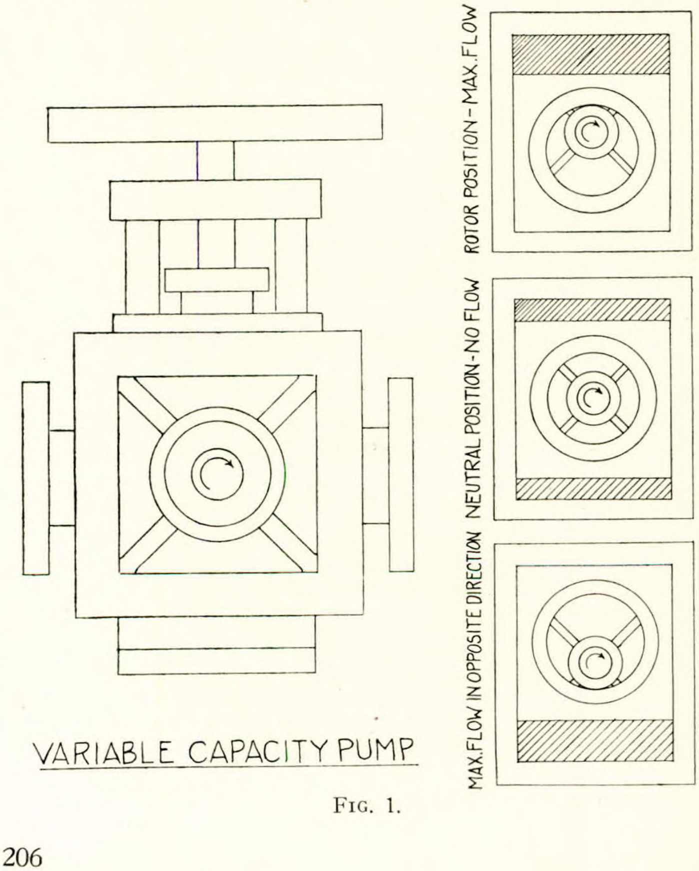
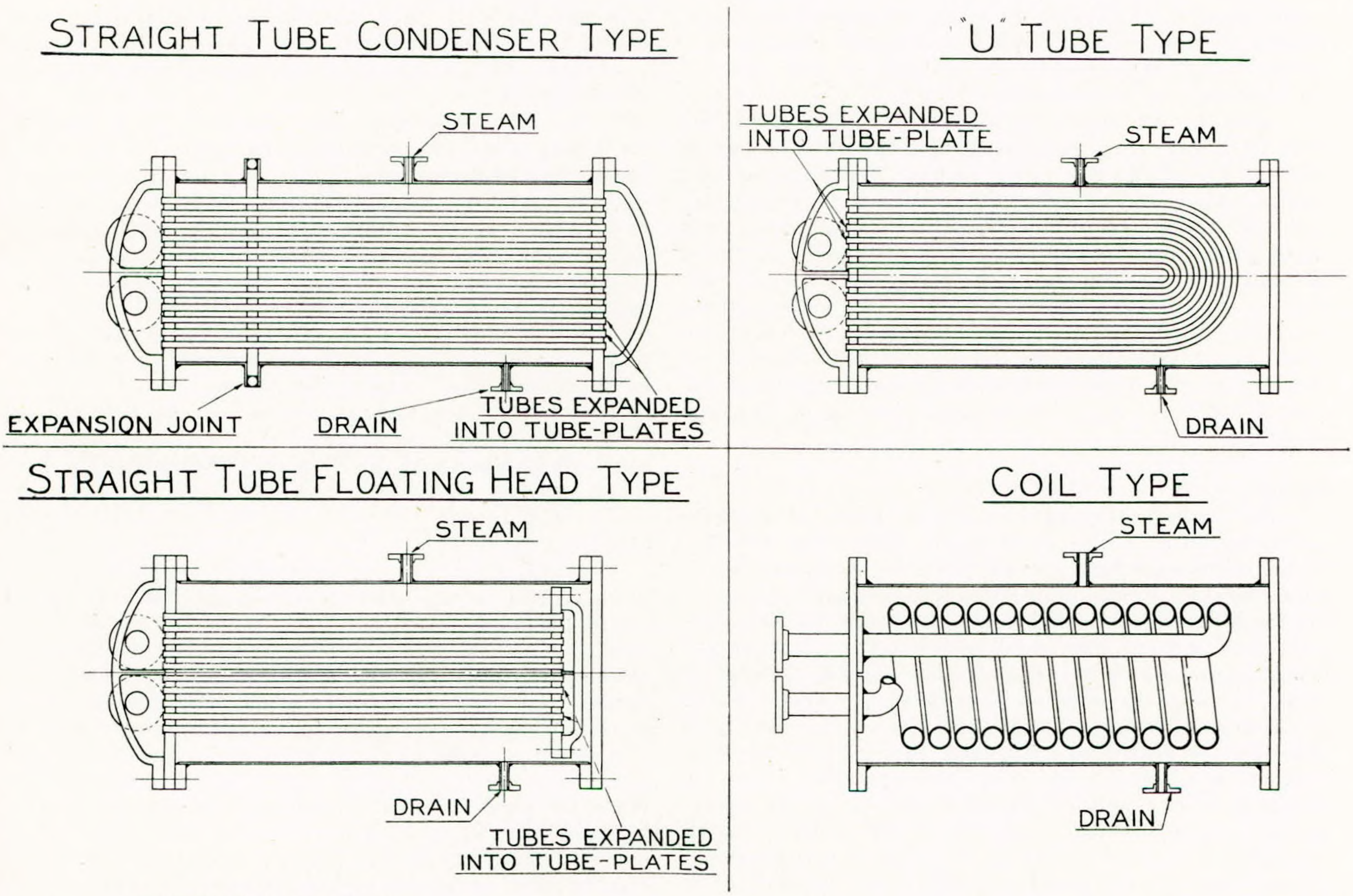



Fig. 1.



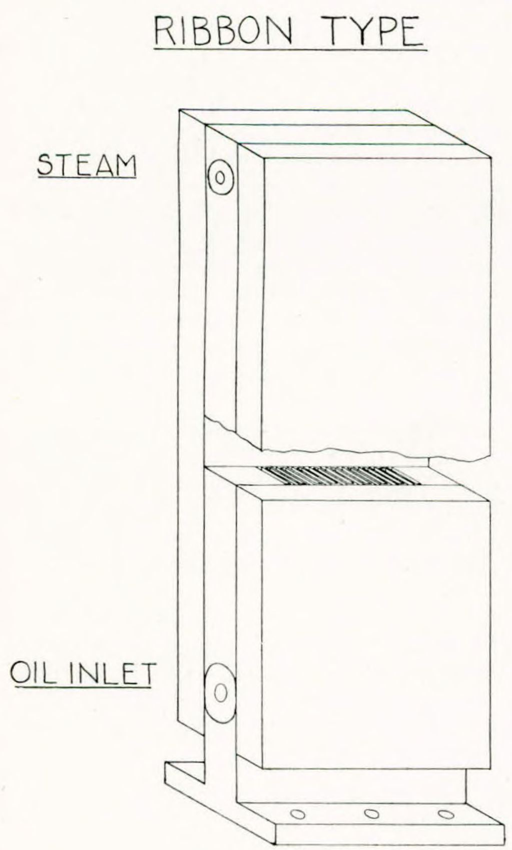




Fig. 2.—*Oil fuel heaters.*

a few minutes and is accomplished by checking the oil suction valve sufficiently to allow the snifting valve to lift automatically, thereby allowing a charge of air to pass through the system to the air vessel. A definite rule for the periods when the air vessel should be recharged is difficult to establish because the rate of air absorption depends upon the characteristics of the oil, its pressure and temperature, but with a fair-sized air vessel it should not be necessary to recharge more than once every 100 hours.

For this purpose no connections are necessary on the air vessel. It should be of welded construction and completely sealed against any possible leaks. In some cases a gauge glass is fitted which shows the amount of oil contained in the air vessel, but this fitting is quite unnecessary because the oil pressure gauge indicates directly it becomes necessary to recharge. With a hand-operated air pump, unless of large capacity, a man would probably take several hours to recharge; if compressed air is used, and this is seldom available at sea, there is always the danger of the oil finding its way back to the compressor. The snifting valve alone should be used as it has been proved the most satisfactory method of carrying out this operation efficiently.

With electrically-driven rotary pumps a relatively steady pressure is delivered and therefore an air vessel is not essential. Unless fitted with a variable-speed motor, pumps of the positive displacement types must have a spring-loaded relief valve and by-pass to take care of the various load requirements.

This is not altogether a satisfactory method, because with light loads the greater portion of the oil is by-passed through the relief valve to the suction. Variable-capacity pumps which can be regulated by hand are more satisfactory. In one pump of this type, which is of very novel design, the output is regulated by adjusting the eccentric disposition of the centres of the pump body and driving shaft. When the rotor is concentric with the driving shaft no pumping action takes place; therefore an infinitely variable capacity from zero to maximum is obtained in either direction without reversing the direction of rotation. Fig. 1 shows an illustration of this type of pump.

## Heaters.

For good atomisation when using mechanical atomising burners it is necessary to reduce the viscosity of the oil to something around 144 secs. Redwood No. 1, which has been found to be suitable at ordinary pressures. Of the different types of heaters obtainable for this purpose most perform their work satisfactorily, although the design of some may not be altogether suitable for marine work. One of the finest is the ribbon type heater which is fabricated from a solid steel block. Grooves and channels are milled on each face, thereby forming in a manner a plate having deep corrugations; steam is admitted to one side of the plate and oil to the other. In this way there is no possibility of the oil mixing with the steam or vice-versa and the flat surfaces of the milled grooves can be very easily and effectively cleaned. The heater stands vertically, takes up very little floor space and is of extremely simple and robust construction.

Coil or U-tube heaters work very well but are difficult to clean properly, and unless the inner tube surfaces are maintained free from carbon, economical results cannot be obtained.

The straight-tube floating-head type is constructed with the oil header having a flanged joint in the steam space, which, as already mentioned is not desirable. An oil leak in the heater shell would probably have serious results before being discovered. For good heat transfer and inexpensive construction the most suitable is probably the straight-tube heater of the condenser type, fabricated throughout of steel and having the tube-plates welded to the shell. Fig. 2 shows the various types referred to. A water collector is not a necessary fitting to the heater drain as the condensate can be more effectively and economically controlled by means of a steam trap. The temperature of the oil to give the predetermined viscosity is regulated by means of the steam valve. A reliable thermostatic control however will maintain a constant temperature within a few degrees and although it is not an essential fitting it is well worth the slight extra cost involved. Steadier conditions are maintained and steam is used more economically.

To guard against any possible oil leak in the steam space which would pass through with the condensate into the hot-well an observation separator drain tank allows the heater discharge to be visually examined and minimizes the possibility of the boiler feed becoming contaminated.

The reading of the steam pressure gauge fitted to the heater gives an approximate indication of the condition of the tube surfaces. For example, if it becomes necessary after a while to run at a higher steam pressure to give the original temperature with the same grade of oil, it means that the tubes have probably developed a coating of carbon on the inner surfaces which has an immediate effect upon the rate of heat transfer.

To facilitate cleaning at any time, the heaters should be installed in such a manner that there is little difficulty in dismantling for cleaning the tubes.

With the straight-tube condenser type referred to, it is only necessary to remove the end covers when the tubes are exposed and can be readily cleaned with a wire brush attached to a rod.

## Discharge Strainers.

Strainers of the self-cleaning type are a great improvement on the perforated basket type for hot oil discharge purposes as they may remain in use for considerable periods without inspection or dismantling for cleaning purposes. A single turn of the straining pack removes any carbon deposits which may adhere to the plates and after prolonged periods of running it may be cleaned at a convenient time by removing the access door from the body, after which the strainer is then ready for further service. Although not standard on all strainers of this type, a very useful fitting is a blow through valve fitted to the base of the strainer body which may be used to remove any collection of carbon instead of isolating the strainer completely and cleaning by means of the access door.

## Installation of Equipment.

In many cases the whole of the auxiliary equipment, *i.e.* pumps, heaters and strainers, is mounted as a combined unit on a bedplate. All the parts are together. The unit is usually very neat and compact and does not take up a lot of space, but if any part of the equipment requires immediate attention the compactness of the outfit in many cases makes the parts difficult to dismantle and not very convenient to attend to; therefore, from the point of view of accessibility, the equipment should be erected in such a manner that adjustments may be carried out with the minimum of difficulty. Sufficient space should also be allowed around the pumps to enable an engineer to attend to valve gear adjustments, or any gland leaks which may develop. It is important that the auxiliary oil-burning equipment should be maintained in a clean condition, leaks, whether steam or oil from flange joints or glands, should have immediate attention.

## Draught.

While natural draught is suitable for ordinary purposes, the high boiler capacities which may be developed with oil require positive draught. Air at the required pressure may be supplied to the burners in any one of the

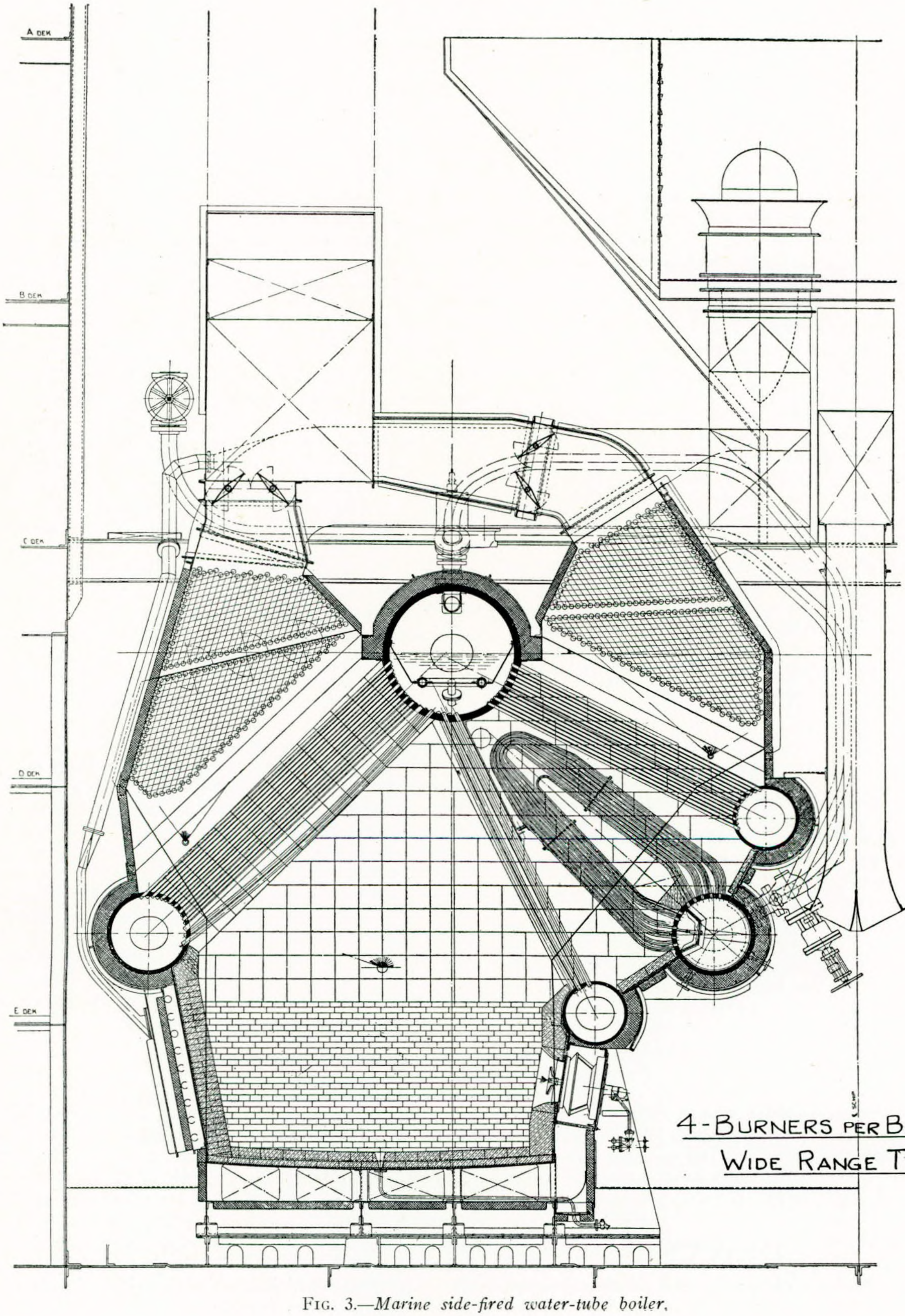



FIG. 3.—*Marine side-fired water-tube boiler.*

following manners :—

(*a*) An induced-draught fan in the uptake or base of the stack.

(*b*) Forced-draught fans discharging into a closed stokehold.

(*c*) Forced-draught fans discharging through ducting or directly into the burner windbox.

With induced-draught fans, high heat liberations require a high combustion chamber suction and there is therefore a tendency for air infiltration through the brickwork setting of the furnace. The air required for combustion must pass through the burners where it is directed into the oil spray in the proper manner. Air admission elsewhere serves no useful purpose and is an unnecessary excess quantity. Excess air, unless maintained at a minimum, lowers the furnace temperature and on account of the resulting greater volume the gases of combustion pass through the boiler at a higher velocity. High exit and superheat temperatures are developed and less heat is utilized in the furnace for steam generation.

An entirely closed stokehold with the necessary air-locks is not always a practical proposition, so that there is every indication that forced-draught fans should be employed, preferably mounted on the boiler and discharging directly into the air heater as shown in Fig. 3. The fan employed in this case is of the streamline propeller type. The runner has blades of aerofoil section and is mounted on the armature shaft in a streamline casing. After leaving the heater the air passes around the sides, back and floor of the combustion chamber to the burner wind-box. This system eliminates all ducting and forms a very compact self-contained boiler unit.

## Furnaces.

With the exception of the larger passenger vessels most marine boilers are of the Scotch or multitubular type. The furnaces of these boilers are usually termed "all black" because there is no radiant heat from brickwork as in the case of water-tube boilers.

It is important in furnaces of this description that care should be taken to prevent the oil spray from impinging directly on the furnace tube with consequent carbon formation. The spray angle should be such that the particles of oil are allowed sufficient travel in which complete combustion can take place. The path of the gases of combustion should be rotational, but this can only be achieved by imparting direction and spin to the air through an air register of correct design.

At ordinary powers of 500-600lb. of oil per hour, which is about the average amount of fuel burned in furnaces of this type, the flame length should not extend more than six or seven feet from the burner tip. The combustion chamber is therefore free of flame and does not require any protective brickwork although brick rings in the back end of the furnace are advantageous in retarding the flow of gases.

Providing sufficient draught is available to overcome the frictional resistance, retarders in the smoke tubes and air heater tubes are recommended. The waste gases are given a longer travel, the velocity is increased and the maximum amount of heat is given up to the generation of steam.

In the case of water-tube boilers with brick-lined furnaces the burners should be installed in the position from which a good flame pattern may be obtained and where no excessive heat is directed into any particular spot where local heating might occur.

The burner capacity in water-tube boilers of the marine type is up to 1,500lb. of oil per hour per burner and probably more, as the tendency is to install a small number of burners of large capacity rather than a large number of burners of small capacity. With this arrangement excellent combustion results are obtainable.

## Air Registers.

Without proper air distribution complete combustion and good furnace conditions will not be obtained. Air registers must be designed so that a high rotational velocity is given to the air entering the burner throat and to achieve this the maximum available air pressure should be utilized. Intimate fuel/air mixing is then obtained, which ensures more rapid combustion and produces a short flame. With forced-draught installations having air heaters designed to give higher temperatures in the region of 400° F., it is of course very desirable to fit insulated front plates and panels to the air register and burner windbox casing.

Regulation of air at the burner is of vital importance to maintain the excess air quantity at a minimum, but the number of movable parts and controls should be kept as low as possible. Any adjustments should be accomplished by means of only one control rod or hand-wheel.

In certain cases the air register back plate may be very effectively used as an air preheater, thereby further increasing the temperature of the air entering the furnace. The more heat given to the air before entering the burner throat is an advantage and besides promoting rapid combustion of the fuel reduces the gas exit temperature. Under certain conditions burners installed to give the air a rotational spin in the same direction may cause flame drift across the furnace. This can be rectified by fitting half the number of registers to deliver the air in a clockwise direction and the other half in an anti-clockwise direction. The possibility of uneven heat distribution and excessive heating of the tube bank at one side is thereby minimized if not entirely eliminated.

## Burners.

To obtain efficient results the particles of oil issuing from the orifice of the tip should be scrubbed and completely enveloped by the correct amount of air necessary for complete combustion. This can be accomplished in good design but if the atomisation of the oil is coarse, the particles may be of sufficient magnitude to travel into the furnace and impinge in places before being completely consumed. It is therefore necessary frequently to break down the carbon formations resulting from this into small pieces which can then be allowed to burn away in the bottom of the furnace.

To obtain high heat liberations with the desirable short flame pattern, it is therefore essential that the burner should be capable of fine atomisation regardless of load conditions or output.

Steam was originally adopted as the atomising agent for heavy fuel oils but with the exception of oil refineries and such places where difficult waste fuels must be used, the mechanical atomising burner is recognised as being the best practice.

An incandescent smokeless flame is generally obtained from a steam atomising burner which is due to the very fine breaking-up action the steam has upon the oil and also the hydrogenation which takes place during the process of combustion.

These burners are very suitable where the whole of the furnace is to be inspected periodically, such as in tube stills and the like, but for obvious reasons steam cannot be used for marine purposes, or where plentiful supplies of fresh water are not available.

The pressure type mechanical atomising oil burner has therefore been adopted. In most burners of this type the oil is injected at a pressure through slots or holes machined tangentially in the whirling chamber of the tip in such a manner that a rapid rotary motion is obtained. On being liberated from the orifice the oil breaks up into small particles which fly off radially in the form of a hollow conical spray.

The angle of the spray can be adjusted to suit the particular purpose for which the burner is used, for example in some cases a narrow spray may be required in preference to a wide spray. Being a function of the tangential velocity of the oil in the whirling chamber and the forward velocity in the direction of flow, the tip specification provides for the required angle.

The atomiser should be so designed that the internal parts offer a minimum of frictional resistance. The walls of the whirling chamber should be highly polished and the material used for this part of the burner should be hard and resistant to erosion. Many materials have been used by burner manufacturers for this part of their equipment, including special steels, tungsten carbide and in some cases hard precious stones. Tungsten carbide will resist abrasion or corrosion and it therefore lasts almost indefinitely. It can be fabricated to fine limits and finished with a high polish. This is important because it has been found that carbon will not adhere to the smooth surface of the whirling chamber when made of this material, and it is therefore possible to allow burners to remain in service for long periods without cleaning.

In some mechanical atomising burners the tip or plug is constructed with a solid conical-shaped core in the centre of the whirling chamber. This type of construction is not correct as the cone does not appear to serve any useful purpose and the extra surface in the whirling chamber has a braking effect upon the oil rotating at high velocity. Friction losses, after the oil leaves the slots, should be avoided as far as possible.

Burners of the pressure-jet mechanical atomising type designed for maximum capacities cannot be operated successfully at lower rates. For large variations in output different size tips must be substituted which is unsatisfactory and inconvenient. A small variation may be obtained by regulating the oil pressure but as the output of the tip varies approximately as the square root of the pressure, the range obtainable in this manner is limited. For example if the equipment is designed to operate at 80lb. per sq. inch working pressure, it would be necessary to reduce to 5, 20 or 45lb. per sq. inch to obtain $\frac{1}{4}$, $\frac{1}{2}$ or $\frac{3}{4}$ load respectively. Atomisation at these very low pressures would be coarse, and probably the oil would issue from the tip orifice in a solid jet. Instead of a spray of finely-atomised particles of oil, large drops would be projected into the furnace where, during their passage through the hot zone, they would undergo a cracking process and solid carbon would accumulate in the furnace in an unburned state. Impingement on the furnace floor and sides would occur which would then cause formations of carbon to build up.

Many attempts have been made to overcome this great limitation of the mechanical atomiser and one of the earliest designs which was adopted by some burner manufacturers consisted of a tapered valve spindle extending through the centre of the burner and seating in the orifice of the tip. Adjustment of the spindle could be made by means of a graduated handwheel mounted on the burner coupling. The area through the orifice or "valve opening" could therefore be increased or decreased to give the desired capacity and some degree of range could be obtained.

This arrangement was quite good, although on account of the very fine limits to which it is essential to work in the construction of this vital part of the burner it was difficult to maintain concentricity and accuracy. Unless the tapered spindle was absolutely dead centre in the tip an even distribution of oil spray from the lip of the orifice could not be obtained. Also as previously mentioned the extra surface of the spindle in the whirling chamber retards the rapid rotary motion of the oil and further, because the coefficient of discharge through the tip is very low, generally about ·2 to ·3, it will be seen that it is not the area of the orifice but the circumference which should be reduced to lower the output.

Another variable-capacity design consisted of an orifice plate and a number of slotted discs and spring-loaded ball valves. The ball valves seated on springs of different tension, opened and closed automatically with the oil pressure variation. Yet another type had two or more tips fitted, each of which could be brought into service by hand or by electrically-operated valves. This type of construction was complicated and springs or ball valves of small dimensions are not reliable when dealing with heavy fuel oil.

The solution to the range problem, however, came with the wide range burner. Engineers were quick to realize that giving a range of capacity of the very high order of 10 : 1 whilst maintaining good atomisation throughout, this burner represented probably the greatest advance in oil burning. It has been adopted in many land plants, particularly in oil refineries where difficult waste fuels which are not suitable for the market must be disposed of.

The design is simple and the principle of operation is no doubt very well known, but it has not been installed so generally in steamers. A description of this up-to-date burner will therefore be interesting to marine engineers.

## Wide Range Burners.

As already explained, fine atomisation depends principally upon the speed at which the oil is liberated from the lip of the tip orifice. It is therefore necessary to maintain the high rotary speed in the whirling chamber regardless of the amount sprayed through the orifice.

This is achieved in the wide range burner by delivering to the whirling chamber the maximum amount of oil for which the burner is designed regardless of the capacity required. The range obtainable is about 10 : 1 which is sufficient for ordinary purposes, but with certain modifications to the system (which is described later) an even greater range of the order of 50 : 1 is possible. In one particular installation operating at present, a "banked fire" condition was required and the range in this case amounted to 75 : 1. Requirements of this nature however are very special and not usually demanded in ordinary marine practice.

Fig. 4 shows a section of the wide range atomiser assembly with the secondary outlet or return tube.

In operation, the oil at constant supply pressure is delivered to the burner barrel. A number of holes in the tip plug allow it to pass into the annular groove in the tip and thence through the tangential slots into the whirling chamber, where it takes a spiral path in the form of a ribbon gradually increasing in speed towards the centre.

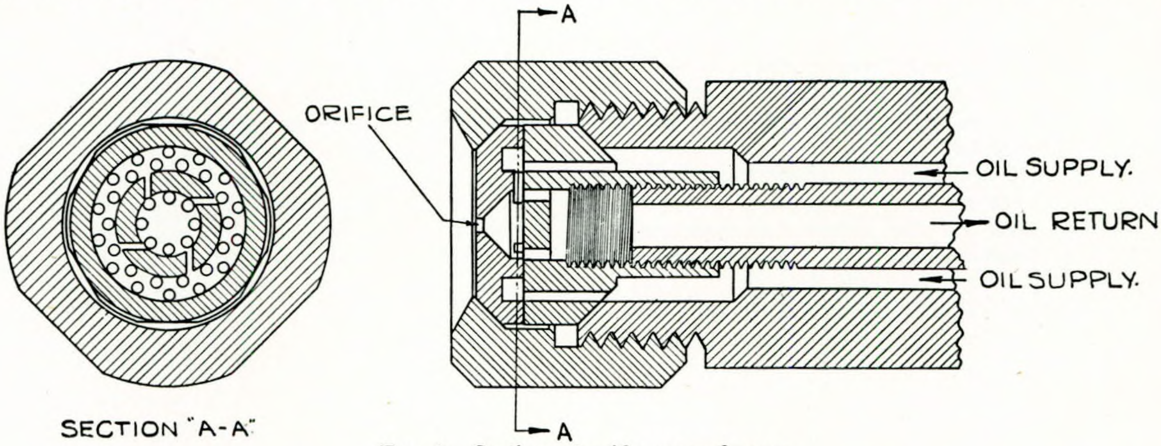



Fig. 4.—*Section of wide range burner.*

Thus, so far, the wide range burner conforms to the design of the ordinary pressure-jet mechanical atomiser. The essential difference, however, is the introduction of the secondary outlet from the whirling chamber which allows oil to return through the inner tube, back to the service tank or pump suction. The return oil is regulated by the by-pass or return valve and is the difference between the total amount delivered to the burner and the amount required to be burned. To put this another

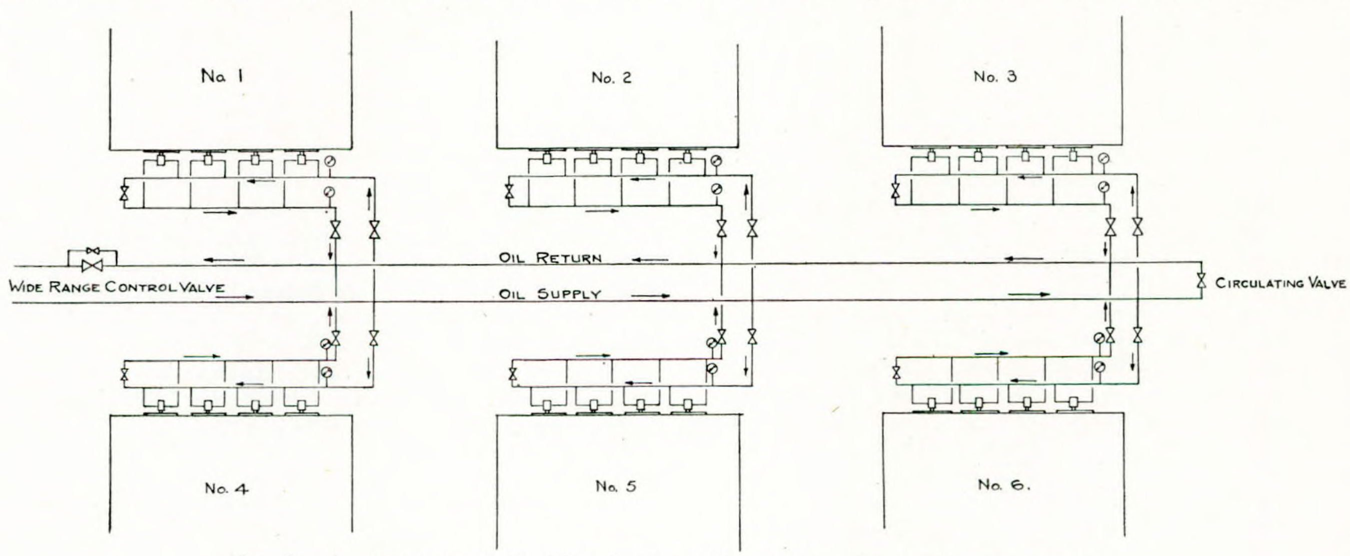



Fig. 5.—*Arrangement of oil piping for six boilers fitted with 24 wide-range burners.*

way, if the burner is designed to deal with 1,000lb. of oil per hour at maximum capacity but only 25 per cent. of the rating is required, then 1,000lb. will be delivered to the burner, actually into the whirling chamber, and the by-pass or return valve will be regulated to allow 750lb. per hour to return, giving a burner output of 250lb. per hour through the tip orifice. In this manner the amount of oil passing through the slots of the tip is not reduced, the high rotational velocity of the oil in the whirling chamber is maintained and the atomisation at reduced capacity is unimpaired.

Any number of boilers or any number of burners may be connected into one common return line and controlled by means of a single valve over the entire capacity range. This valve which may be placed in any convenient position remote from the burners can be manipulated by hand or alternatively by automatic control.

Fig. 5 shows the piping arrangement of a six-boiler marine installation fitted with 24 wide range burners.

Originally a single return hole was used in the tip plug, but this design was later improved by drilling a series of holes evenly spaced at the edge of the whirling chamber. It was found that with a single return hole, which of course had to be much larger than the tip orifice, the oil in the inner tube was also rotated. This was unnecessary, and besides energy was also absorbed in doing work which was not useful. A more stable condition was found when using the flat-faced plug with the series of holes, as the smooth surface of the plug offered less resistance than the column of oil in the return tube. Further, as the oil rotated at a higher speed towards the centre of the whirling chamber, the velocity at this point could be used to better purpose, namely, for atomisation. The tests carried out to prove these points were interesting. An atomiser made in glass allowed observations to be made and conditions noted in the whirling chamber. It appeared reasonable to assume that a hollow streamlined core would be produced in the centre of the whirling chamber, but this was not so. There was undoubtedly a vortex but this was cylindrical in shape of slightly less diameter than the orifice but having parallel sides extending from the orifice to the face of the tip plug. When using a single return hole plug, the vortex extended through the inner tube in distances varying with the differential pressure across the slots, gradually tailing off and taking the form of a "retarder" with convolutions of increasing pitch.

The skin friction of the inner tube surface was therefore having a retarding effect on the rotating column of oil.

A further test was taken with a burner in operation using alternately plugs having a single return hole and others with a series of holes. The same oil was used and conditions in both cases were maintained exactly similar, *i.e.* oil pressures, oil temperature and viscosity, rate of flow to the burner, draught and air register adjustments.

With the plug having a series of return holes, finer adjustment and steadier control could be maintained. Atomisation remained fine throughout the range which indicated that because the centre portion or core of the rotating body of oil in the whirling chamber was not being drawn off to the return a more stable condition was being obtained.

Using the single return hole plug, control was not so steady. Slight variations in pressure occurred after valve adjustments were made, which appeared to be due to the friction of the inner tube surface. This assumption was also borne out by an increased discharge through the orifice of the tip. Conditions having been maintained exactly similar throughout the tests, *i.e.* pressures, temperatures, etc., the only way in which the output could be increased would be by a reduction of tangential velocity and a corresponding increase of the velocity in the direction of flow. Atomisation at lower capacities became coarser, which slightly reduced the efficient range of the burner. There were indications, however, that when using a single return hole, it was possible to run for longer periods without cleaning the burner. This is of some importance in special cases where changing burners is not only inconvenient but at times not possible without causing complications to the remainder of the installation. Also when using certain grades of fuel, including some of the Pool fuel oils at present being supplied, considerable deposition of particles of free carbon occurs at temperatures exceeding the burning temperature. Slots and holes in the atomiser, therefore, unless of reasonable size, tend to plug quickly. The large single-hole return plug in this case offers less restriction to the return oil and the tendency for carbon particles to accumulate in the whirling chamber is reduced. They are allowed to pass directly through the return to mix with the fresh supply of oil in the suction line, being trapped before reaching the pump by the duplex suction strainer.

### Differential Valve.

It has already been stated that the angle of spray from a mechanical atomising burner is a function of the tangential velocity of the oil in the whirling chamber and the forward velocity in the direction of flow. When operating at reduced capacities and oil is allowed to return, the forward velocity is reduced and a consequent widening of the angle of spray takes place. If the burner is adjusted in the register in such a way that at ordinary capacities the oil spray just clears the brick throat, it follows that at reduced capacities, the spray, becoming wider, may impinge on the brickwork.

Further, the atomising power of any pressure-jet mechanical atomiser is a function of the speed of rotation in the whirling chamber and as the speed of rotation is in turn a function of the pressure difference between the supply and return pressures, any reduction in return pressure, with a constant supply pressure, increases the oil rotation in the whirling chamber with a consequent improvement in the spray quality. Better atomisation, however, is not required because the tips are designed to give the desired quality at maximum capacity.

To maintain the predetermined spray angle and a constant quality of atomisation a differential valve was evolved which automatically maintained the pressure differential across the slots of the tip throughout the range of capacities. This was achieved by inserting the valve in the oil supply line and allowing the oil return pressure to control the movement of the valve through a small bore pipe connected to the upper side of the

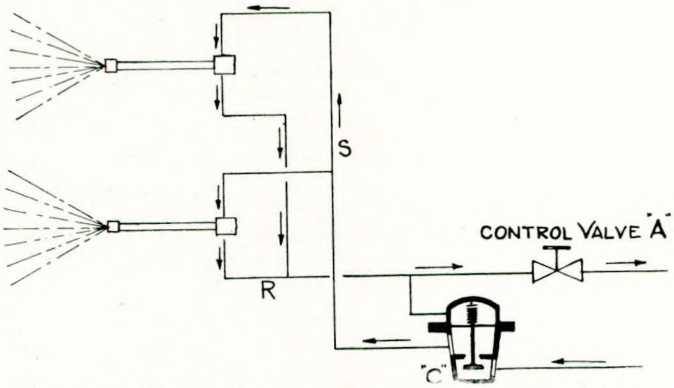



FIG. 6.—*Constant differential system using differential valve.*

diaphragm. The supply and return pressures were accordingly maintained in equilibrium. Fig. 6 shows the principle of operation. To reduce the output of the burners, the control valve *"A"* is opened, thereby allowing oil to return from the burner to the pump suction with a corresponding decrease in return pressure *"R"*. The differential valve *"C"* then automatically tends to close due to the action of the reduced pressure *"R"* on the diaphragm, and the supply pressure *"S"* is consequently decreased by the same amount as the return pressure *"R"*. This arrangement proves to be very suitable for automatic control, because with a constant differential pressure a straight line relation is obtained between the return pressure and the amount of oil burned.

## Differential Pumps.

The subsequent development of the differential valve was the adoption of the differential pump. Its purpose is similar but it possesses other advantages. The diagrammatic piping arrangement in Fig. 7 shows the position

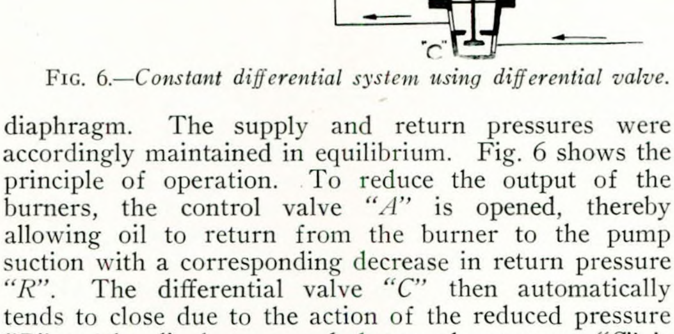



FIG. 7.—*Constant differential system using differential pump.*

of the pump in relation to the burners and indicates the direction of flow.

Oil from the conventional oil burning system is delivered at *"P"* and the amount required at the suction of the differential pump, or in other words the burner capacity, is regulated by the control valve *"A"*. The pressure is then boosted and supplied to the burners at the higher pressure *"S"*. When decreasing the burner capacity by closing the control valve *"A"*, the oil supply pressure *"S"* is automatically reduced by the differential pump *"C"*, which is running at constant speed, by the same amount as the return pressure *"R"*.

The pressure differential across the tangential slots of the top and consequently the velocity remain constant, which gives a constant speed of oil rotation in the whirling chamber with a constant spray angle and a degree of fineness of atomisation which remains unchanged.

The differential pump deals with a constant quantity of oil which in turn gives a straight line relation between the return pressure *"R"* and the quantity of oil burned.

The system therefore lends itself very well to automatic control and an even greater flexibility and range as high as 50 : 1 may be obtained.

Through using the higher pressure of the differential pump, *i.e.* 300lb. per sq. inch, improved atomisation may be obtained over the entire operating range, and by installing the pump adjacent to the boiler front only the ring circuit at the burners need be designed for the higher pressure. The remainder of the system would only necessarily be suitable for the lower pressure of 200lb. per sq. inch.

Any objection to hot oil returning to the tanks is entirely overcome by using the differential pump system. No oil either hot or cold is returned to the tanks o service pump suction and any difficulties which may be due to hot oil at the pump suction are avoided. Only the oil actually burned is pumped to the boiler. All the burners on a boiler are controlled by means of a single valve opened to increase and closed to decrease the supply to the burners. The partial opening or closing of the control valve varies the pressure of the oil delivered to the suction of the differential pump which in turn regulates the amount of oil burned.

## Pitch and Creosote.

Although burning pitch at sea is extremely unlikely, reference to this fuel will be of interest to those marine engineers who are now established in shore positions. There are at present large stocks in the country and many gas works and tar distilleries are burning both hard and soft pitch in a liquid state.

The actual burning of the fuel does not present any difficulties and can be generally dealt with satisfactorily in an ordinary oil burner with perhaps some slight modification to the atomiser. It is, however, of the greatest importance that a constant temperature should be maintained and the circulation through the delivery and return lines should be uninterrupted. Using a burner of the mechanical atomising type it is necessary to heat the pitch to about 600° to 650° F. for burning, but assuming that the heater or pitch boiler is some distance from the burners there will be a temperature drop of probably 30° to 50° F. This will necessitate delivering at a temperature approaching 700° F.

There will probably be deposition of free carbon in the lines at this temperature and to minimize the possibility of plugging the slots and orifice of the atomiser a constant circulation should take place through the burner.

The burner of the wide range type lends itself very well to this work, because a high rate of circulation can be maintained and, as has already been mentioned, good results can only be obtained if the fuel is kept moving.

The high temperatures required for mechanical atomisation are not always obtainable if superheated steam at a high temperature is not available and in some cases a hand-fired pitch boiler is employed.

The more general method, however, is to use a burner of the steam atomising type which can deal equally satisfactorily with the fuel at the lower temperature of 400° F. The steam used for atomising, however, must be dry and preferably superheated, because otherwise with low-pressure steam the pitch would be cooled out in the atomiser.

Although adding considerably to the cost of the installation, all pipes carrying pitch should be steam jacketed, because if the supply pump breaks down the pitch in the lines rapidly becomes solid and the application of heat in some manner is necessary to recommence circulation.

To avoid the high temperature required, pitch mixed with creosote gives equally satisfactory results and is probably more convenient to handle as it is in a liquid state at ordinary temperatures. This mixture, however, is not generally used because creosote is more expensive and not available in the same quantities as pitch, besides being required for other purposes at the present time.

### Instruments.

To operate a steam generating plant efficiently, instruments should be provided to enable the staff to make the required adjustments to the combustion equipment. An elaborate installation is not necessary but those which are fitted should be of robust design and capable of giving accurate readings without requiring constant attention. The following list is intended only as a guide and could of course be modified to suit the particular plant:—

(*a*) Oil pressure gauges should be fitted to each boiler, especially with wide range burners, to allow the heat release to be regulated to give an equal evaporation from each boiler. In some cases, however, a number of boilers may be worked together to give a constant output and one operated separately to take any fluctuations in the total steam demand.

(*b*) Thermometers at the heater are not essential because there is bound to be a temperature drop before the oil reaches the burners and if the operators are given a certain burning temperature any reading except at the burners is apt to mislead. It is worth noting that when adopting the required temperature for the particular grade of oil being used, an allowance should be made for the temperature of the air delivered to the burners. Cold air naturally has a cooling effect passing around the burner parts and reduces the temperature before the oil reaches the burner tip. The reverse consequently takes place with preheated air.

(*c*) The air supply can only be adjusted to give each burner the requisite amount if sensitive hydrostatic gauges or points are fitted to each burner. In many cases the pressures taken in the burner windbox are uneven and unless individual adjustments are made to each burner, some may have a high excess quantity and others insufficient. Gauges of the dial type calibrated to ·01in. are preferable to the out of date U-tube.

(*d*) $CO_2$ instruments should be of the indicating and recording type. Great care should be taken in their installation and the point decided upon from which the sample of gas is to be taken. The readings are of little value unless accurate and representative of the gases of combustion being produced. There may be many small leaks in the boiler casing where air infiltration might occur and it is therefore advisable to place the inlet to the sampling pipe well into the path of the gases and as near as permissible to the furnace. The smoke-box doors on Scotch boilers, although generally a good fit and tight enough to prevent a serious air leakage which might affect operation, very often allow sufficient air to leak through into the uptake materially to dilute the gas sample. This can be overcome by inserting the sampling pipe a few inches into a smoke-tube where no infiltration of free air can possibly reach.

With a first-class oil burning installation a gas analysis showing 14·5 per cent. $CO_2$ is obtainable, although this figure varies slightly with the carbon content of the particular oil being used. For all practical purposes however, 13·5 per cent. $CO_2$ is good if maintained over prolonged periods.

# OBITUARY.

## WILLIAM GEORGE WINTERBURN.

We record with regret the death of Mr. William George Winterburn, who passed away at his home, Pasadena, California, on Thursday, August 8th, 1940.

Mr. Winterburn was born at Whitby, Yorkshire, in 1862, the eldest son of Frederick R. Winterburn, jet ornament manufacturer. Upon completing his schooling he went to Stockton-on-Tees where he served his apprenticeship with the object of becoming a marine engineer. He then went to sea and at an early age obtained his Extra-First Class Board of Trade Certificate. During this period of his career he served as chief engineer in various ships, sailing mostly to the Orient. While in the East he was associated with the Siamese Navy and with the Chinese and Japanese Merchant Navies. He then retired from the sea and became managing director of Messrs. George Fenwick & Co., shipbuilders, of Hong Kong.

Later he moved to Victoria, British Columbia, and in 1917-18 was surveyor and representative of the French Government for vessels built for that Government at Victoria. During this period he associated himself with various clubs and organisations. He was recognised in China and throughout Western Canada as a leader in his profession, and was a frequent contributor to leading naval and engineering journals. He was the recipient of a gold medal for one of his technical papers. For several years he represented the Bureau Veritas and the North German Lloyd on the western coast of Canada as surveyor. He also conducted a school for marine engineers wishing to obtain Board of Trade certificates.

Mr. Winterburn was elected a Member of The Institute during 1889, the year of The Institute's formation, his membership number being 157, and his interest in The Institute's work and in his profession continued undiminished until the day of his death. The Council elected him Vice-President for the Vancouver area in 1904 and after almost uninterrupted service as a Vice-President until 1929 he was elected an Honorary Vice-President in recognition of the valuable assistance rendered by him to the Council and The Institute over this long period of years.

Mr. Winterburn was also a Member of The Institution of Naval Architects. He was initiated as a freemason in the Lion Lodge, Whitby, in 1895. Although for the ten years preceding his death he had been in retirement at Pasadena, California, the maintenance of his keen interest in engineering matters was evidenced by his presence at several of the international conferences of the engineering institutions. He married Elizabeth Watson, of Toronto, Canada, who predeceased him ten years ago. He leaves a son, George Frederick Winterburn, Eng. Lt.-Comd'r. of H.M.C.S. "Ottawa", now serving in the present war, and three daughters, Mrs. Winifred M. Anderson and Mrs. Jessie Henry, both of Los Angeles, California, and Mrs. Maple Hunter, of Toronto, Canada.

## ADDITIONS TO THE LIBRARY.

Presented by the Publishers.

**The following British Standard Specifications:—**

No. 693-1940. Oxy-Acetylene Welding in Mild Steel (revised Oct., 1940).

No. 436-1940. Machine Cut Gears. A.—Helical and Straight Spur (revised Oct., 1940).

**Earthquakes and Structures.** By D. Laugharne Thornton, M.A. (Member). Paper published in the Journal of the Royal Society of Arts.

**Hoisting Machinery.** By William H. Atherton, M.Sc. The Technical Press, Ltd., 314 pp., 162 illus., 32s. 6d. net.

This is a comprehensive treatise dealing with all types of cranes and lifting machines that could be said to be covered by the title. Thus, although the greater part of the book deals with cranes, yet telphers, transporters, skip and truck hoists, stacking machines are all adequately treated. The range of cranes is very large and includes in addition to practically every type of commercial crane, particulars of special purpose cranes. Component parts are carefully described and fully illustrated by sketches which have the quality of being clearly printed.

The descriptions indicate sound lines for design and weaknesses to be avoided. The value of this is apparent when it is remembered that a crane failure due to incorrect application of principles is rare; most failures can almost invariably be traced to the unsuitability or weakness of a component. The book is not confined to British practice but includes typical American and Continental examples. The author realizing that many factors control methods of construction does not attempt to be insistent on certain methods for certain types. Alternative methods are given, the advantages and disadvantages discussed, including those decisive factors, first cost and maintenance.

The importance of the grab as an aid or deterrent to maximum outputs has not been overlooked and the various types of this most important auxiliary are carefully analyzed so that a user may easily recognize the one most suitable to his material. Two chapters are allotted to stacking machines and small mobile cranes which have come into prominence recently for the handling of goods in warehouses. The important principle of level luffing is exhaustively treated in one chapter, and coal handling plant is generously represented including a reference to an anti-breakage coal box. There are frequent references to Home Office safety devices and British Standard Specification requirements are quoted.

The author rightly calls attention to the confusion that tends to arise by the use of different terms for the same component according to geographical position and makes the excellent suggestion that exact terminology shall be introduced as has been done in the sciences. Among the special purpose cranes described we missed any reference to the "Creeper" cranes such as were used in the construction of Sydney Harbour and Howrah

(Calcutta) Bridges. It would be of interest if future editions included some particulars of this specialized type of crane.

The book is well printed and produced and contains forty-eight excellent photographic plates in addition to the numerous sketches and drawings. The bibliography will prove useful for those wishing to specialize. This book should prove a valuable work of reference to consulting engineers, designers, inspecting engineers, maintenance engineers and students.

**How to Prevent Electrical Troubles.** By E. B. Watton. Percival Marshall & Co., Ltd., 104 pp., 25 illus., 2s. 6d. net.
**Small Electric Motor Construction.** By J. G. Hall. Percival Marshall & Co., Ltd., 66 pp., 27 illus., 2s. net.

The first of these small handbooks is an excellent half-crown's worth and has obviously been written as a result of first-hand practical experience. The title explains its subject very correctly and there are many hints and tips, at least some of which will be new even to those with long practice. Prevention of trouble is dealt with from a purely practical point of view, and the book contains no formulæ or theoretical consideration of electrical faults which remain a problem for the design and test departments of the manufacturers. No doubt some of the recommendations are open to dispute, but practical engineers will always have their own ideas and a second suggestion is always helpful. Care in the choice of words—or care in their interpretation—may be of considerable importance in a handbook of this type. For instance, the author states that with ball bearings "the inner race should be a tight fit on the shaft", and "take a piece of pipe and drive on the inner race". True, he speaks of ball races being "accurate and delicate things", but many would prefer the expression "light tap fit" to avoid expanding the race and tightening the bearing which might be more serious than creeping. Without discussing theory the chapters on generators and motors could with advantage include simple diagrams and advice on shunt, interpole and series field polarities and methods of checking and connecting, since reassembly after cleaning may result in some doubts and mysterious but simple faults. There is an excellent chapter on switch and control gear maintenance including very sound advice on fuses and their treatment and maltreatment. The book is not written specifically for ships' electricians, but the general advice is sound and can be applied by anyone on maintenance work, and it lays particular stress on what *not* to do. There are often several satisfactory methods, but always one which is wrong and harmful.

The second book is in a different category and is one of the "Model Engineer" series. It will be of interest to those who wish to make miniature motors for driving models or small machines in the home workshop and is based on the use of standardised parts available from a number of manufacturers whose names are given. Theory of design is intentionally excluded and the construction details are somewhat vague in parts, but anyone wishing to make up a model in his spare time will find the book helpful. Beware, however, of running low voltage motors from d.c. mains through a series resistance as suggested in chapter VI—it is much too risky, especially if your small boy gets hold of it!

**Production Engineering—Jig and Tool Design.** By E. J. H. Jones. George Newnes, Ltd., 304 pp., 240 illus., 12s. 6d. net.

This is a book which will be of great assistance to those engaged on tool, jig and fixture design and manufacture, and can be recommended as a book well worth studying by works managers, draughtsmen and students of production engineering.

The volume can be described as an easily read textbook on jig and tool design with numerous illustrations clearly detailed. At the same time it can be said that mass production examples and photographs of special purpose machines so prevalent in some text books have been avoided.

The opening chapter deals with the function and organization of the jig and tool departments and useful information on fits and tolerances follows. Other chapters in the book describe very fully gauges, cutting tool materials, small tools, milling tools, milling cutters, tool calculations and development, and multiple tooling. A section is devoted to broaches and broaching fixtures, a subject on which information is not so widely known, and will be appreciated by readers. The underlying principles of jig and fixture design are clearly defined before going on to chapters on jig and fixture details, drill jigs and milling fixtures. The latter part of the book is devoted to grinding fixtures, grinding wheel truing devices and air operated fixtures, all of great interest to those engaged in jig and tool design.

The author has given freely of his practical knowledge of the subjects covered, and the wide experience he has gained with the Associated Equipment Company should be of immense value to readers of "Production Engineering".

**Sea Power.** By T124. Jonathan Cape, 252 pp., 8s. 6d. net.

This book could with advantage have appeared some years before the war. Had it done so, and had it been read and digested by those then in authority, we should have been spared the military disaster on the Continent last summer and many of those dangers we are now facing at sea owing to our shortage of warships. But this book, late though it is, may yet exercise a salutary influence on the war if its lessons from the past and its bearing on present problems receive the attention that they deserve.

This is a notable book in every sense, its theme being the disastrous consequences, economically and militarily, that must ensue if those directing war policy look to the land instead of to the sea for victory over our enemies. T124, a pseudonym which conceals the identity of a well-known and very brilliant naval writer, exposes the myth of the absolute necessity of preventing the Low Countries and the Channel Ports from coming under enemy occupation, as they now have, and the writer shows conclusively how this myth has adversely affected our strategy in the past and in this war.

This book should go a long way to curbing the ambitions of the Continental military school in this country, who still seem to be hankering after another Continental adventure on the grand scale, instead of exploiting our maritime strength and geographical advantages to the utmost against Hitler.

"Sea Power" is not only enlightening but is a fascinating study of the proper handling of the sea affair, and any marine engineer who reads this book will have his interest stirred and kept alive from the opening chapter to the end.

**Engineering Drawing—Principles and Practice of Draughtsmanship.** By W. Weeks. Percival Marshall & Co., Ltd., 88 pp., 83 illus., 2s. net.

The first impression gained of his handy little book was unfortunate, as it reached the reviewer by post in a slightly damaged condition. A certain amount of criticism may be levelled at the publishers for failing to provide a binding comparable with the otherwise high standard of the work.

Written for the elementary student and based on work in evening classes, the book covers the whole of the basic requirements of drawing-office work in surprisingly small space; the diagrams and illustrations make up by clearness for their restricted size. The sections on instruments and their use are well illustrated with photographs, though the author is surely rather bold in labelling as "incorrect" on page 22 a method which really depends on individual taste or quality of lighting? The correlation of the eight different types of line in a representative drawing on page 18 is a good point, but one might criticize the retention on page 43 of the old system of indicating different metals by varying arrangements of section lines. Surely in dealing with students one should follow the lines of the British Standards Institution report? On page 49, in drawing a hexagon nut, the central chamfer curve is represented as an arc radius $D$ while the corners are shown as chamfered at 30°. These two measurements will not agree; the chamfer angle is nearer 45° if this central curve is so drawn.

The value of perspective views and shading lies mainly on the advertising side, and this is not usually the concern of the engineering draughtsman as such; but one is glad to notice a section on welding, which is so often omitted by authors of similar works, and without doubt the question of limits and tolerances would have received more attention had space permitted. Only one misprint was noticed—on page 69 "bisect" should read "intersect".

Despite all these minor criticisms this is a very good little book, which deserves better than to have made its debut in such times as these.

**Engineering Economics—Works Organization and Management. Book I—Elements of Industrial Organization.** By T. H. Burnham, B.Sc., B.Com., M.I.Mar.E., and G. O. Hoskins, B.Com., M.Sc.

Book II of this well-known work, relating to the economics of manufacturing, was reviewed on page 68 of the April, 1940, issue of the TRANSACTIONS. The fifth edition of Book I dealing with the elements of industrial organization has now been issued. It is assumed that the engineering students of this book intend to become executives and that the reason they are studying is that they are determined to understand the admittedly complex but not mysterious problems which have so profound an effect on their own profession. A primary object of the book is therefore to introduce the engineer to a study of the techniques that impinge on and affect his own technique and to give him a necessarily brief sketch of the economic system—the system of production and distribution—which will help him not only to see how his own technique fits into the general system, but also to realize his responsibility in the efficient working of this system. Even though the conclusions reached by economic studies are not necessarily of direct use to an individual business they will give the student a training in judgment which is bound to be of practical value in life. A secondary object is to provide in convenient form an introduction to the reading required for Section A (Fundamentals of Industrial Administration) of the examination of The Institution of Mechanical Engineers, for the Graduate examination of The Institution of Production Engineers, and for the optional subject in the syllabus for graduate membership of The Institution of Electrical Engineers.

The ground that has to be covered is, however, so extensive that in several branches of study only the briefest treatment is practicable. The student who wishes to go further than the minimum requirements for examination purposes is recommended to pursue his reading in the books mentioned at the end of each chapter. These are arranged in two groups: (*a*) easier works which all students should attempt to read, and (*b*) more advanced works. This new edition has been completely revised. Chapters I and II on Elements of Economics and Money, Banking and Exchange, have been entirely rewritten, and a new chapter on the Trade Cycle has been introduced. Chapters III and V on Resources and Business Organization have also been reconstructed and much new matter added. The remaining chapters have all undergone considerable revision and rearrangement.

**Machine Design Drawing Room Problems.** By C. D. Albert, M.E. Chapman & Hall, 3rd edn., 441 pp., copiously illus., 21s. net.

This volume is a very comprehensive collection of everyday design problems and would be a definite acquisition to any technical department library. As the author has written the book in very practical language it is both interesting to read and easy to assimilate. The problems are dealt with in such a manner that they can be extended to cover an almost unlimited field of design. This being the case, it is not necessary to specialise in the various types of machines or prime movers. Many of the expressions and terms used in the book will be more or less "foreign" at first sight to the British designer, but after a little thought one realizes that, however the nomenclature of basic principles may be expressed, the fundamental root cannot be altered.

The introductory chapter is a general discussion concerned mainly with the classification of the basic types of machines, and in each succeeding chapter a definite problem is dealt with. Each problem is explained clearly from the original idea, through all the design calculations to the final "as made" drawing.

The only criticism one can offer, if it may be deemed such, is that all the tabulated data in the concluding pages is of little use to any designer outside the U.S.A., as American Standards are used throughout.

# JUNIOR SECTION.

## Naval Architecture and Ship Construction (Chapter VI).

*By* R. S. HOGG, M.I.N.A.

### Engine Seatings.

The fore and aft position of the engine seat is dictated largely by considerations of trim. When the probable draught and desired trim have been decided upon, it becomes necessary to ensure that the centre of gravity shall be on the same vertical line as the centre of buoyancy. It will be assumed that a fairly accurate estimate of hull weights, equipment, stowage weights and so on has been made, and that the centre of gravity of these weights relative to amidships is known. If now the weight of machinery is available, it is comparatively easy to adjust the position of the engine room so as to give the appropriate position of the centre of gravity of the ship consistent with the desired trim.

The question of hull vibration does not in general receive the consideration it deserves. Quite obviously there is some position for the machinery where these vibrations would be reduced to a minimum, and it might be expected that some attempt would be made to determine this position. However, probably due to the difficulties involved in accurate calculations, precedence is almost invariably given to the question of weight distribution, and except in the case of large passenger liners, vibration is left to take care of itself. Nevertheless, so far as the design of the engine seat is concerned, much can be done to minimize the influence of the unbalanced periodic forces which exist in reciprocating machinery. An engine seat must be well distributed so as to spread the weight fairly over the floors and girders in the double bottom. It must be as shallow as possible in order to avoid tripping, and tearing out of rivets and holding-down bolts. Above all it must possess great rigidity and must be strongly attached to the main hull structure in order to prevent structural discontinuity.

In the early designs box girders of the form illustrated in Fig. 55 were built above the tank top. This

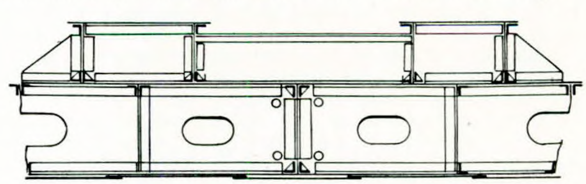


FIG. 55.

arrangement consists essentially of vertical fore and aft girder plates, suitably supported transversely by means of diaphragm plates and brackets, and over the top there would be a heavy horizontal fore and aft plate known as the sole plate. It is to the latter that the engine bed plate would be bolted.

Superficially, this arrangement looks very sound, but experience has frequently indicated the inability of this type of structure to transmit the loads satisfactorily to the hull structure. It must be understood that the height of the engine bed plate relative to the ship's keel is fixed by the position of the shaft as it enters the engine room, and this in turn will depend upon propeller diameter and the amount by which it is desired that the blade tip shall be buried.

These factors demand a built-up engine seat or, what is undoubtedly the better solution, a comparatively small rake to the shaft coupled with an increase in the depth of double bottom in way of the engine room, thus enabling the bedplate to be bolted direct to the tank top. The last-mentioned scheme is the one invariably used to-day. The double bottom is increased in depth, additional internal stiffening is provided in the form of floor plates at *every* frame position, double reverse bars on the tops of the floors, and if thought necessary additional longitudinal side girders (side keelsons, as so many know them) can be fitted. The tank top in way of the engine bedplate will be thickened to as much as one inch. This thickened tank top plating should extend far enough aft also to take the thrust seating.

It is not an easy thing to land a heavy bedplate over a line of studs, and the better practice is to place the bedplate in position, get it accurately adjusted, and then drill and tap the holes in place. The studs are screwed into the thickened tank top plating and check nuts are placed underneath. To obtain the correct vertical adjustment, the bedplate is first landed on wooden chocks which can be set up to the proper height. Patterns are next made for cast-iron chocks, which when ready are fitted in position between the studs. Room is left for teak wedges to be driven in to provide the necessary cushioning effect. Fig. 56 gives a detail of a holding-down bolt (stud) as fitted when the engine bedplate fastens direct to the tank top. Before leaving this part of the subject the reader is advised to consult a very interesting and discursive paper by Mr. J. L. Adam in the TRANSACTIONS OF THE INSTITUTE OF MARINE ENGINEERS ("Effects of Propelling Machinery on Hull Structure", December, 1931, Vol. 43, Part 11) in which a number of different methods of solving the problem of engine seatings is suggested. The diagrams are particularly instructive.

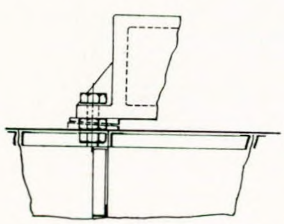


FIG. 56.

## Turbine Seatings.

Fig. 57 illustrates an arrangement of transverse box girders suitable for the support of turbine feet. An interesting point arises here. The longitudinal expansion

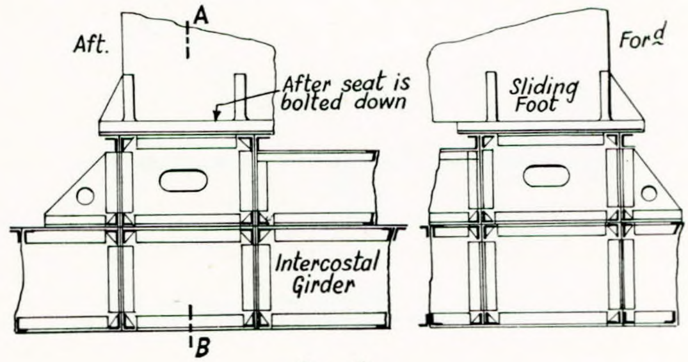
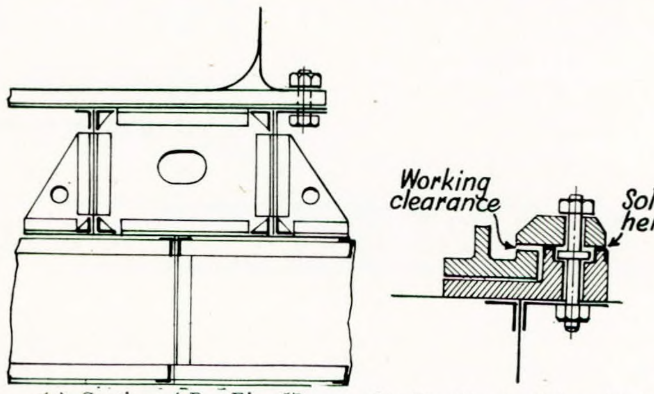



FIG. 57.

which takes place in the turbine rotor casing makes it necessary for the forward feet to be free to slide, although of course the after feet may be bolted down.




(*a*) *Section A.B. Fig. 57. Turbine foot is bolted direct to seating at A.E.*

(*b*) *Detail of sliding foot at F.E.*

FIG. 58.

Fig. 58 (A) indicates a section at the after foot showing a fixed bolt. Fig. 58 (B) gives a detail of the sliding foot at the fore end.

## Boiler Stools.

A boiler though very heavy is nevertheless a deadweight, and the question of support is not so involved as in the case of the engine. To begin with the double bottom is specially stiffened, floor plates being fitted at every frame position, although alternate spacing may have sufficed elsewhere, and the thicknesses of both floors and longitudinal girders will be augmented by approximately one-tenth of an inch. The boiler sits in transverse vertical cradle plates, cut to fit the curvature of the boiler shell. Two such stools or cradles will be sufficient to support a single-ended boiler, whereas three or perhaps four will be necessary in the case of a double-ended type. Some form of longitudinal bracing is desirable to prevent the stools from tripping. Figs. 59 and 60 will give a general idea of the requirements for a single-ended boiler.

In Fig. 60 a collision chock is shown at the fore end. A sudden reduction in speed would cause the boiler to jump forward. If this movement were not arrested,

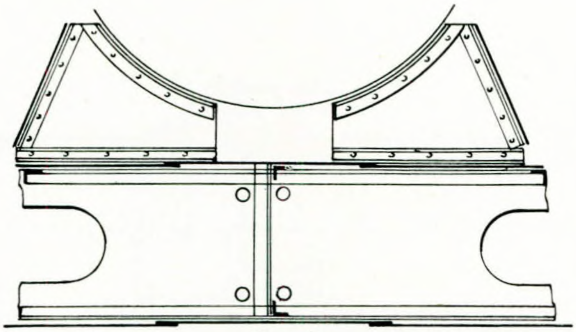


FIG. 59.

there would be a serious possibility of steam pipes and the like becoming fractured. It is equally true that any sudden increase in speed would tend as it were to leave

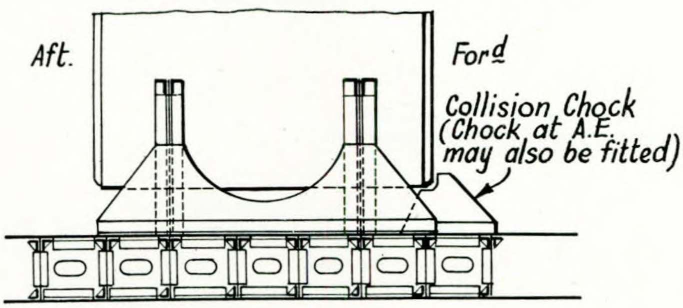



FIG. 60.

the boilers behind, and so it is wise to fit one or perhaps two collision chocks at the after end as well. These chocks are simple in construction and may consist of bracket plates securely riveted to the tank top as depicted in the illustration, or heavy vertical angles suitably stayed may be employed.

When rolling there might be some transverse movement of the boiler. To prevent this from happening tie rods secure the boiler shell to one of the side frames and there would be a wire connecting one boiler to its neighbour in the same transverse row. Details will vary in different ships, but it has not been thought necessary to illustrate so simple a point.

Double-bottom tanks have to be completed and water tested prior to launching. It is not often possible to get boilers in position at this early stage, if for no other reason than the paucity of lifting appliances around the slipway. It might be supposed however that there would be no objection to securing the stools, but a little consideration will make it clear that with all the stools in place great difficulty would be found in hoisting the wing boilers into their cradles. The usual procedure is to fit the wing portion of the cradle, slide the boiler into place, shore up and then fit the inboard cradle. This latter operation, therefore, cannot be carried out until after launching, since the boiler does not go in until then. This in turn might mean the piercing of the double-bottom subsequent to testing, a proceeding which is not allowed unless a further water test is carried out. There are two ways of overcoming this difficulty. Short transverse "aitch" bar girders may be worked over the tank top in line with the stools previous to launching. The stools could then be fitted to the tops of these girders when and as convenient. Alternatively the lower angles on the inboard portion of the cradle can be riveted in place, but the plate itself omitted until such time as the boilers have been shipped.

## Seatings for Water-Tube Boilers.

Fig. 61 shows an entablature of plates and bars suitable for the support of a water-tube boiler. Cast-steel feet are riveted (or welded) to the ends of the boiler drums, each foot being bolted to a pedestal of the type illustrated. One of these feet is securely fastened to the

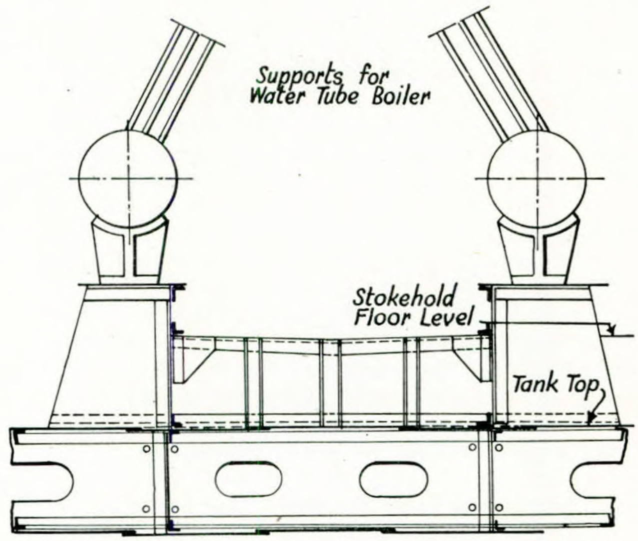



FIG. 61.

seating, but in the case of the others the holes are elliptical so as to permit of a certain amount of play. In this way any distortion arising from expansion in the boiler is not restricted. There will be no need for collision chocks or stays with this type of boiler as the method of securing to the seatings will itself prevent movement due to rolling or sudden change of speed.

## Shaft Tunnel, Thrust Seatings and Tunnel Stools.

The tunnel may be said to serve a dual purpose. It prevents the cargo from coming into contact with the revolving shaft, and in the event of damage aft leading to a serious inrush of water, it is reasonable to suppose that the latter will be restricted to the tunnel. For this reason then the tunnel must be strongly built. The plating will be arranged in fore and aft strakes, and the transverse stiffening will consist of heavy arched angle bars fitted at intervals not exceeding three feet. The tunnel top plating will be increased in thickness immediately under the squares of the hatches. Access to the tunnel is through a watertight door fitted on the engine-room bulkhead, which of course gives immediate access to the thrust recess compartments.

To enable the thrust shaft to be unshipped if required, the opening in the bulkhead must be big enough to permit the flange to pass through. It is usual to close this opening by means of portable pieces of plate bedded on felt or red lead and bolted to the bulkhead. There is of course a gland at this position. The tunnel is built slightly off the centre line so that a passage way may be left for the engineers, usually on the port side. The tank top forms the actual base of the tunnel, but although there should not be much water lying about on the bottom in a modern vessel, it is usual to fit a wooden platform about a foot above the inner bottom. The height of the tunnel should be enough to provide reasonable head room. It would be very inconvenient, not to say serious, were the tunnel to become flooded, and a drainage well is fitted at the after end to prevent seepage past the stern tube finding its way through.

The importance of the part played by the tunnel as

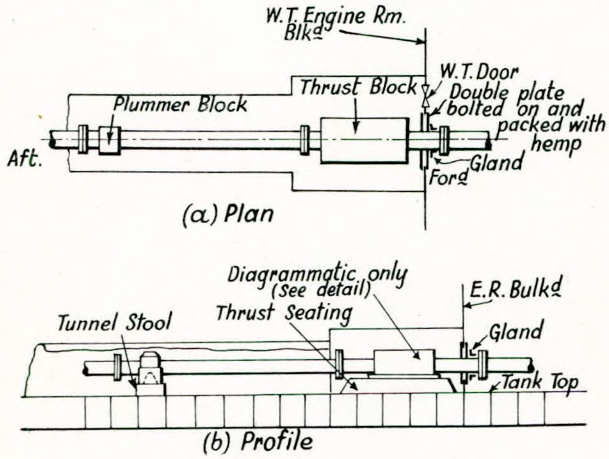



FIG. 62.—*Thrust recess and tunnel.*

an effective element in the watertight subdivision of the ship is not always appreciated and engineers will be well advised to take great care that the plating is kept free from rust, in sound condition, and they should ascertain that both the gland and the watertight door on the engine-room bulkhead are kept in a good state of repair. Figs. 62 (A) and (B) show the general arrangement in way of the engine-room bulkhead.

## Thrust Seatings.

Thrust seatings must be strongly built, and if as previously mentioned the thickened tank top under the engine bedplate be extended far enough aft to take the thrust seatings, there will be little chance of relative movement between engine and thrust block. Fig. 63 illustrates a typical arrangement of thrust seatings. It consists of two vertical fore and aft plates adequately supported transversely by means of diaphragm plates. The longitudinal adjustment of the lower portion of the block is of importance. To facilitate this the holes which take the holding-down bolts are elliptical. At each end of the block heavy chocks or angle irons are riveted to the top of the seating and teak wedging can be driven in to secure the precise fore and aft location. The bolts are now hove down, and friction alone should be sufficient to hold the block and transmit the thrust.

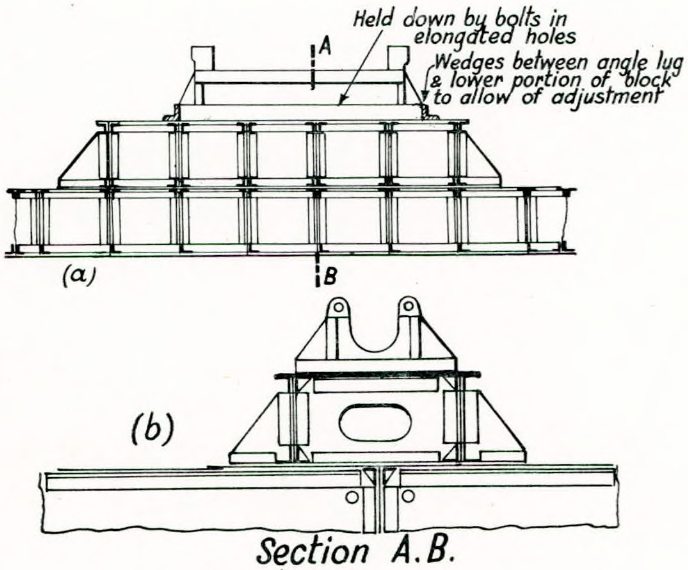



FIG. 63.—*Thrust seatings.*

## Tunnel Stools.

These are provided at intervals in the tunnel as required by the engineers. Their construction is simple, although needless to say they must be comparatively strong and rigid if correct alignment of the shaft is to be maintained. The correct support of the shaft is primarily

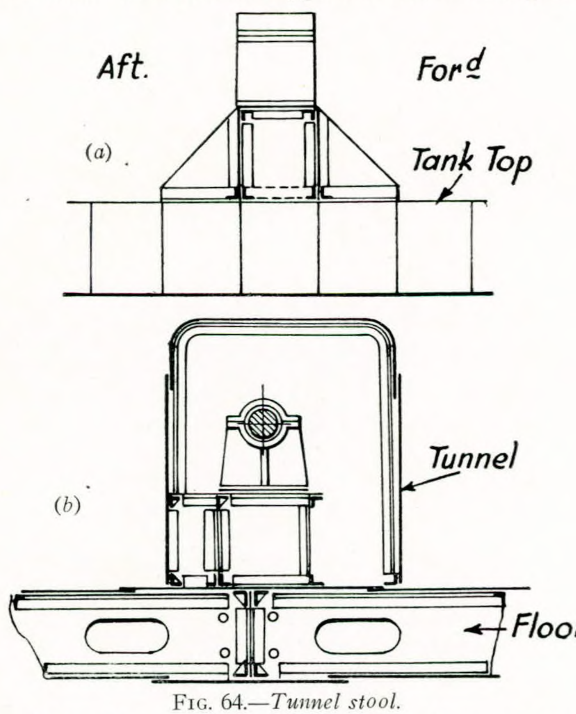



FIG. 64.—*Tunnel stool.*

the affair of the engineer, but vibration is a matter which also concerns the naval architect. It may be opportune therefore to hint that a slightly irregular disposition of plummer blocks might do something to reduce the effects of whipping. The actual construction of a tunnel stool will be understood from Figs. 64 (A) and (B).

Machinery Casings.

Large openings have to be provided in the decks to allow of proper lighting and ventilating of the machinery space. So far as the boiler room is concerned the opening must be big enough for the funnel to pass through and yet leave ample room for fresh air to be supplied to the stokehold. The space around the funnel must be permanently open and is therefore covered only with iron gratings known as *fiddley gratings.* Clearly if no casings extended above the deck level the whole of the engine and boiler spaces would be liable to flooding in the case of the vessel being swept by a sea. It is for this reason that casings of a height of not less than 7ft. 6in. are fitted above the upper deck. Although most of the space in the lower parts of the engine and boiler rooms is occupied by machinery, this is not so in the upper 'tween decks. If the machinery casings be extended down to the lower deck, the wing spaces thus provided may be utilized as bunkers or store rooms. whichever is convenient. The space above the freeboard deck enclosed by the casings is known as the "light and air space", and when computing the tonnage deductions permitted for the machinery spaces, this space may be included as part of the machinery space if so desired. It is usual for the casings to extend over the whole length of the machinery compartments, but as all the space thus provided is not absolutely essential it is possible to allocate some of it for housing the donkey boiler, etc. Bearing in mind that engines and boilers will not be shipped until after the launch, but that the plating of decks and erection of casings will be advanced as far as possible, it is clear that the deck openings must be large enough to enable the machinery to be passed through them. Actually the job is not quite as simple as this, and certain portions of the casings and some of the half beams may have to be omitted until an advanced stage of construction.

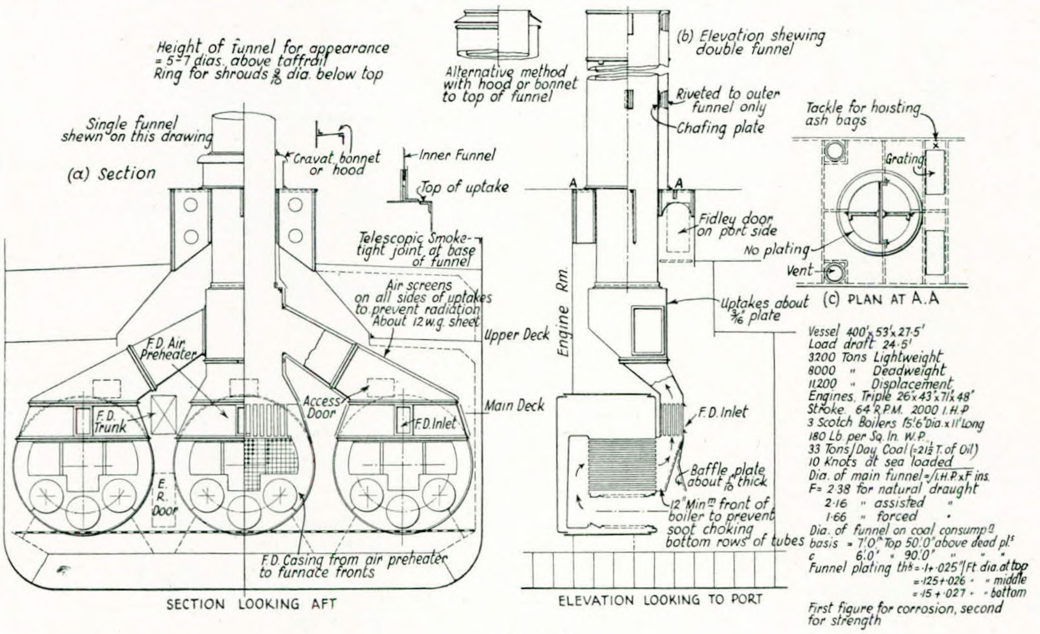



FIG. 65.

Large openings weaken the deck, and as frequently pointed out in this work the constructor must ever be mindful of the most appropriate means of compensation. A strongly constructed casing well connected to the half beams, and with strong beams fitted wherever possible, will do much to restore the strength of the deck. Deep coaming plates of substantial thickness are fitted at each deck, and they must extend sufficiently below the decks to enable the half beams to be efficiently connected to them. The plates forming the side of the casing are arranged in vertical strips the seams of which are single riveted. The stiffeners are spaced 2ft. 6in. apart and are of angle iron section about 4½in. × 3in. × 3in. thick.

Figs. 65 (A) and (B) will give a general impression of a typical arrangement of boiler casings. These drawings also show in some detail the method of supporting the funnel. No attempt will be made here to discuss the construction of the uptakes, although a careful study of the drawings may disclose some interesting features.

Fig. 65 (A) is a transverse section, and shows the method of bracketing when a single funnel only is employed. The arrangement is quite simple and consists of a few bracket plates riveted to the casings and also connected direct to the funnel by angle lugs. In some cases brackets are riveted to the funnel and rest on a shelf attached to the casings. In this way any slight vertical movement of the funnel resulting from expansion is unimpeded. To prevent the shipping of water under extremely heavy weather conditions, hinged plate covers are to be provided over the fiddley gratings. In Fig. 65 (B), which is a longitudinal view of the same ship, an alternative arrangement of the funnel is shown. The general structural arrangement of the ship and boilers is of course the same in both sketches (65 (A) and (B)), but in the latter a double funnel is shown. The method of bracketing and supporting the inner funnel is substantially the same as for a single funnel. The outer funnel is landed on the casing top and secured by means of an angle iron. Small brackets rivet on to the inner side of the outer funnel, and bear on chafing plates riveted to the outside of the inner funnel. Thus are the two funnels kept in their correct relative positions.

As a point of interest some details have been supplied relating to the vessel for which these funnels were intended, and a few hints are included indicating the method of determining the appropriate diameter and height of funnel.

# Abstracts of the Technical Press

**High-speed Water Transport.**

The passenger hydroplane "Express" which is now plying regularly between Sochi and Sukhum, two health resorts on the eastern coast of the Black Sea some 87 miles apart, is claimed to be the fastest passenger vessel in the world. After a series of preliminary experiments and tests carried out with scale models in 1921-1932 and numerous alterations in the original design, the actual construction of the vessel was begun in the summer of 1937. She was assembled for launching in the spring of 1939 and completed her preliminary trials at sea by the end of the following summer. The "Express" has since been employed on regular passenger service between the two ports referred to above throughout the past season. The vessel consists essentially of two identical hulls, each about 80ft. in overall length, with a moulded breadth of about 15ft. and a "stepped" bow. The maximum draught (at the propellers) is about 4ft. 7in. The upper portions of these twin hulls are rigidly connected by a platform-like structure extending over rather more than half their respective lengths and on this platform is a deckhouse of streamline form which extends the full width of the vessel, the total breadth of which is about 40ft. A portion of this breadth is accounted for by the exceptionally stout pneumatic rubbing-strakes or fenders secured to the outboard side of the fore-part of each hull. The frames and beams of the hulls are of tubular steel, with wooden planking and decks. The underwater portions of the two hulls are sheathed with a plastic material described as "Textolite", which is partly metallised and claimed to be immune from the action of sea water. A special form of bakelite varnish, developed by the Russian engineer Lobovich, was used for treating the hull planking and has proved to be eminently satisfactory in every way. The interior of the vessel is finished in sprayed-on cellulose. The subdivision of the twin hulls is identical, there being a watertight fore-peak, then a small compartment for the crew, connected by a W.T. door with the engine room just abaft it. Behind the engine room is a passenger saloon with a central gangway having facing-forward double seats on either side—as in a railway coach. Access to the saloon is obtainel by a stairway leading down from a lounge in the central deckhouse, but there is also an emergency exit for each saloon right aft. The lounge or observation room between the saloons in the port and starboard hulls is furnished with settees, tables and chairs, and is equipped with a bar. An entrance for embarking passengers is provided at each side, with the stairway to the lower saloon abaft it, then comes a cabin de luxe, a baggage compartment and a space for a lifesaving raft. The wheelhouse compartment is in the centre of the deckhouse and projects above it, with lavatories at either side. The after part of the deckhouse is occupied by the captain's cabin (P), W/T room (midships) and a double cabin for the chief engineer and the mate (S). The propelling machinery in each of the two engine rooms comprises two G.A.M.-34 petrol engines driving twin propeller shafts through clutches and reverse-reduction gears of special design. A small G.A.Z.-M.I. petrol engine for cruising and starting up purposes is connected to each of the inboard main engines through a clutch and a reverse-reduction gear. These six engines are all of the automobile type adapted for marine propulsion and are equipped with closed-circuit fresh-water cooling. The stern-tube bearings are lined with indiarubber and require to be lubricated by water only and the electric generators are arranged for cooling by water. The vessel is steered by means of small propellers mounted abaft the main propellers and concentric with them, operated by a wheel in the usual manner. The "Express" can attain a speed of over 47 knots with a full complement of 125 passengers and their baggage, while a cruising speed of over 38 knots can be maintained under ordinary service conditions. Although the attachment of the connecting platform to the twin hulls is adequately rigid and strong, the various sections of the vessel (twin hulls and central platform) can readily be disconnected for transport by rail to any port in the Soviet Republic. While it is not contended that the "Express" constitutes a solution of the present-day problem of high-speed marine transport, her designers can claim that the vessel represents an important step forward in this respect.—*V. A. Hartvig, "Soudostroienie", Vol. 10, No. 4-5, April-May, 1940, pp. 183-186.*

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**Wear and Corrosion of Hulls of Small Craft.**

The Leningrad Department of Inland Water Transport recently completed an exhaustive investigation of the causes and extent of wear and tear and corrosion of the hulls of river and harbour craft in Soviet Russia. The results of this investigation have now been published in the form of a report giving tabulated particulars of the dimensions and construction of 63 small vessels and of the nature and extent of the wear to which their hulls have been subjected. Of the 63 small craft concerned 42 are employed on the rivers around Kiev, 11 at Leningrad and 10 at Astrakhan. Almost all of the first-named group are open passenger launches of fairly recent construction, propelled by internal-combustion engines, whereas the vessels based on Leningrad are steam tugs—mostly built in Finland—with engines of from 100 to 280 h.p. The Astrakhan group comprises a number of tugs and miscellaneous vessels of pre-revolutionary construction and unorthodox design. The decks of such craft are frequently heavily overloaded, while the side plating is subjected to damage when going alongside piers and quays. Damage from ice is another important factor, the extent of which it is difficult to estimate. Broken stems are a common occurrence. The bottom plating is constantly buckled and distorted through running aground on rocks and hard river beds. The resulting wear and corrosion of such plating is particularly heavy and cases have been noted in which the rivet heads of the keel plating have been worn away. The plating around propeller stern tubes also suffers severely from the effects of wires and rope ends caught up by and wound around the propellers. The report sets out the following conclusions from the data available:—(1) Extensive buckling and rusting of the hull plating is usually observed after the vessel has been in service for a period of about five years; (2) when the vessel is 12 to 15 years old the bottom plating is liable to rust through and show holes at isolated places; (3) after 18 to 20 years' service rusting of the hull plating becomes so widespread as to necessitate extensive patching; (4) by the time the vessel is 20 to 25 years old the side plates as well as the bottom plating are worn through and require partial renewal; and (5) when the vessel is 30 to 35 years old the whole of the outer hull plating probably requires renewal and new decks are likewise necessary. The further life of the vessel is then dependent on the carrying out of large-scale external and internal repairs to the hull and equipment. Generally speaking, it has been found that the maximum useful life of the small craft at Kiev and Leningrad does not exceed 60 years, while that of the Astrakhan vessels is not more than 40 years. (Abstracter's Note:—*With reference to the apparently great ages of these small craft it must be remembered that local climatic conditions limit their annual period of service to a maximum of six months and that the actual years of service performed by such vessels probably amount to about 40 per cent. of their age.*)—*V. P. Joukov, "Soudostroienie", Vol. 10, No. 415, May, 1940, pp. 233-235.*

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**Internal Tension in Transverse Welded Joints.**

Investigations may be (*a*) photo-elastic, using models of Bakelite or glass, (*b*) dilatometric, using metallic test-pieces, (*c*) analytical based on the theory of elasticity. All welds may be reduced to combinations of two standard simple shapes. Method (*a*) shows a stress concentration of 6·92 and 4·75 at the base and tip of the deposited weld metal [see A. G. SOLAKIAN; *J. Amer. Weld Soc. 13, No. 2, 1934*], (*b*) gives values of 3·8 and 3·9 respectively [see BIRRETT AND GRUNING; *Stahlbau 6, No. 22, 1933*]. A test-piece *machined to the shape of the joint but unwelded* shows strength 0·4 to 0·8 that of the equivalent area in solid metal, corresponding to stress concentration of 2·5 to 1·25. Further, in analysis, the results depend only on the form and dimensions of the joint, but in actual practice the results vary approximately between 1 and 2. The author points out that technical application is based on neither conception but is absolutely empirical, tabulated values attributing a standard strength to the joint without regard to quality of the material. For homogeneous iron this is actually about half the ultimate stress and is the value which by experience has been found acceptable, but should harder materials become general, as in the modern trend, this basis of calculation may cease to be valid. He suggests that on superimposing a gradually increasing stress on a transverse weld, internal stress at first increases exactly as revealed by photo-elastic tests, but beyond the elastic limit localised deformation results in a more uniform stress distribution. From this it follows that a plastic metal should show a greater breaking stress, and a joint in perfectly elastic material should break at 1/7 the load deduced from photo-elastic experiments. A definition of plasticity is necessary, the obvious one being the ratio of areas below and above the yield point in the stress/strain diagram; as this is too cumbersome the author suggests the ratio of elastic to plastic deformation, *i.e.* $\lambda_e/(\lambda_r-\lambda_e)$, for iron and mild steel this is approximately equal to $\lambda_e/\lambda_r$. The ideal breaking load of the joint $\sigma_i$ is less than that of the metal $\sigma_m$, in proportion to the elasticity, *i.e.*

$$\sigma_m/\sigma_i=\phi[\lambda_e/2(\lambda_r-\lambda_e)]=f(\lambda_e/\lambda_r).$$

The following experimental results are reported for soft Swedish, ingot, common, and wrought irons, mild steel, and decarburized medium steel.

| $\lambda_e$ (%) | $\lambda_r$ (%) | $\lambda_e/\lambda_r$ | $\sigma_i$(Kg./mm.$^2$) | $\sigma_m$(Kg./mm.$^2$) | $\sigma_m/\sigma_i$ |
|---|---|---|---|---|---|
| 0·0906 | 29·0 | 1/320 | 21·5 | 32·0 | 1·49 |
| 0·1123 | 27·5 | 1/245 | 24·4 | 38·3 | 1·57 |
| 0·1155 | 26·0 | 1/225 | 25·3 | 40·8 | 1·61 |
| 0·1355 | 22·4 | 1/165 | 24·2 | 41·9 | 1·73 |
| 0·1824 | 21·0 | 1/115 | 24·4 | 46·0 | 1·89 |
| 0·2270 | 15·9 | 1/70 | 24·2 | 55·2 | 2·28 |

These figures satisfy very closely the empirical relation

$$\sigma_m/\sigma_i=7{\cdot}2391(\lambda_e/\lambda_r)^{2/7}+0{\cdot}0409,$$

and from this ratios of 1·1 and 7·28 are obtained for perfectly plastic and perfectly elastic materials, in good accordance with experience. The second value is higher than that deduced from photo-elastic determinations on Bakelite at low loads, the author concludes that under these conditions some plastic deformation does, in fact, occur, and suggests that tests on glass models might give more concordant results. While the above equation cannot be considered exact there appears to be unequivocal correspondence between malleability of the metal and strength of the joint resulting, which suggests that a welded joint is *ab initio* unsuitable for metals of high tensile strength and low plasticity. A possible development might be a heterogeneous bond of weak and ductile materials.—*Guido Guidi; Acta Pontif. Acad. Sci., 4, No. 6, 1940, pp. 37-46.*

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**The Automatic Control of Central Fan Systems in Winter Operation.**

The purpose of this paper, which was awarded the Charles Ellet Award for 1940 by the Western Society of Engineers, is two-fold, and it is accordingly divided into two parts. The first part deals with the development of the three main functions of winter central fan systems, *viz.* (*1*) heating, (*2*) ventilation, and (*3*) humidification. Some of the various problems to be considered in conditioning the air within a space are also discussed. The rapid spread of winter-air-conditioning has necessitated the development of automatic control of temperature and humidity, and the author therefore devotes the second part of his paper to a description, with the aid of schematic diagrams, of the operation of a winter central fan system. No attempt is made, however, to deal with the design or method of functioning of individual control devices. The author likewise considers ventilation and warm-air systems and their control, but states that the discussion of automatic control application to cooling systems or industrial conditioning systems lies outside the scope of his paper. He points out that the various control schemes described and illustrated are only a few of the methods suggested by one of the large control manufacturers in the U.S.A. and that these systems can be used with electrical, pneumatic or a combination of both types of controls. The author concludes by expressing the hope that his paper will give a better understanding of term "air conditioning" and that it will serve to show how important the automatic control of the functions of the winter central fan system is to the health and comfort of the entire community. The text of the paper is illustrated by seven diagrams, and a bibliography is appended.—*Paper by R. F. Erickson, "Journal of the Western Society of Engineers", Vol. 45, No. 2, April, 1940, pp. 59-78.*

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**New Air-conditioned River Steamer.**

The paddle steamer "Admiral" recently completed by the Carrier Corporation for Streckfus Steamers, Inc., of St. Louis, is claimed to be the largest river vessel ever built for excursion trips on inland waterways. The ship is 374ft. long and of steel construction, the sides being insulated with three inches of rock wool. The hull is divided into 74 watertight compartments and retains its buoyancy with 11 of them flooded. In order to give the ship a streamlined appearance the paddles are built into the hull, the customary paddle sponsons being eliminated. The vessel has five decks, and of these two are completely enclosed for air conditioning. They comprise a main deck or dance floor and a mezzanine or balcony floor for dining tables. The dance floor has an area of about three-quarters of an acre and will accommodate 2,500 dancers at one time. The air-conditioning system of the vessel is of the type employed in the largest transatlantic liners and is stated to have a cooling effect equivalent to the use of about 270 tons of ice daily. The system is zoned so as to distribute cooled dehumidified air evenly throughout the decks, irrespective of the direction of the sun on the ship. Provision for comfort on both the sunny and shady sides is necessary because of alterations in the course of the ship, so that more cooling has to be provided on the sunny side than on the shady one. The equipment for each zone consists of an outside air intake, a dehumidifier with six-row coils, a spray pump and the necessary air filters. Each of the four zone systems can deal with from 18,000 to 20,000 cu. ft. of air per minute. The air is discharged through registers in the ceiling and from the side walls under the low ceilings at the orchestra and mezzanine floors. Each of the four zones also has a small tempering heater for humidity correction and tempering of the outside air, should the vessel require a little heating in the late autumn. Condensing water is taken from the Mississippi River and discharged back into the latter through the condenser. The cold water circulating system consists of a centrifugal pump driven by a steam turbine on the lower deck, which pumps circulating water through the cooler to the four dehumidifier sections located above the paddle wheels, an arrangement which makes ingenious use of the waste space above them.—*"The Nautical Gazette", Vol. 130, No. 9, September, 1940, pp. 15 and 23.*

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**Slip Coupling for Electric Windlass.**

The accompanying illustration (Fig. 9) shows how a slip coupling designed for particularly arduous and onerous duty, is incorporated in an electric windlass of the type used on board ship. The slip coupling, which is of the multi-disc type and capable of transmitting large powers in a restricted space, is arranged between the motor and a worm gear, the motor driving an extension of the worm shaft by means of a flanged hub keyed to the latter, and the drive being transmitted to the outer casing of the slip coupling through friction discs. At the far end of the worm gear and mounted on the worm shaft is a

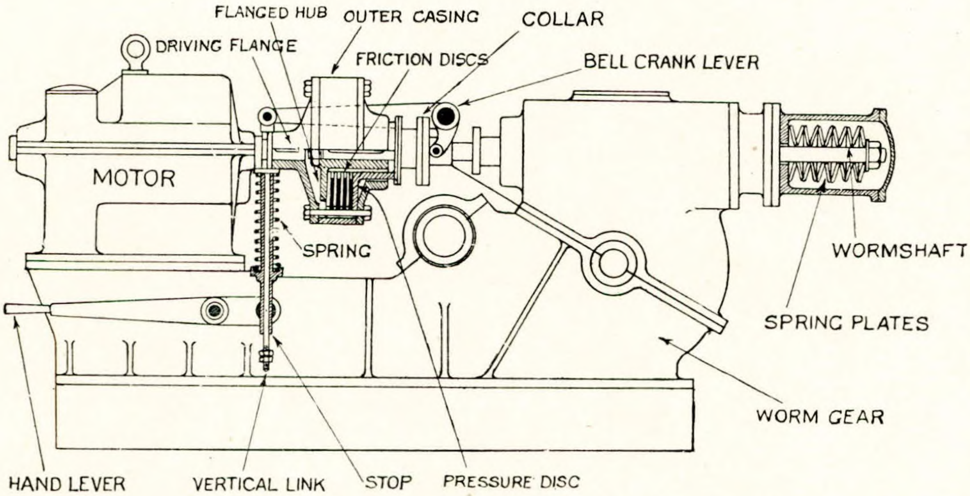


FIG. 9.—*Slip coupling for electric windlass.*

spring device built up of a series of dished plates. These are so adjusted that they hold the worm in its normal driving position relative to the worm wheel. In the event of a sudden and excessive overload, however, as by the jamming of an anchor in a hawse hole, the spring plates yield and the worm shaft is displaced axially. As stated above, a flanged hub is keyed to the worm shaft extension at the coupling end, and axial displacement of the worm also displaces this flanged hub, thereby disconnecting the clutch and protecting both the motor and gearing from damage. The worm shaft carries a ball bearing collar, to which the short arm of a bell crank lever is pin-jointed. The axial displacement of the worm shaft causes this bell-crank lever to follow the movement of the collar due to the action of the spring surrounding the vertical link, which comes up against the lower end of the adjustable tubular stop, thereby releasing the friction discs. To re-set the disc coupling after it has operated, the hand lever is depressed to compress the spring on the vertical link, causing the bell-crank lever to move the pressure disc to the left and thus again bringing the friction discs into action.—*R. Waring-Brown, "Power Transmission", Vol. 9, No. 104, September, 1940, pp. 342-345.*

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**High Tensile Steel for Shipbuilding.**

There are two varieties of steel with higher yield points and breaking stresses than the ordinary mild steel used in shipbuilding, *viz.,* that in which the improved qualities are obtained by the introduction of alloys, and that which relies on special heat treatment at the rolling mills to enhance the physical properties. If this latter class of steel is used there should be no difficulty in working it with ordinary shipyard machinery, whereas steels with a high carbon content and alloy steels require special machinery; they must be drilled instead of punched, for instance, and the cost of working them is substantially higher. Furthermore, any welding work which may have to be carried out with this class of steel is not as simple and straightforward a process as it is with ordinary mild steel. As regards corrosion, there is no appreciable difference between the various kinds of steels, although it has been claimed that some of the alloy steels have a greater immunity in this respect. The special quality steel which has been used in the construction of some cargo vessels is of the variety which owes its improved properties to heat treatment and as there is no difficulty in working and machining this material there would seem to be no technical objections to the employment of such high elastic point steel. The main obstacle to its extended use, however, is the fact that special quality steels are about 20 per cent. dearer than ordinary steels, so that the initial cost of a ship built of such materials must undoubtedly be higher. Even allowing for the decrease in dimensions, the reduction in the steel weight is only of the order of 7½ per cent., which means that the total cost of the steel required is about 10 per cent. greater than would be the case if mild steel were specified. This extra cost is, of course, only a fraction of the total cost of the ship and may be justifiable in the case of a passenger vessel. Another point to be considered is the fact that shipowners are not always anxious to increase the deadweight of their ships; the cubic capacity may be as important for them as the deadweight, and as the adoption of special quality steel has obviously no effect on the capacity, mild steel is the more economical material to use. It is reported that it was considerations of this nature which induced a well-known shipowning firm to abandon the experiments which they had been making in the use of special quality steel.—*"Fairplay", Vol. CLV, No. 2,993, 19th September, 1940, p. 316.*

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**The U.S. Destroyer Depot Ship "Denebola".**

Built at Seattle in 1919 as the cargo steamer "Edgewood" and acquired from the U.S. Shipping Board by the U.S. Navy in 1921 and renamed "Denebola", the vessel was fitted out for duty as a destroyer depot ship. Soon afterwards, however, the ship was paid off to be relegated for service as a floating barracks at the Norfolk Navy Yard and subsequently laid up entirely. Early this year the "Denebola" was brought forward for a further period of service as a destroyer depot and repair ship and underwent a thorough refit and partial reconstruction at Baltimore Yard. She is a single-screw vessel, 423ft. 9in. by 54ft. by 37ft. 9in., with a draught of 20ft. at her service displacement of 10,000 tons, equipped with D.R. geared turbines of 2,500 s.h.p. and three oil-burning single-ended cylindrical boilers, giving her a speed of 10½ knots. The auxiliary machinery includes eight air compressors, two turbo generators and a reciprocating-engined dynamo with a total output of 350 kW., and a large distilling plant. The ship is primarily intended to serve as a mobile repair base for destroyers and to carry out every class of repair work that can be undertaken without dry docking. The "Denebola" is able to deal with four destroyers alongside at a time, supplying them with steam, electric current, distilled water, etc., thus allowing them to shut down their own main and auxiliary machinery. In the course of her recent refit the "Denebola" had a number of new machines installed in her repair shops. The latter are subdivided into eight major units, equipped as follows:—*Machine Shop:* Lathes, drilling machines, boring and milling machines. *Smithery:* Drop hammers, forges, grinders, etc. *Coppersmiths' Shop:* Forge, bending slabs, screw cutting machines, welding machines, etc. *Foundry:* Crucible, oven, cupola, furnace, etc. *Shipfitters' and Sheet Metal Shops:* Shearing and punching machines, sheet-metal working machine, etc. *Carpenters' and Joiners' Shops:* Woodworking machines, band saws, lathe, etc. *Instrument Shop:* Watchmaker's lathe, drill, etc. *Electrical Shop:* Lathes, grinders, coil winders, spreaders, etc.—*"Marine Engineering and Shipping Review", Vol. XLV, No. 9, September, 1940, pp. 78-79.*

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**Wooden Sailing Schooner Converted for Special Service.**

The "Anna Sophia", a wooden schooner, built in 1923, in Pennysville, Me., has been reconstructed by the Marine Basin Company, Brooklyn, N.Y., as a dynamite carrier for service between Wilmington, Del., and South American ports. The vessel was originally designed to carry granite and was of particularly stout construction. The hull is 102ft. long, with a beam of 30·6ft., a depth of 8·5ft. and a draught of 11ft. The 12-in. frames are spaced 15in. apart and planked with 4-in. yellow pine, with a sheathing in the cargo hold of 5-in. yellow pine. The ship was dry-docked in order to equip her with twin stern tubes and supporting struts just forward of the stern post. The outer ends of the tubes were fitted with spring-loaded oiltight stuffing boxes, the tubes being kept full of oil under pressure by a gravity tank in the engine room. At the same time the entire hull below the water line was sheathed with Muntz metal. The width of the rudder was increased by 12in. to enable advantage to be taken of the steering effect of the propeller slip stream. An engine room was provided by constructing a steel bulkhead across the hold, just forward of the mainmast. As a protection against sparks in the cargo hold, where the dynamite is stowed, the forward side of this bulkhead was sheathed with wood and the heads of the metal spikes which fasten the 5-in. sheathing in the hold were covered with cement. The present capacity of the hold is 200 tons of dynamite. The propelling machinery installed in the engine room comprises two 135-h.p. Superior Diesel engines running at 700 r.p.m. and driving the propeller shafts through Twin Disc clutches and 3 to 1 reduction gears, the clutches being provided for declutching the propeller when the vessel is under sail. Cylindrical fuel tanks, each of about 17 tons capacity, are arranged in the E.R. wings and further aft, under the poop, are the starting air tanks. The fuel and air tanks are supported from the deck beams by steel hangers welded to the tanks, with wooden saddles underneath to prevent swaying. Electric current is supplied by a 10-kW. propeller-shaft-driven generator working in conjunction with a 240 amp.-hr. battery. Auxiliary power is provided by a 5-h.p. Diesel engine connected through clutches to a 2-kW. generator, an 11-cu. ft. compressor, and an 11-ton general service pump. The old hand-operated anchor windlass has been adapted for power drive, a single-cylinder 5-h.p. Diesel engine being installed just forward of it and connected to the windlass by a train of gears. This engine can also be used to drive a warping windlass for handling the sails.—*"Motorship and Diesel Boating", Vol. XXV, No. 9, September, 1940, pp. 518-519.*

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**Launch of First C-1 Class B Type Ship with Geared Diesel Drive.**

The launch on the 8th August at San Francisco of the motorship "American Manufacturer", marked an important stage in the completion of the first of five such C-1-B passenger and cargo vessels under construction for the U.S. Maritime Commission. The ship is also the first all-welded sea-going vessel of her size to be launched at San Francisco. Her main dimensions are 417ft. 9in. by 60ft. by 37ft. 6in., with a gross tonnage of 6,750 tons and a displacement of 12,875 tons at a deep load draught of 27ft. 6in. The ship will carry a crew of 59 officers and men and have accommodation for eight passengers. The propelling machinery will consist of two sets of 7-cylr. 2-stroke Busch-Sulzer Diesel engines, each developing 2,160 b.h.p. and geared to a single propeller shaft through electro-magnetic couplings and S.R. gearing. The engines will normally run at 233 r.p.m. with a propeller speed of 90 r.p.m. The whole of the auxiliary machinery will be electrically driven, current being supplied by two 250-kW. d.c. generators directly driven at 350 r.p.m. by two 450-h.p. 6-cylr. 4-stroke Atlas Diesel engines. The service speed of the vessel will be 14 knots fully loaded and the bunker capacity of 760 tons is designed to provide a maximum cruising radius of 20,800 nautical miles. The whole of the main and auxiliary machinery, propeller shafting and steering gear was installed on board prior to launching. The total cost of the ship is to be $2,127,500 (£600,000).—*"Motorship and Diesel Boating", Vol. XXI, No. 9, September, 1940, pp. 535-536.*

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**Tests of Generating Units for C-1 Type B Ships.**

The Atlas Imperial Diesel Engine Company recently carried out a series of shop trials with the ten generator sets built at their Oakland works for the five C-1 type B motorships under construction at San Francisco, for the U.S. Maritime Commission. Each set consists of a 6-cylr. Atlas 4-stroke engine having a 13-in. bore and 16-in. stroke, developing 550 h.p. at 350 r.p.m. and direct-connected to a General Electric 250-kW. d.c. generator. The corresponding load on each engine is approximately 375 h.p. The main purpose of the tests was to ascertain whether the engines would operate satisfactorily on the heavy grade of oil fuel which is to be used for the main engines of the Commission's motor vessels. The generator engines were run continuously for 10 days, the horsepower load for the first 48 hours being 125, and for the remaining 192 hours the load was increased to 375 h.p., when the fuel consumption proved to be 0·379lb./h.p.-hr. The 10-day test was succeeded by a two-hour run at 450 h.p., when the same fuel consumption was obtained. The new engines differ from the Atlas standard design in that they are fully enclosed, thereby providing completely automatic lubrication for the rocker arms and valves. Another difference is that they have the Bosch fuel injection system in order to adapt them to burn the heavy, low-cost fuel specified. Provision for burning such fuel is also made by means of a steam pre-heater, supplied with low-pressure steam from a waste-heat boiler. Special attention has been paid to the cooling of the fuel-injection valves, which are directly water-cooled.—*"Motorship and Diesel Boating", Vol. XXV, No. 9, September, 1940, p. 523.*

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**American Naval Authorities' Ostensible Preference for Steam Propulsion.**

The U.S. Navy has recently acquired a number of ships from the U.S. Maritime Commission and private owners for service as fleet auxiliaries, and further vessels recently built or now under construction are to be purchased for that purpose. Although some of the ships already acquired are equipped with Diesel engines, the U.S. naval authorities are stated to be expressing a preference for steam-propelled vessels, and the writer of the article shows considerable concern at this policy, which he considers to be a mistake. He declares that there is nothing to choose between steam and Diesel machinery in regard to reliability and that the much debated question of relative cost of operation does not arise in this instance. Other things being equal, he points out, the importance of cruising radius is paramount and the ability of Diesel-engined tankers, hospital ships, supply vessels, repair ships, ammunition carriers and tenders to remain at sea for 30 days instead of 20 without refuelling, appears to constitute an irrefutable argument in favour of the motorship for auxiliary naval service.—*"Motorship and Diesel Boating", Vol. XXV, No. 9, September, 1940, p. 513.*

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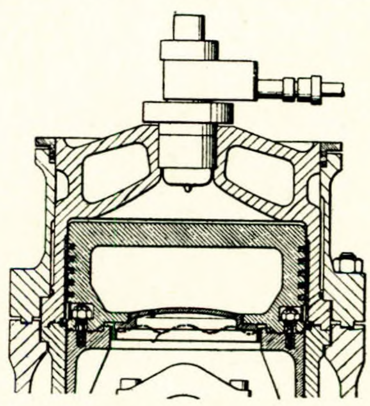
**Improving Piston Ring Accessibility.**

The accompanying diagrammatic illustration shows a simple form of construction adopted in a patented cylinder design developed by Sulzer Bros., which is considered to be of special value for yachts, tugs, submarines and other vessels where space —especially headroom—is limited. The usual cover-line joint has been lowered so as to render it possible to inspect—and, if nececssary, replace—the piston rings by merely breaking the



cover joint and raising the cover. This feature, in association with a two-piece piston, also makes it possible to remove the piston crown for an inspection of the cylinder bore and ports (of a two-stroke or Sulzer compound-admission four-stroke engine) simply by turning the particular piston on to bottom dead centre. A separate renewable liner is fitted inside the improved cover, the joint between the cover and liner proper being sinusoidal in the interests of ring wear.—*"The Marine Engineer", Vol. 64, No. 758, September, 1940, p. 211.*

**New Diesel Engine Thrust.**

A new compact propeller thrust bearing has recently been developed by the manufacturers of the Kingsbury thrust bearings, for mounting at the after end of a Diesel engine crankcase. Designated "Style GC", it embodies the standard Kingsbury feature of pivoted segmental thrust shoes bearing on a single collar. There are two such shoes on each side of the collar, and just beyond them is a self-aligning journal bearing which supports the weight of the flywheel. The lubrication of the thrust unit is entirely separate from that of the engine, saw-toothed bronze closures being fitted at each end of the former to retain the oil and to prevent any mixing with that from the engine. The closures, like the thrust bearing itself, are claimed to be practically non-wearing. Oil circulation in the thrust bearing is automatic, oil picked up by the collar from the bath being scraped off at the top of the collar and distributed to the thrust and journal surfaces. A copper cooling coil in the bath serves to absorb the heat due to oil friction as well as that penetrating into the unit from the adjoining crankcase. One of the first vessels to be equipped with the new bearings is the Union Barge Company's twin-screw river tug "William Penn", in which each of the two 650-b.h.p. Diesel engines is fitted with a "Style GC" bearing having a thrust collar 19in. in diameter and designed for a thrust load of about 21,000lb. per shaft.—*"Motorship and Diesel Boating", Vol. XXV, No. 9, September, 1940, p. 537.*

**"Details in Ship Construction".**

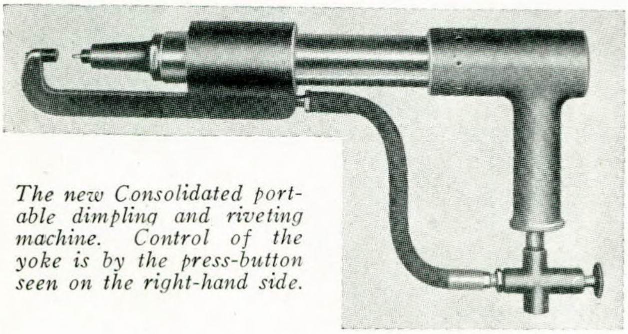
This paper is supplementary to one read by the author some years ago, and is, in the light of practical experience in new construction and repairs, intended to call attention to various structural details and fittings which have given trouble in service, together with suggested improvements. Among the items discussed are corners and boundary angles of tanks, plating around sternposts and frames, stem plating, ships' rudders and rudder posts and other structural details. Among the various fittings dealt with are hawse pipes, gangway doors, ash shoots, sounding pipes, scuppers, pipes in double-bottom tanks, engine-room skylights and sliding watertight doors. As it is difficult to obtain structural steel and fittings during the war period, the author has made no attempt to formulate new designs, but prefers to aim at improvements in existing practice, so as to effect a saving in time and material.—*Paper by A. W. Jackson, "Bulletin of the Liverpool Engineering Society", Vol. XIV, No. 2, 30th September, 1940, pp. 5-29.*

**Marine Insurance.**

The purpose of the paper is to present an outline of the principles and practices of marine insurance for the guidance of marine engineers. The author explains the object of marine insurance and the structure of the marine insurance market, and then describes the functions of Lloyd's and Lloyd's underwriters. He states that the present-day organisation of the marine insurance market comprises :—(*a*) Private underwriters and companies accepting *marine* risks on hulls, freights and cargoes; (*b*) Private underwriters and companies accepting *war* risks on hulls, freights and cargoes not insurable under various Government schemes; (*c*) State departments accepting construction and *marine* risks on certain mammoth liners and *war* risks on cargoes consigned to and from the U.K. in British and foreign vessels, also some cross voyages by British ships only; (*d*) Protection and indemnity associations undertaking on the basis of mutuality certain liabilities of shipowners not covered by the ordinary policy of marine insurance and also administering a scheme of ship and freight *war* risks insurance on British ships supported by Government reinsurance to the extent of 80 per cent. of the values involved. Other matters dealt with include insurance brokers, procedure of marine insurance, insurance institutions (Lloyd's agents and average agents, average adjusters, shipping registers, and salvors), the contract of marine insurance, hull insurance, claims, general average and third party claims. Facsimiles of policy forms are reproduced in the paper and explanations of their various clauses are given. In his concluding remarks the author points out that in the case of an accident from which a claim may arise, the primary responsibility must necessarily devolve on the chief engineer, but that the engineer on watch should nevertheless be as sedulous in his attention to detail as if it were his job to see the claim through to the end. A bibliography is appended to the paper.—*Victor Dover, "Transactions of the Institute of Marine Engineers", Vol. LII, No. 8, September, 1940, pp. 147-171.*

**Dimpling and Riveting.**

In many aircraft assembly operations it is difficult to make use of a standard type of flush riveter, and a portable machine which could be taken to the work would be of great advantage in speeding up production. The new Consolidated portable machine illustrated was produced for a specific instance of this kind and is now being produced as a special type for use particularly where access for riveting is greatly restricted. Both dimpling of the sheets and closing of the rivets can be carried out with this machine. Its operation is based upon that of the same firm's one-shot riveting gun, a special form of which is



*The new Consolidated portable dimpling and riveting machine. Control of the yoke is by the press-button seen on the right-hand side.*

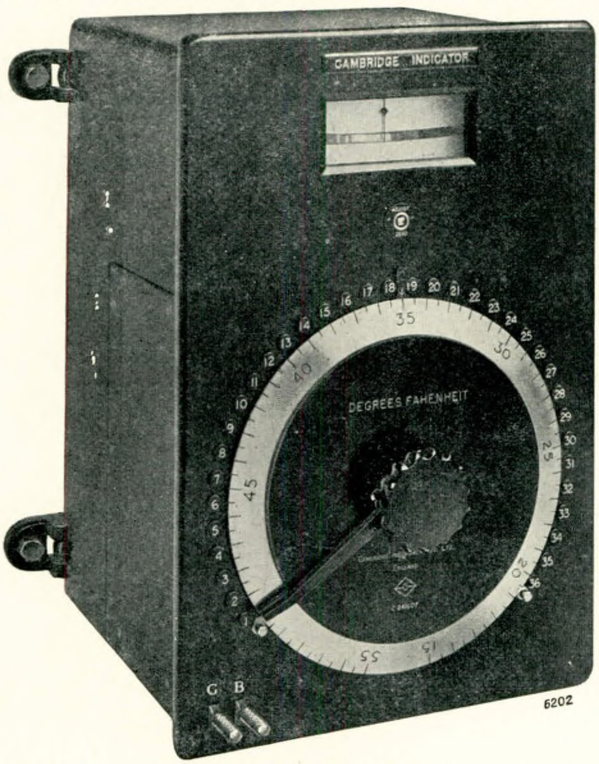
incorporated. A press-button valve mounted below the handle controls the opening of the yoke. Pressure upon the button exhausts air through a flexible pipe from a feed cylinder which slides upon the barrel of the riveter. The yoke is formed integrally with the cylinder and opens under the action of an internal return spring. With the yoke extended the riveter can be placed in position over the work. By releasing the button air is admitted to the feed cylinder and closes the yoke by overcoming the action of the return spring. Pressure on the handle then admits air behind the hammer piston and brings it down with one sharp blow on to the rivet set or dimpling tool. The weight of blow can be controlled by means of a knurled-head screw which allows for a very sensitive adjustment. Dimpling tool and rivet set are interchangeable in the nose of the machine. Yokes are obtainable having a throat depth up to 6in., and special types can be supplied to suit individual requirements. The machine has an overall length of 16¾in., with a weight of 6lb., and will close rivets up to $\frac{5}{32}$in. in diameter.—*"Flight", Vol. XXXVIII, No. 1,662, 31st October, 1940, p. 382.*

**New Self-righting Lifeboat.**

A ship's lifeboat of new construction has recently been built and tested in Sweden. It is of the pontoon type, entirely covered and built of steel. The boat measures about 21ft. in length and is provided with a superstructure under which can be accommodated 32 persons. At the bow and stern are small decks. Through the provision of a large number of watertight compartments the boat is stated to be practically unsinkable. It is also self-draining and self-righting. The boat is propelled by a 10 h.p. Bolinder oil engine, watertight enclosed, which gives it a speed of 5¾ knots when fully loaded. The boat is also well equipped in other respects. It has a wireless plant which can be used under the worst possible conditions. Warm food and drinks can be prepared on a special stove and the supplies are stored in watertight lockers. The new lifeboat has undergone comprehensive tests in the presence of Swedish shipping authorities with very satisfactory results. It has also been approved by the Swedish Shipping Inspection Board. The designer of the boat is a Swedish engineer, Mr. E. Sivard.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 35,177, 31st October, 1940, p. 5.*

**New Marine Storage Thermometer.**

The accompanying illustration shows a marine storage thermometer, developed by a well-known British firm of instrument makers, which differs from the usual type of appliance by the fact that it utilises a "null" or balancing method of reading, resulting in an open scale, a high degree of accuracy and great freedom from the effect of vibration. The "null point" method of reading is claimed to be extremely accurate and easily carried out in circumstances where vibration may cause "dancing" of the indicator pointer. The indicator, together with




the slide wire and a selector switch enabling 6, 12, 18, 24, 26 or 40 thermometers to be connected, is totally enclosed within a metal case, which may be arranged either for bulkhead mounting or for flush mounting on a panel.—*"Modern Refrigeration", Vol. XLIII, No. 511, October, 1940, p. 209.*

**Extending a Motor Shaft.**

The extension of small electric motor shafts without removing the rotor, is an operation that is sometimes necessary. Experience has shown that ordinary steel welding is not satisfactory because of scaling which reduces the journal diameter several thousandths of an inch. Most motors run in bronze bearings, and it is normally not good practice to run moving parts in bearings of the same metal. It has been found, however, that bronze-welding rod is well suited to the job. The deposited

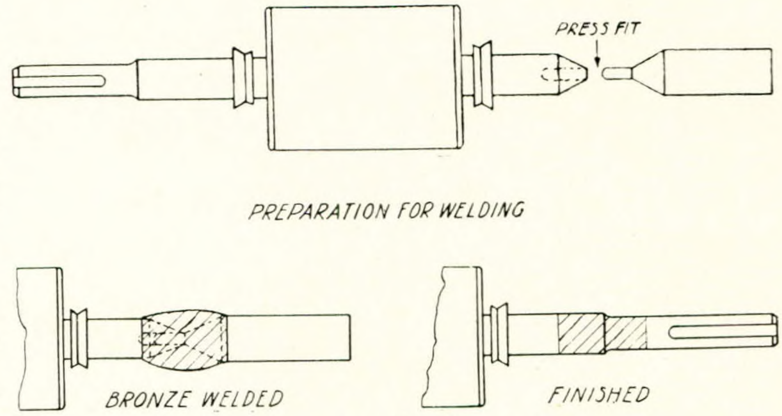



FIG. 2.

bronze makes a perfect joint and is hard and tough enough to wear well against either bushing bronze or the so-called pot-metal alloys. In addition, the welding rod can be applied at a low temperature to prevent scaling. The accompanying sketches, Fig. 2, clearly illustrate the method used for extending motor shafts. The end of the shaft to be lengthened is first tapered and drilled just large enough to take a small pilot. A piece of cold-rolled steel $\frac{1}{16}$ to $\frac{1}{8}$in. larger in diameter than the desired finished size is then turned on one end and pressed into the shaft. This serves to line-up the work ready to be welded. The shafts chucked and trued with an indicator or tied back on the centre, the welded end being run in the steady rest just back of the weld. Bronze welding rod is then applied. After welding, it has been found advisable to release whatever stresses may exist by first taking a roughing cut over the joint, then recentring and refinishing.—*"The Welding Industry", Vol. VIII, No. 9, October, 1940, p. 259.*

**Turbine Blade Vibration.**

It is well known that one of the principal difficulties confronting the present day turbine designer is the avoidance of blade vibration troubles. Blade vibration, leading to fracture by fatigue, arises where any periodic forces present when a turbine is running happen to have a frequency with which some of its blades can resonate. As these frequencies are generally very high, being of the order of several hundreds a second, it is usually only a short time before the blade has experienced enough stress reversals to break by fatigue. The prevention of blade vibration has come into prominence in recent years as a result of progress in turbine design towards higher efficiencies and larger outputs from given frame sizes. Contemporary turbines have proportionately longer blades than was once the general practice, and such blades are correspondingly more liable to resonant vibration. The problem is not, however, one which can be accurately stated in simple terms, and the measures taken to solve the problem and to avoid the trouble are equally diverse and hard to summarise. The measures of prevention are, generally speaking, the results of two lines of study, one directed to the causes of vibration and the other to the nature of the phenomenon when it occurs. The principal cause of blade vibration is rapid variation in the steam forces acting on the blades. Full circumferential admission and accurately similar nozzles at all points on the ring are needed to eliminate this cause. Study of blade vibration itself results in "tuned rotors" in which the resonant frequencies of the blades are arranged so that they will never coincide with any of the vibration frequencies likely to be met in service. Such tuning, while important for normal constant-speed turbines, becomes critically so for variable-speed turbines of the kind which drive pumps, in which vibration exciting forces are provided at a wide range of frequencies. Study of blade vibration has to be qualitative as well as quantitative. The problem is not only one of calculation and measurement; it is also necessary to discover all the ways in which the blade on any one wheel can vibrate. It is found that these vibrations can take place in a large number of different modes, both singly and in groups, and that these modes vary from wheel to wheel. Much light has been thrown on this complicated problem by a device consisting of a small air turbine carrying an unbalanced weight, which device when attached to a rotor or to a segment of blades, applies alternating forces at any desired frequency between about 4,000 and 40,000 per minute. In addition to revealing all the many modes of possible vibration, this device also allows their frequencies to be accurately measured. Other methods of study generally employed for investigating the problem make use of electro-magnetic vibration-excitation with appropriate electrical apparatus for recording and measurement. The frequencies obtained from experiments on stationary blades have to be corrected by calculation for the centrifugal force, etc., existing under running conditions. Finally, all the evidence is utilised in an appropriate choice of blade sections or lengths, the shrouding, binding wires, etc., to attain the desired tuning. The turbine, when completed, is then doubly protected against blade vibration, by elimination of cause and prevention of effect.—*"The Allen Engineering Review", No. 8, October, 1940, p. 2.*

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**Large Controllable-pitch Propellers.**

Controllable-pitch propellers have been used in a number of small craft belonging to Scandinavian owners for some years past, but until quite recently no designs for their application to large ocean-going vessels had been considered. Just before the outbreak of war, however, the question of fitting a controllable-pitch propeller to a 16,000-ton Norwegian tanker equipped with a 4,000-b.h.p. Diesel engine was under discussion. The accompanying diagrams (Fig. 3) show the layout of the arrangement proposed. The control is carried out electrically from the bridge and when the manœuvring lever is operated it starts an electric motor which moves the sliding rod in the propeller. The oil pump is chain-driven from the propeller shaft at a speed of 900 r.p.m., but when manœuvring is carried out a larger pump driven by an electric motor is automatically brought into operation. The oil is continuously cleaned by passing through a filter. On the bridge there is a dial indicator for showing the propeller pitch. In this particular installation the propeller was to be 15ft. in diameter.—*"The Motor Ship", No. 249, October, 1940, pp. 230-231.*

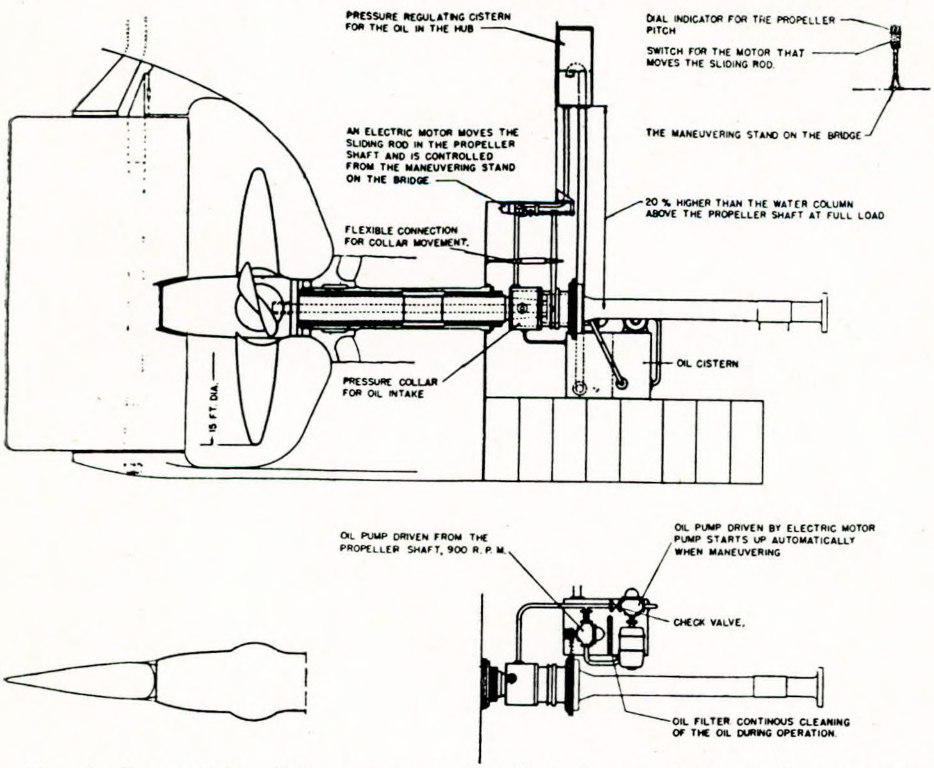


FIG. 3.—*Proposed installation of a contro llable-pitch propeller in a 16,000-ton motor tanker.*

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**Powdered Metal and Bakelite Bearings.**

Bearings of powdered metal and bakelite are discussed by M. Melhuish in a paper entitled "Bearing Metals and their Suitability for Modern Requirements", published in a recent issue of the *Journal of the Institute of Automobile Engineers.* Such bearings are normally manufactured from bronze powder of the copper-tin class, although they can be made from ferrous metal. The powder is placed in a mould and compressed to shape under pressure and then hardened by sintering. The bearings should not be machined except for reamering the bore when in position, as if they are machined the tool is liable to tear particles out instead of cutting through. The oil-impregnated type is manufactured in a similar manner, and after the sintering process the bearings are immersed for a short time in mineral lubricating oil, heated to about 240° F. and then cooled off in cold oil. These bearings usually contain 30 to 40 per cent. of lubricant by weight. The same process can be used to re-impregnate bearings that have lost their oil from prolonged storage or any other cause. No emery paper or other abrasive should be used in fitting this type of bearing, as the cellular or porous nature of the material may cause small particles of abrasive to penetrate its surface and act as a lap with disastrous results to the shaft. A fine file or scraper should be used to remove burrs or to form small radii. The advantage of employing this type of bearing in places where lubrication is difficult is obvious. Lubrication is continuous and automatic, and varies with the pressure and temperature of the bearing. Oil grooves within the bearing can be eliminated. Some types of sintered bearings are rather brittle and will break or crack if subjected to shock, but the oil-impregnated kind are less fragile in this respect. Nevertheless, it is highly desirable that they should be forced home into their housings with the aid of a mandrel to ensure true alignment when being inserted. There is no surplus oil to cause splashing, neither is there any risk of seizure since a lubricating film is maintained between the surfaces, this film adjusting itself automatically according to the pressure and temperature of the bearing. Synthetic resin and resin-bonded fabric materials of the phenol formaldehyde type have gained a certain amount of popularity for bearings where heavy pressure obtains. They are made from laminated fabric which has been impregnated with synthetic resin. The material is generally made in blocks from which the bearing itself is machined. This makes a very strong job, and will stand considerable pressure. Owing to their low factor of heat conductivity it is usual to lubricate these bearings with water to carry away the heat. If great strength is required it can only be obtained by winding woven fabric on a mandrel of the desired size before impregnating. Bearings made in this manner will stand up to most duties within the bounds of their limitations. The material is light, takes on a good finish—an essential feature of a good bearing—possesses a low coefficient of friction, and by using modern resins, can be lubricated with oil. It is doubtful, however, whether this material will be developed to such an extent as to make it a serious competitor to other bearing materials now in use in internal combustion engines.—*"The Engineer", Vol. CLXX, No. 4,422, 11th October, 1940, pp. 240-241.*

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**Engine Telegraph Interlocking and Safety Mechanism.**

An improved form of interlocking device for a marine Diesel engine control system is the object of a recently published British patent, the patentee being a Dane resident in Copenhagen. Referring to Fig. 1 of the accompanying diagrams, the engine-room telegraph (1) has an indicating pointer (2) connected with the reply handle (4) by a pin (3) which engages a recess in an arm attached to the pointer. The reply handle is secured to a shaft (5) in a housing which is bolted on the engine frame (6). The shaft carries a cam (7) having an oblique rim (7′) engaged by two rollers (8) mounted in the upper end of a lever (9). The lower end of this lever is pivoted on a pin (10) and has an arm (11) coupled to a rod (12) which works the starting air distributor control; the mechanical connection is not shown in the diagram. A hand lever (14) working over a quadrant (15) is provided for starting and fuel control through the medium of a rod (16). Assuming the engine to be running ahead and the order is given for astern operation, the reply handle can be turned anti-clockwise, but only so far as position A. When the fuel lever (14) is pulled back to the stop position the reply handle is released and it can then continue its motion through the reversing interval V, causing the levers (9, 11) to move and reverse the starting air distributor through the rods (12, 13), owing to the action of the rim (7′) on the cam (7). Turning the cam effects a displacement of the end of the lever (9) carrying the rollers (8). While the reply handle (4) is being moved through the reversing interval V, the locking mechanism secures the starting and fuel control lever (14), which is prevented from leaving the stop position. When the handle has passed beyond position B, the lever (14) is free to move and the engineer is then enabled to start the engine in the reverse direction. In the diagram the reply handle (4) is shown in its central position, reversal having been commenced but not yet completed.—*"The Motor Ship", Vol. XXI, No. 249, October, 1940, p. 237.*

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**Electric Winch Controlling Device.**

A recently-published British patent concerns an electric control for winches, the object being to provide an arrangement for automatic adaptation to varying conditions of load and give safety with high speed of operation. The device has been developed by a well-known firm of engineers in the West Country and is illustrated diagrammatically in Fig. 2 (accompanying previous abstract) which shows its application to a normal 3-ton winch having contacts (21) opening for loads exceeding 1 ton (heavy loads) and contacts (25) closing for light loads of under 5 cwt. When the winch is lowering with no load, the controller being in the full-speed lowering position, a circuit is established from the positive bus bar through contacts (22), a resistance (9), an auxiliary series field (5), a diverter resistance (8), the motor (2) and the contacts (24) to the negative bus bar. As the motor speeds up, the voltage across the armature rises, and since the contacts (20, 21) are closed, when the voltage rises to a value sufficient to operate the relay winding (10), the contacts (11) are closed. The main series field (4) is brought into action; as it is wound so as to oppose the auxiliary series field, the motor speeds up still further and a fast lowering speed is obtained. The shunt field (3) is permanently in connection through its own series resistance (7). With a small, safe load between 5 cwt. and 1 ton, the contacts (25, 26) are closed. The circuit extends from the positive bus bar through the relay winding (12) to the negative bus bar; the contacts (13) are accordingly closed. This establishes an automatic dynamic braking loop through a resistance (14), switches (15, 16, 17, 18, 19), the main series field (4), and the motor armature (2), the contacts (24) and the negative bus bar. A feed circuit extending through the contacts (22), the resistance (9), the auxiliary series field (5), the diverter resistance (8), the main armature and the contacts (24) still exists, the diverter resistance being in parallel with the contacts (11) and the main series field (4). Accordingly, safe lowering is obtained. Should the load exceed 1 ton and lowering be required, the circuits established are the same as those for the smaller load, except that the contacts (2) are opened and the relay (10) de-energised, leaving, however, the main series field (4) effective for dynamic braking. Accordingly, there is no risk of the load taking charge, and full control is maintained.—*"The Motor Ship", Vol. XXI, No. 249, October, 1940, p. 237.*

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**A Marine Diesel Engine Governor Adjusting System.**

This device is the object of a recently published British patent, communicated from Denmark. The purpose of the governor shown in Fig. 3 (accompanying abstract "Engine Telegraph and Safety Mechanism") is to allow adjustment in such a manner that when the engine speed exceeds the permissible limit, the device allows the machinery to run immediately at the maximum practicable speed below this. Furthermore, the "passive" system of the governor may be set so that extended pitching of the ship with the propeller out of the water for a comparatively long duration, does not cause the engine to run at an unduly fast rate. The governor comprises a double-

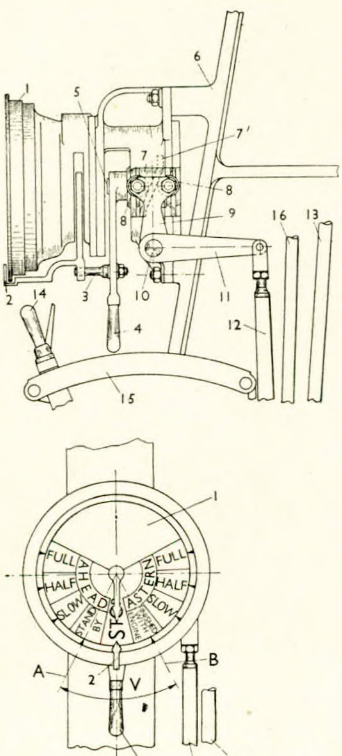


FIG. 1 (*left*).

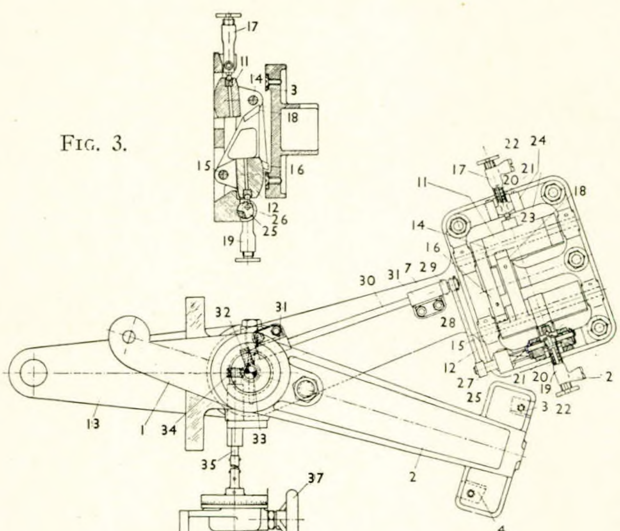


FIG. 3.

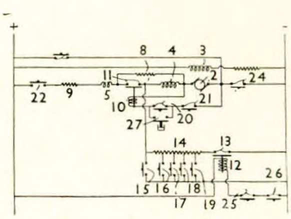


FIG. 2 (*right*).

armed lever (7, 13) pivoted on a bracket on the engine frame. One arm (13) is connected to the engine so that an oscillating movement is imparted, in time with the revolutions. The outer end of the arm (7), has a head with two apertures, in each of which a pendulum (11, 12) is mounted. Each pendulum turns on a pin (14, 15), one of which (11) comprises a ratchet (16) projected by a spring (17) into the position where the pendulum bears on the head of the arm (7). Correspondingly, the pendulum (12) has a ratchet (18) with a spring (19) so that the ratchet is kept retracted against the head. The "passive" system includes a lever (1, 2) mounted on the same pivot as the lever (7, 13) and of which one arm (1) is connected to links controlling the fuel supply. The second arm (2) is provided with two abutments (3, 4) with which the ratchets (18, 16, respectively) engage. Each spring device (17, 19) comprises a housing (20) enclosing a helical spring (21), the tension of which may be adjusted by a screw (22). The housing of the spring (17) is journalled in bosses (24), while that of the spring (19) is pivoted eccentrically in a rotatable shaft (25) by pins (26). The shaft carries a depending lever (27) connected by a rod (28) to a lever (29) on the end of an adjustment shaft (30); this shaft turns in bearings (31) on the lever (7) and carries a gear wheel (32) meshing with a rack (33) displaceable with the pivot of the lever (7, 13). Another gear wheel (34) meshes with the rack and is mounted on a shaft (35) rotated by a hand-wheel (37). When the engine is running at its normal revolutions, the pendulum bodies occupy the position shown in the small diagram. If racing occurs, the inertia forces overcome the pressure of the spring (19); the ratchet (18) is thrown out and engages the abutment (3), causing the control lever (1, 2) to move upwards, with the head, thereby reducing the fuel supply. During the following downward movement of the lever (7, 13) the control lever (1, 2) is also swung down as a result of the ratchet (16) engaging the abutment (4), so that the fuel pumps are again set for normal delivery. The spring load on the pendulum body (12) can be adjusted while the engine is running; this is effected by rotating the shaft (25). It is claimed to be possible to adjust the speed limit at which the pendulum is thrown out (and reduces the fuel supply) exactly, enabling the engine to run at approximately normal speed in bad weather without danger of racing.—*"The Motor Ship", Vol. XXI, No. 249, October, 1940, p. 237.*

#### New Type Tuna Clipper with Novel Propulsion System.

The Diesel-electric tuna clipper "Challenger", recently completed at San Diego, Cal., at a cost of $225,000 (£60,000) embodies a number of special features in her design, the hull construction being the subject of a basic patent application. The vessel has a length of 128ft. 6in., a beam of 27ft. and a depth of 13ft. 3in. The hull, which is of the raised foredeck type with cruiser stern, is of composite construction, Philippine mahogany being applied over an electrically-welded steel frame. There are three decks, the second of which is devoted to living spaces for the crew of 16 men, the wireless room, chapel, etc. The keel, 108ft. by 14in. by 16in., has a $\frac{5}{16}$-in. steel keel plate bolted to it and to this the steel frames 4in. by 3in. by $\frac{3}{8}$in., are welded on 19-in. centres, the deck beams, of similar dimensions to the frames, being likewise welded to the latter. The hull planking and decks are of $3\frac{1}{2}$-in. Bataan mahogany and additional stiffening of the hull is provided by two longitudinal $\frac{5}{16}$-in. steel bulkheads, traversing the shaft alley and secured to two 12-in. steel I-beams which extend to the fore peak, one on each side. The keelson space is utilised as a double-bottom fuel tank with a capacity of about 53 tons of Diesel oil. Steel tanks in the fore and after peaks hold an additional 33 tons of fuel. The propelling machinery consists of two 275-h.p., 8-cylr. Atlas Imperial engines, running at 514 r.p.m., each direct-connected to a 175-kW. 440-volt a.c. Westinghouse generator, and of one 200-h.p., 6-cylr. Atlas Imperial engine driving a 125-kW. 440-volt a.c. Westinghouse dynamo. There are three variable-speed propulsion motors driving a single shaft, the first being rated at 60 h.p. at 495 r.p.m., the second at 250 h.p. at 870 r.p.m., and the third at 500 h.p. at 1,160 r.p.m. Although coupled together and rotating simultaneously, power is applied to only one motor at a time. Thus, beginning with the 60-h.p. motor, this is brought up to its full speed, the initial current consumption for starting being just over twice the rated horsepower. As the second motor is by this time running at 495 r.p.m., the initial current required to increase its speed to 870 r.p.m. is not over 250 h.p. Similarly, in the case of the third motor, the initial current consumption required to bring it up to its full speed is less than the rated output of 500 h.p. The shaft to which these three motors are coupled drives the propeller shaft through a 5·8 to 1 double-helical type reduction gear, the full speed of the 3-bladed propeller being 200 r.p.m. The propulsion motors are controlled by means of a motor-driven drum-type switch in the pilot house. The 60-h.p. motor will drive the ship at a speed of 4 to 5 knots, the 250-h.p. motor at 9 knots, and the 500-h.p. motor at the full speed of $10\frac{1}{2}$ knots. This arrangement of propulsion motors is termed a "three-unit cascade assembly a.c. propulsion system" in the patent application filed by its designer. The drive is claimed to provide more complete flexibility than could be attained with a directly-connected engine, as any propeller speed between 40 and 200 r.p.m., either ahead or astern, is automatically selective. The starting current required for the propulsion motors in this "cascade assembly" is less than the full-load current. The primary circuit breaker is located just above these motors in the engine room, while the propulsion control board is on the main deck. The main switch-board is at the port side of the upper engine room. Although the combined power of the three Diesel engines is 50 per cent. greater than that required for the largest propulsion motor (750 h.p. and 500 h.p., respectively), the 37 auxiliary motors driving the refrigerating machinery and miscellaneous pumps, etc., require a total of 290 h.p. However, as all these motors cannot be in operation at the same time, the power furnished by the Diesel engines is more than sufficient for all practical requirements. The fuel capacity of the "Challenger" is designed to give the ship a cruising radius of over 7,000 miles at full speed and with maximum auxiliary load.—*"Motorship and Diesel Boating", Vol. XXV, No. 9, October, 1940, pp. 520-522.*

#### New Geiger Torsiograph for High-speed Engines.

The Geiger torsiograph, as hitherto constructed and largely used in conjunction with ships' Diesel machinery, is mainly adapted for relatively slow-running engines. An improved form of torsiograph suitable for use with high-speed engines has now been developed by Dr. Geiger, and particulars have recently become available. The range of frequency measurement of the new instrument is very wide, short belt lengths enabling frequencies of 10,000 per min. to be registered. Apart from aero engines, there are no machines possessing a higher natural shaft frequency. The higher torsiograph speed of the new instrument has made it necessary to replace the spiral watch spring formerly used for coupling the belt pulley and its internally fitted balance weight by two plate springs diametrically arranged in a radial

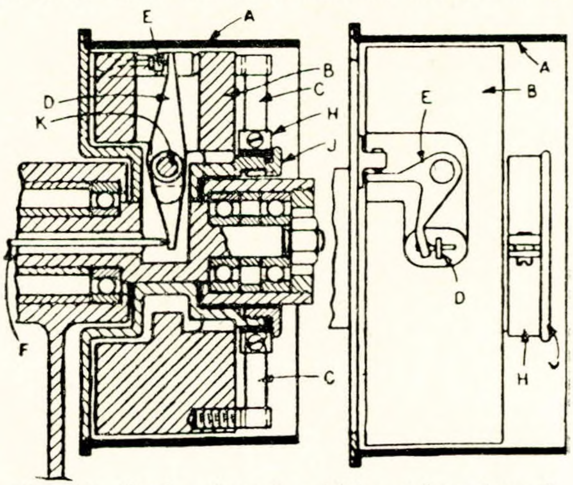



FIG. 10.—*Section through a high-speed torsiograph.*

direction. The inner ends are fixed to the hub of the belt disc and the outer ends are held in rounded slots in the disc flywheel. Instead of the bell crank lever transmission hitherto used for transforming the tangential rotary movement into a radial and then into an axial movement in the centre of the hollow axis, the new instrument makes use of another arrangement (E—Fig. 10), by which the tangential rotary movement is converted into an axial motion, but outwards to the periphery of the belt pulley. A radial self-extending double-armed lever (D) transmits this movement to one in the axial direction in the centre of the shaft. The motion is then transferred in the usual manner, through a needle on the recording lever (with three different magnifications) to a moving waxed paper band. Fig. 10 shows the arrangement of the new system in which centrifugal force cannot cause interference with the movement of the recording lever. The centrifugal force acts at right angles to the direction of movement of the lever (E). The lever (D) is self-balanced since the centrifugal force of the interior long and relatively heavy levers more or less equalises that of the light outer parts. The recording gear, clock-work, writing arrangement, time and dead-centre indicators are similar to those of the normal torsiograph, and the new instrument can be used to take a normal torsio-diagram as well as to record horizontal and vertical vibrations in vibrographs and to show the movements of small parts in acceleration or in relative motion graphs. In consequence of the high frequency at which the high-speed torsiograph operates, a clock mechanism recording ½ seconds or 1-5th seconds is provided. When using the new instrument as a torsiograph, it is observed that owing to the very small moment of inertia of the flywheel, the natural frequency of the flywheel plate spring is considerably higher—about 700 per min.—than with a normal torsiograph. Because of this the new device can only be used for torsional vibrations with frequencies of more than 1,300 per min. As, however, it is designed for high-speed engines, this is of no importance, since in machinery of this class vibrations of low frequency are seldom encountered. The combination of high frequency and waxed paper is claimed to give important advantages over ink or carbon, as it allows fine-lined diagrams to be obtained, which are sharper than with impressions on celluloid.—*"The Motor Ship", Vol. XXI, No. 249, October, 1940, pp. 220-222.*

**A Vibrating Reed Tachometer.**

It is often necessary to determine the speed of rotating or vibrating parts of machinery under circumstances which make it difficult, or even impossible, to obtain direct contact with an ordinary tachometer. A novel form of instrument designed for use under such conditions, has now been put on the market by an American firm. Known as the Frahm tachometer, this appliance operates on the vibrating reed principle, and only requires to be held against some part of the engine for a reading to be obtained. The mechanism comprises a series of accurately timed steel reeds, which, on the principle of resonance, become energised by the vibration of the machinery under test. A graduated scale enables the speed to be read direct. Among the advantages claimed for the device are the absence of wearing parts, no magnets or electrical connections, no load on even the smallest motor, and the fact that the instrument can be used in any position.—*"Shipbuilding and Shipping Record", Vol. LVI, No. 17, 24th October, 1940, p. 399.*

**Standardising Marine Oil Engines.**

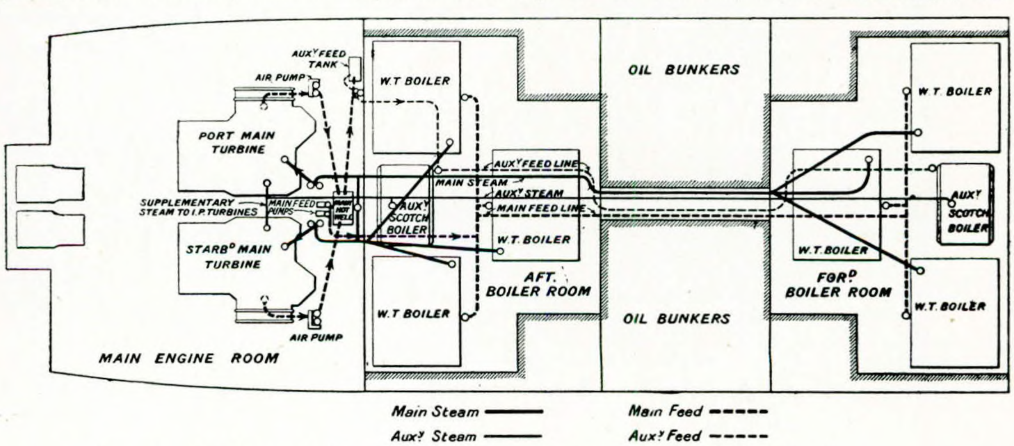
An effort is being made to introduce some degree of standardisation in the design of marine oil engines, as it is recognised that the number of models built is excessive and that some rationing of types would probably be welcomed by both manufacturers and users. Under ordinary commercial conditions agreement to a general policy would hardly be possible, but in the present circumstances an arrangement might be worked out. A committee, under the chairmanship of Sir John Lithgow, has accordingly been set up with the object of arranging for a more effective standardisation of the manufacture of internal combustion machinery.—*"The Engineer", Vol. CLXX, No. 4,423, 18th October, 1940, p. 258.*

**The Merchant Shipping Act and the Engine Room.**

Hopes are being expressed that certain long overdue and repeatedly deferred amendments to the Merchant Shipping Act will be made after the war. One of the weaknesses of the Acts is the computation of net tonnage with deduction for engine-room space, and this trouble goes back beyond the first Merchant Shipping Act. In 1819, when the builders' old measurement of burthen tonnage was the rule, and when the Government were desirous of encouraging the construction of steamers, an Act was passed which ordered that the length of the engine and boiler rooms, then generally combined and, of course, at the widest part of the ship, should be deducted from the length of keel for the computation of tonnage. It was very rough rule which failed to satisfy either the shipowners or the port authorities and under a later Act it was modified by stipulating that the machinery space should measure between 13 and 20 per cent. of the total cubic capacity for gross tonnage in order to qualify for a statutory deduction of 32 per cent. When this rule was framed it provided a reasonable engine room for the machinery of that day, but as engines and boilers have now become so much more compact, it requires great ingenuity on the part of designers to get the space between 13 and 14 per cent., a large number contriving to make it between 13·0 and 13·1. War-time conditions draw attention to the fact that this ingenious practice, although quite legal, does not allow the carrying capacity of modern ships to be utilised to the best advantage.—*"Shipbuilding and Shipping Record", Vol. LVI, No. 17, 24th October, 1940, p. 398.*

**The Johnson Boiler Feed System.**

The accompanying diagram shows the arrangement of the boiler feed system in the Canadian Pacific liner "Duchess of Bedford", the first of the four 21,500-ton vessels of the "Duchess" class built for the Liverpool-Montreal passenger service some 12 years ago. These ships were exceptional steamships in every respect, having the unusually economical specific fuel consumption of under 0·64lb. of oil per s.h.p.-hr. for all purposes. One of their most interesting features was the application of the successful patented boiler feeding system developed by the chief superintendent engineer of Canadian Pacific Steamships, Ltd.,




*Layout of Johnson boiler feeding system in the "Duchess of Bedford".*

Mr. J. Johnson, which utilised a combination of water-tube and Scotch boilers, the latter virtually acting as evaporators for the high-pressure water-tube boilers as well as supplying steam for certain auxiliaries. The system ensures absolutely pure feed for water-tube boilers and has, it is stated, proved eminently satisfactory wherever it has been applied.—*G. R. Hutchinson, "The Marine Engineer", Vol. 64, No. 759, October, 1940, pp. 227-228.*

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**Heating System with Grateless Boiler.**

A somewhat remarkable heating system, having an automatic temperature control of the water used for the heating radiators in relation to the outside temperature, had been developed in France just before that country was overrun by the Nazis. The boiler is enclosed in a sheet-metal asbestos-lined cabinet, which is surmounted by a fuel hopper of suitable size, closed at the top, and filled at intervals with anthracite or other smokeless fuel. The fire-box of the boiler is oval in form and has no grate. The fuel hopper opens into the roof of the fire-box and combustion of the fuel takes place in the pile on the floor of the latter. The construction of the boiler is shown in the accompanying sectional sketches—Fig. 2. Primary air for combustion enters the cabinet surrounding the boiler through a number of holes in the end door. Inside the asbestos-lined cabinet the air is heated by the heat of the unlagged boiler walls and passes into the boiler through a large-diameter pipe *A* situated behind the fuel hopper and opening into the casing. Through this pipe the air is carried to a chamber *B* under the fire-box whence it passes up through a short tube *D* in the roof of the chamber and emerges under a water screen *E* located at the back of the fire-box *E*. The function of the tube *D* is an important one, as its size regulates the amount of primary air admitted, and it is one of the two controls provided on the boiler. Once installed, however, this tube is never touched unless the type of fuel is to be changed, in which event the boiler regulation has to be adjusted to suit the new fuel. The volume of primary air admitted is regulated by the size of the tube *D* and is therefore determined once and for all before the boiler is lighted. The water screen *E* at the back of the fire-box serves to keep the coal from the fuel hopper directly above from falling into the air inlet. Coal falls down on the fire-box floor and forms a pile at its forward end, through which the primary air from under the water screen passes horizontally to permit combustion. As the fuel burns, the slag melts and is pushed forward towards the front of the boiler by the weight of fresh fuel above it, so that it can easily be removed in large cakes when the boiler is refuelled. To produce complete combustion of the gases formed by the combustion of the fuel, secondary air admission is provided by means of two air inlet pipes *G* at each side of the top of the boiler, the heated air entering the fire-box at the back, behind the pile of fuel. These secondary air inlets constitute the second of the permanent controls of the boiler, being provided with sheet-metal covers clamped over the open ends of the pipes *G* and pierced with a hole. The size of this hole determines the amount of secondary air which can be admitted, and it is altered only when the type of fuel is changed. Burning gases leave the fire-box through two openings *H* at the front and pass into a combustion chamber *J* above the fire-box, from which the hot burned gases pass through flue tubes *K* to a smoke collector at the bottom of the boiler and out by the flue *L* at the rear. During their passage through the flue tubes and smoke collector the gases give up heat to the water surrounding these elements. The somewhat long and complicated path of the flue gases introduces considerable resistance and precludes the use of natural draught. An induced draught fan is therefore provided for the flue L and is mounted at some convenient point outside the boiler cabinet. While this fan is running the boiler operates in an absolutely constant manner at its maximum capacity, since the amount of both primary and secondary air and the quantity of fuel and size and shape of the fuel pile are determined once and for all by the construction of the boiler. An alternative flow path for the gases is available, however, when it is desired to operate the boiler at less than maximum capacity. The flue tubes and smoke collectors are cut out of the circuit, and the gases rise directly from the fire-box into the chimney through a second flue *M* opening directly into the combustion chamber *J*, discharging directly into the chimney and by-passing the induced-draught fan. The operation of the latter is controlled by a thermostat governed by the water temperature in the boiler and by a butterfly valve worked by the fan motor in such a way that when the fan is running this valve closes off the second flue and opens it again when the fan stops. The construction of the boiler is such as to maintain the water at a substantially constant temperature, regardless of the outside temperature or heating requirements, so that to provide proper heating to the building it is necessary to regulate the amount of water at this temperature taken from the boiler for heating purposes. When heating requirements increase the quantity of water taken must increase, and *vice versa*. The amount of hot water taken out is controlled by means of a device called a "Variostat", not unlike a large bent-tube pressure gauge in its general conception. A flexible tube runs from each end of the bent tube of the apparatus, each tube ending in a large bulb. The whole of the tubes are filled with mercury. One of the bulbs runs to the outside of the building to be effected by the outside temperature, while the other is immersed in the pipe taking hot water to the radiators of the system. As the bent tube of the "Variostat" maintains a given shape, it follows that any variation in the outside temperature must be compensated by a proportional and contrary variation in the temperature of the water fed to the radiators. Instead of an indicator hand,

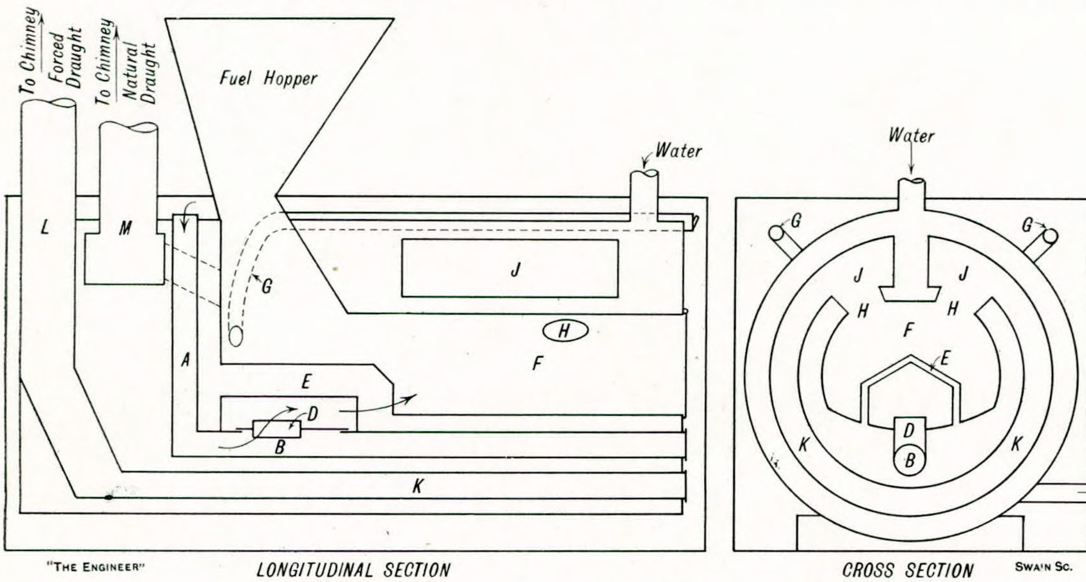


FIG. 2.—*Diagrammatic arrangement of boiler.*

as on a pressure gauge, the bent tube of the "Variostat" controls an arm bearing two or more mercury make-and-break contactors. Hot water to the radiators is supplied from a small mixing tank on which the "Variostat" is generally mounted, the supply pipe being led out from the top of this tank, while the return pipe from the radiators runs into the bottom of the tank together with a feed pipe from the boiler. Both these feed pipes are controlled by a butterfly or sluice valves. In addition, a branch from the radiator return pipe runs to the boiler to provide feed water, the amount of water supplied to the boiler through this pipe being equal to the quantity taken from the boiler to supply the mixing tank. The valves controlling the admission of either hot water from the boiler or cooled water from the radiator return pipe are controlled by small electric motors operated by the mercury make-and-break contactors on the "Variostat" in such a manner that when one valve is closed the other will be open. Variations in the outside temperature have to be compensated by contrary variations in the temperature of the water fed to the boiler, so that if the "Variostat" is to maintain its normal position it is clear that whenever the temperature of the water in the mixing tank drops below that necessitated by the outside temperature, the "Variostat" arm will be moved, thus causing operation of one of the mercury make-and-break contactors it carries, resulting in the closing of the valve on the radiator return pipe and the opening of that on the boiler supply pipe. When the temperature of the water has risen sufficiently to cause the "Variostat" arm to return to its former position, the mercury make-and-break contacts will again be reversed and the position of the valves reversed. Tests carried out with this heating system are reported to have shown an efficiency as high as 93 per cent. over a twenty-four-hour period. Heat carried off in the gases amounted to only 3·7 of the total available in the fuel, while radiation losses amounted to 2·6 per cent. The number of calories absorbed as latent heat by the evaporation of moisture in the fuel amounted to 0·28 per cent. of the total available, unburned fuel left in the cinders represented 0·25 per cent., and unburned gases accounted for 0·17 per cent. An analysis of the smoke showed a mean temperature of 235° F., and $CO_2$ content was 17 per cent., oxygen was 1·9 per cent., and CO was 0·1 per cent.—*"The Engineer", Vol. CLXX, No. 4,424, 25th October, 1940, pp. 269-270.*

**Vessels for Shallow Rivers in Soviet Russia.**

The Commissariat of River Transport of the U.S.S.R. is building a number of shallow-draught vessels for service on some of the smaller rivers of the Soviet Union. The first batch of these craft will have a draught of 10in. to 14in., and after they have been tested the construction of a large number of similar vessels will be undertaken. The building of these shallow-draught craft will make it possible to transport millions of tons of freight on shallow rivers. The standard type of these vessels will be a flat-bottomed pontoon, resembling a sledge in front. It will be 26ft. 3in. long, with a beam of 9ft. 10in., and a draught of 10¼in. Powered by a 21-h.p. producer-gas engine, such a vessel should be able to tow three 10-ton barges.—*"The Engineer", Vol. CLXX, No. 4,423, 18th October, 1940, p. 258.*

**Lubrication of Marine Refrigerating Plants.**

Although lubrication does not present such important problems in its application to refrigeration as it does to other forms of heavy engineering, it is necessary to ensure the correct lubrication of the various rubbing surfaces of the plant by correct methods of design and operation. In some respects the problems involved in the lubrication of refrigerating machinery are unique, as in the case of vapour compression, where mixing of the lubricant with the refrigerants is undesirable, while the ordinary problems of lubrication such as viscosity, temperature, density, etc., are still involved. Thus in the compressor, the bearings take a heavy load and if, as in most cases, the compressor is double-acting, both the top and the bottom bearing halves will need to be lubricated and the bearing metal in both parts is grooved accordingly. With rotary compressors, the same conditions for lubricating the bearings must be provided for. In the reciprocating type of compressor, while lubrication of the stuffing

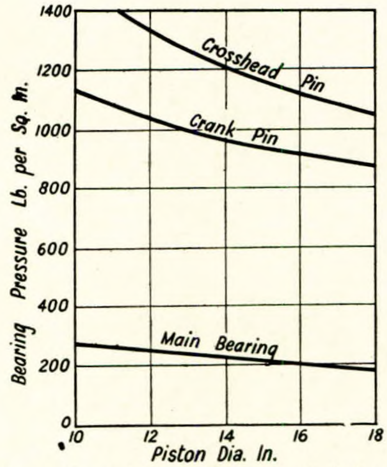


FIG. 4.—*Relative loads carried by principal bearings of a marine refrigeration compressor.*

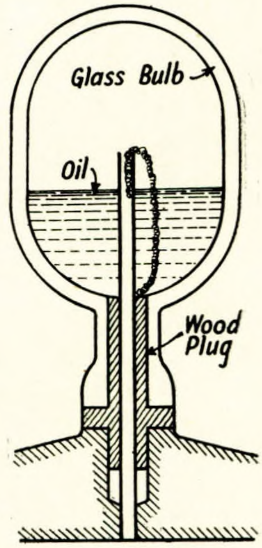


FIG. 5.—*Drip bottle lubricator.*

box helps to act as an oil seal, there is a tendency to flood the cylinder and so mix the lubricant and refrigerant. The crank and gudgeon pins bear high surface pressures and, together with the crosshead and crosshead-bearing pin, need lubricating with as much care as the main bearings. Auxiliary machinery such as brine and circulating pumps require lubricating at the bearings either by oil or grease. Mineral oils are generally used for the lubrication of refrigerating plants owing to their cheapness and freedom from acidity, combined with their satisfactory lubricating properties. Since the operating temperatures of a refrigerating plant must be very low it is possible to use mineral oils with their low flash point (300°-350° F.) without any fear of spontaneous combustion due to leakages of oil vapour into the plant. There is, however, some danger likely, due to the refrigerant reacting with the lubricant and causing dangerous gas pockets. Methyl chloride and ethyl chloride will dilute oil and for that reason it is necessary to use heavy, viscous oils in the lubrication of such plants, as also with rotary compressors, which require a viscous oil to act as a gas seal in the compression chambers. Glycerine and ethylene glycol have been experimented with as lubricants for ethyl chloride machines but without much success, because the refrigerant tends to turn these oils into sticky sludges. In addition to the gumming which is caused by these lubricants, a further disadvantage arises since glycerine is highly hygroscopic and it is essential that the lubricant should be thoroughly dehydrated. When sulphur dioxide is used as a refrigerant a chemical reaction is set up with any moisture in the lubricant, while with methyl chloride the moisture will be precipitated and freeze at the low temperatures, thus impeding lubrication and perhaps causing a seizure. For the lubrication of the compressor either the splash or forced-feed system of lubrication may be used; some drip-feed system is generally used for the pump bearings. Small vertical compressors of the enclosed type can generally rely upon the splash system in the crankcase for the lubrication of internal parts, with an oil ring for any outside bearings, although in machines using an eccentric instead of a crank the splash system is not so satisfactory since the oil needs to be carried to at least the shaft

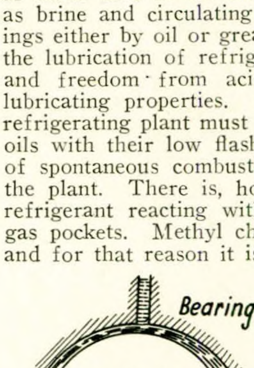


FIG. 6.—*Large bearing clearances are necesaary with the lubricator shown in Fig. 5.*

level. Larger machines need some forced-feed system with an auxiliary feed tank and pump. The force pump is generally of a cam or eccentric type and must be capable of distributing oil jets to the stuffing box and main bearings, a spray being made to shoot oil up under the piston to the gudgeon pin and cylinder walls, the overflow pipes being arranged to drip oil on to the connecting rod and crank. Drilled shafts and hollow connecting rods are also used with some forced feed systems in order to facilitate the distribution of oil on to the rubbing surfaces, since the boring of a small hole through the crankshaft does not appreciably weaken it, and the speed is not sufficient to produce high accelerating forces on the connecting rod. The

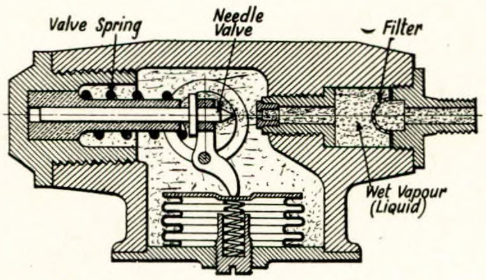


FIG. 7.—*Expansion valve.*

glands of most compressors are of the metallic type with a lantern ring of suitable metal inserted between the packing rings, through which oil may be introduced and made to lubricate the shaft and packing. It is also possible to connect this point to the suction side of the compressor in order that any leaked gas may be conducted through the communicating pipe back to the cylinder. Compressors which have a crosshead sometimes use two grades of oil—a very light oil of low viscosity for the internal parts subjected to pressure, such as the gudgeon pin, cylinder walls, and crankpin, with a more viscous oil for the less heavily loaded external parts. The relative loads carried by each part of the machine are shown in Fig. 4, from which it will be seen that the crosshead pin carries the heaviest load but is not subjected to the high rubbing velocities of the main bearings or of the crankpin. Pump bearings may be lubricated either by the oil-ring method or from a drip bottle, as shown in Fig. 5. In either of these methods the oil is fed slowly along the shaft but it is necessary for the journal to posses a tolerably large bearing clearance as Fig. 6, which shows that the shaft runs eccentrically and maintains a wedge of oil between the journal and bearing. Under the normal conditions in engineering the leakage of oil in the system does not cause any serious trouble other than to create an uncomfortable mess. With refrigerating engineering, however, the leakage of oil into the system is most undesirable and must be stopped, since it hampers the operation of the plant.

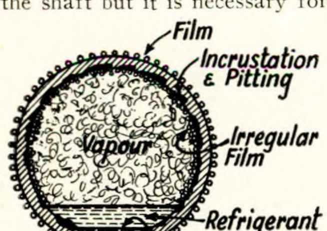


FIG. 8.—*Showing how oil leakage can impair heat transfer efficiency in the condenser.*

Acid oils will set up corrosion within the plant, which is always undesirable, and will tend to form deposits of scale which may become so serious at high temperatures as to make the piston seize, although leaked oil usually interferes with the valves and so reduces the manometric efficiency. If the oil passes through into the system it may get into the expansion valve, where it will congeal at the low temperatures and reduce the orifice area. This restriction in the valve grows rapidly and collects other foreign matter entering the system so that it will not only impede the correct interchange of heat energy in the refrigerant, but such a blockage may cause a serious rise in the back pressure of the condenser, with possibly serious consequences. This becomes more obvious when the various parts of an expansion valve, such as that of Fig. 7, are examined, and it is perfectly clear that a deposit of some sticky substance in the valve, such as oil, will cause harmful results. Oil leakage not only causes dangerous blockages in the compressor and expansion valves, but its very presence in the condenser will reduce the heat transference. That this is so is seen from Fig. 8, in which an exaggerated, yet fully justified, impression is given of the oil leakage. The heat transference through the pipe varies inversely as the thickness and is therefore decreased by the formation of a scale on the inside which slightly increases the thickness. Film thickness, which is so important in the transference of heat, is restricted by the scale which thereby reduces the heat transference still more. Comparative curves between the performance of a condenser when it was clean and when it was dirty are given in Fig. 9, from which it will be seen that the efficiency of a dirty condenser falls off rapidly. This oil leakage may be caused by the use of too much oil which is pumped into the system directly with the refrigerant; or it may be due to the evaporation of some of the oil, the vapour mixing with the refrigerant vapour and being thereby introduced into the system. Purge valves are introduced into most refrigerating plants in order to eliminate the collection of oil, since it can be blown through the valves by the

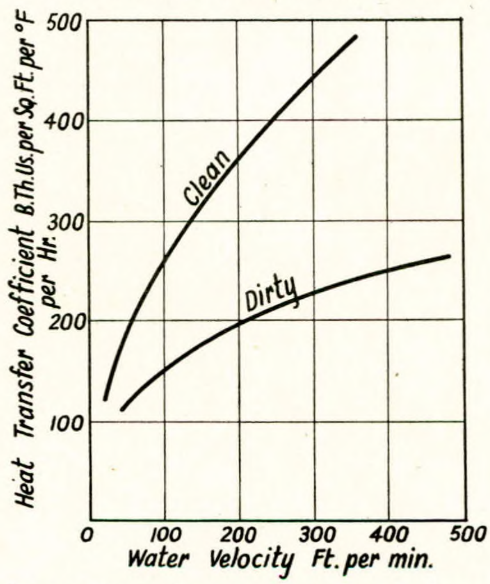


FIG. 9.—*Comparative performance curves for a clean and dirty condenser.*

pressure of the vapour behind it. When it is purged, this oil generally issues in long rolls of coloured sludge. One purge valve is usually fitted to the bottom of the condenser, while another is generally fitted to the bottom of the filter which is sometimes placed before the expansion valve in the circuit. It is only possible to fit these purge valves in the high-pressure side of the plant, since below the expansion valve all oil would have congealed and could not flow out. When purging ammonia plants, great care must be taken to prevent ammonia vapour from entering the room; the wearing of gas masks and rubber gloves is strongly recommended. Lubrication is just as necessary for refrigerating plants as it is for any other machinery, the important factor being that a refrigerator is a plant with several independent units, while most other machinery comprises one large unit. Oil logs should always be maintained and from them the performance of each unit may be checked and any rise in oil consumption immediately controlled by taking the appropriate action of either adjustment or repair.—*R. A. Collacott, B.Sc.(Eng.), "The Marine Engineer", Vol. 64, No. 759, October, 1940, pp. 219-221.*

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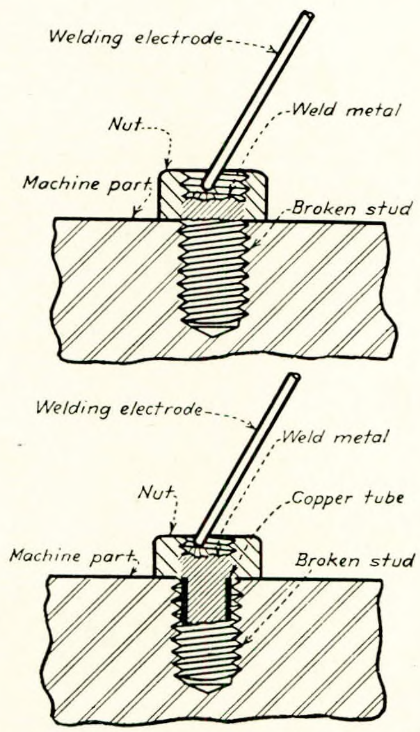
**Removal of Broken Studs.**

The accompanying illustrations from *Power* show simple equipment for the removal of broken studs by means of nuts welded on to the embedded part. If the stud has broken flush




*Diagrams showing methods of removing broken studs by welding.*

with the surface it is only necessary to place over it a nut of the same, or slightly smaller, thread diameter, and build up weld metal on the stud, at the same time welding the deposited metal to the inside of the nut. If the stud has broken below the surface, the exposed part of its threaded hole must be protected by a copper ferrule, fitting snugly and cut flush with the surface; the nut is then put into position and welded to a built-on extension of the stud as before. In both cases, the smallest available size of coated electrode, $\frac{1}{8}$in. or smaller, should be used. The heat applied in welding expands the stud and compresses any rust on its threads, which are thus eased when they contract on cooling. It is then necessary only to tap the nut lightly with a hammer and use a wrench to remove the stud. Care should be taken not to weld the top of the stud to the surrounding machine part.—*"The Power and Works Engineer", Vol. XXXV, No. 413, November, 1940, pp. 275-276.*

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**Arc-welding Equipment in Shipyards.**

Welded ships did not suddenly come into being. The present designs have been developed over the past 20 or 30 years, and the next decade or so will undoubtedly see many improved welded designs for parts of ships' structures that are not yet manufactured by welding. We shall also see more shipyards turning over to welded construction. One of the things shipbuilders have had to learn is to develop the welded design of ships and another is the most suitable layout for a yard producing welded ships. These two problems are closely related and vary somewhat with the type of ship which is built. In most shipyards using welding the change-over to welding has been a gradual replacement of previous processes with but little alteration in general methods of manufacture. Fortunately, such tools as shears, planers, bending rolls and press equipment are all adapted to plate forming for welded work, but many of the punches, drills and riveting equipment are not. Welding equipment is required both in the assembly shop and around the berths. In considering the type of equipment which is most suitable for welding in shipyards, the following factors have to be considered : (1) The operating efficiency

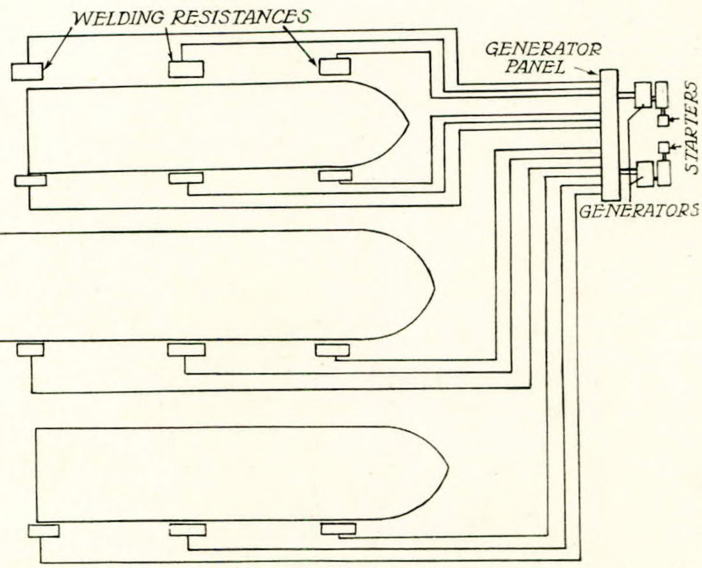


FIG. 1.—*Plan of shipyard with two six-operator welding units.*

of the welders in the yard (*i.e.*, is each operator's arc actually burning for 10 per cent. or 20 per cent. or 30 per cent. of his time?); (2) The largest size of electrode that is likely to be used. The capital cost and the electrical efficiency of the plant purchased are entirely dependent upon the above factors. The best type of welding equipment is that which will produce sound welding at the lowest overall cost per ft. of finished weld, and this varies with different shop conditions. Skilled welding operators will always be necessary, but the welding machine can put many obstacles in the way of the operator and slow up considerably his speed of welding if it has not the electrical characteristics to ensure a steady arc with no pulsating effects. Particularly is this true in the case of vertical and overhead welding, of which there will always be a certain quantity in shipbuilding work. It is sound economics to use the largest electrode possible, as it costs less to complete a weld with, say, six runs of $\frac{3}{16}$-in. electrode rather than, say, 15 runs of $\frac{1}{8}$-in. electrode. The largest size of electrode in general use is $\frac{3}{8}$-in. diameter. To melt a $\frac{3}{8}$-in. electrode at 300 amps. takes about 2 mins., but the same electrode melted at 500 amps. can be deposited in 1 min. 30 secs. If a million electrodes are used in a year the savings in labour and overheads are obviously considerable. A skilled welding operator can produce perfectly sound welds with a good machine or a poor machine, but it is always good engineering practice to give him the best equipment to enable him to produce consistently good work in the shortest time, even under adverse welding conditions. In British shipyards welding equipment of the motor-generator type, delivering direct current at the arc, is generally used. There is, however, no definite ruling upon the use of a.c. or d.c. equipment. The only specification which definitely limits the use of alternating current is the specification of the United States Navy, which uses welding very extensively in its shipbuilding yards. It permits a.c. equipment to be used only for welding in the flat position and never in the vertical or overhead positions, as it is held that the steady arc characteristic of d.c. welding equipment enables the operator to weld more efficiently. Motor generator equipment in general use in British shipyards is of both single-operator and multi-operator type. Fig. 1 shows a typical layout of a multi-operator welding unit for three berths of a shipyard. This has two constant-voltage motor generators each supplying six welding points around the berths. Each generator would be capable of supplying, say, 200 amps. to each of six operators. This type of equipment is economical in first cost and operating cost when the operating factor is low; *i.e.*, when the welding operator is actually welding 10 per cent., 20 per cent. or 30 per cent. of his time. This low operating factor has existed in many shipyards in the past, largely because welding was being tentatively tried out and the general design and layout of the yard and shop were not best suited to the production of welded work. When the operating factor is higher, *i.e.,* when the welding operator is actually depositing weld metal 40 per cent. or 50 per cent. of his time (an operating factor of 70 per cent. is generally the maximum that can be obtained in good shop practice), the single-operator variable voltage (or "drooping characteristic") type of generator is more economical to purchase and run. This type of equipment offers better welding characteristics, since each operator has his own individual generator and there is no sudden surge in output at one arc when the other operators stop welding, nor a sudden drop when other operators strike an arc. Single-operator equipment of this type has an additional advantage in that the polarity of each set can be changed readily. This was of great importance when only mild steel was welded, but now that non-ferrous alloys, such as copper, aluminium bronze and brass are used more frequently, and are readily weldable, it has become increasingly important to have equipment that is the most versatile to take care of all welding applications. Also, on the modern type of single-operator welding generator the current and the open-circuit voltage can be varied independently. This means that any type of volt-ampere curve can be selected to give not only the right heat at the arc (for the size of electrode and the speed of welding required), but also the right type of arc (for flat, vertical or overhead welding). Alternating-current transformers for welding can also be obtained as single-operator or multiple-operator units. This type of welding equipment is in use in some shipyards, but is not so generally employed as d.c. equipment. In view of the fact that the speed of welding and the continuity of arc operation are the biggest factors for reducing the overall cost of welding, it seems unfortunate that automatic welding has not been applied more generally to shipbuilding. Automatic welding consists of a fixed welding head, beneath which mass-produced parts are passed and welded or, alternatively, the same head mounted on a tractor or carriage which runs along the seam to be welded. It is the latter type of automatic equipment which can be most advantageously used for shipbuilding work, notably on deck seams, bulkhead seams (where bulkheads are prefabricated) and for welding columns which are fabricated from angles, channels and I-beams. Tractor-type automatic welders are of two types, metallic arc and carbon arc. The metallic-arc automatic welder consists of a welding head, supplied with power from a welding generator, which feeds a reel of covered wire in to the weld. The arc is struck between the tip of the reel of wire and the work. The carbon-arc automatic head strikes the arc between the carbon electrode and the work and feeds in the welding wire and the fluxing material separately. Higher speeds are possible with the carbon-arc automatic. In the United States these automatic machines (mostly carbon arc) are used extensively for deck seams, etc., and also for prefabricating barges, which are made by automatically welding together channel sections to form the side of the barge, the flange of the channels acting as a stiffener to the finished barge. It would appear that future developments in welded ships in Great Britain and future shipyard layouts designed for welding will be able to use automatic welding to give the most efficient and economically produced welded ships. Both for automatic and hand welding, the essentials are that the welding shop shall have adequate handling facilities. Fabricated sections must be turned so that welding can be done in the flat position. The largest-diameter electrodes and the maximum current values can be employed and the lowest welding costs secured when such handling facilities are available. Further, the shop must have crane facilities capable of handling 40- or 50-ton sections for transit to the berth, where similar crane power must be available for lifting the sections for final assembly. One recent development is the assembly in the shop of sections on trolleys run on rails down to the berth.—*"The Motor Ship", Vol. XXI, No. 250, November, 1940, pp. 250-253.*

**Machinery Space and Cubic Capacity.**

One of the advantages claimed for Diesel engines over steam machinery is the increase in the cubic capacity of the ship effected by the use of the former due to the smaller fuel space required. A motorship usually needs only half the amount of fuel necessary for an oil-burning steamer having the same radius of action, and where coal is burned, the difference in favour of the oil engine is even more marked. In a Diesel-engined ship practically all the fuel can be carried in the double-bottom tanks, whereas in a steamship bunkers have to be provided. Owing to the great increase in the technical efficiency of the triple-expansion steam engine achieved in recent years, the allied problem of reducing the capacity of the machinery space and bunkers has received special attention. The best-known arrangement having this end in view was evolved in Norway and consists of placing the boilers on the deck above the engine room, and carrying the oil fuel in the double bottom and in tanks abreast the machinery space. Another design of a similar nature is one in which the boilers are supported on columns in the wings of the engine room, the firing platform being at about the level of the cylinder tops. A third arrangement, also of Scandinavian origin, is to place the coal bunker between the main boilers and to extend it upwards from the tank top as far as may be necessary to obtain the required capacity. All these arrangements have only been made feasible by reductions in the size of modern boilers due to their increased efficiency. The "boilers on deck" arrangement has already been adopted in ships of up to 9,000 tons d.w. capacity, but the other schemes have so far only been embodied in smaller vessels.—*"Fairplay", Vol. CLV, No. 2,995, 3rd October, 1940, p. 365.*

**American Shipyard Re-opened.**

Two building berths at the Sparrow's Point yard of the Bethlehem Shipbuilding Company have recently been reconditioned after lying idle since 1918, and this part of the yard is now equipped with up-to-date machinery. The slipways are each served by two cranes of the rotating jib type, running on tracks and capable of lifting a maximum weight of 22 tons. Welding generators having a total output of 6,000 amperes are installed at the head of the berths, the welding capacity of the yard being increased by one-third as the result of this addition. Compressed air lines have also been led to the berths, for the Bethlehem Company use both riveting and welding in their constructional designs.—*"The Engineer", Vol. CLXX, No. 4,421, 4th October, 1940, p. 226.*

**Recent Motor Ship and Oil Engine Patents.**

A COMPRESSION-PRESSURE-OPERATED INJECTOR.

It is understood that the fuel injection valve illustrated in Fig. 1 is adapted to work in conjunction with the existing cam mechanism of a blast-injection engine. A primary pump is also employed and it would conveniently be that already fitted to serve as the normal fuel injection pump. Part of the device shown conprises a pump plunger actuated by the compression pressure in the cylinder, the cam mechanism giving a certain amount of additional pressure for injecting the charge of fuel. In order to appreciate the action, it will first be presumed that a certain quantity of fuel has been introduced into the pumping space (23) from the primary pump of the engine. During the latter part of the compression stroke the pressure acts through a pipe (12) on a piston (10), but it is insufficient to effect injection and additional pressure on the pump plunger (9) is exerted through the cam-operated lever (16). During the downward movement of the plunger, a port (28), originally connected to the oil cushion (27), becomes closed and the lower plunger (9B) is forced down, thereby injecting the charge through the passages (22, 6, 5). When the lower plunger reaches the bottom position, it uncovers a port (29) and connects the space (27) with the pipe (30). This action interrupts the effective pump stroke; and the main plunger (9) moves up under the influence of a spring (32) and draws oil through the passage (29), producing the oil cushion (27). Subsequently, the port (28) is uncovered and the primary pump introduces fuel through the pipe (20) into the pumping space (23), the amount being determined by the engine controls, and the plunger (9B) is raised a corresponding distance in the pump cylinder. As soon as the pressure stroke occurs and the port (28) is closed, the upper and lower plungers function together.

KOCKUMS MEK. VALVE SEATING ARRANGEMENT.

Two forms of valve construction are shown diagrammatically

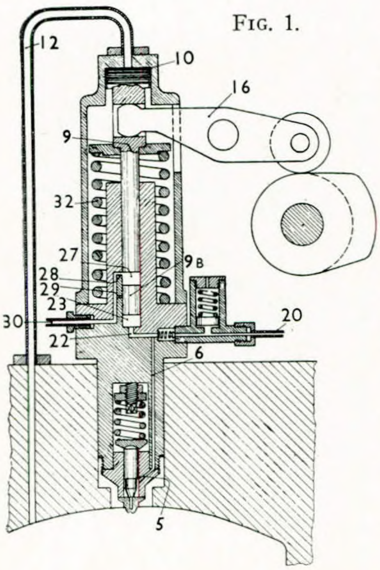

Fig. 1.

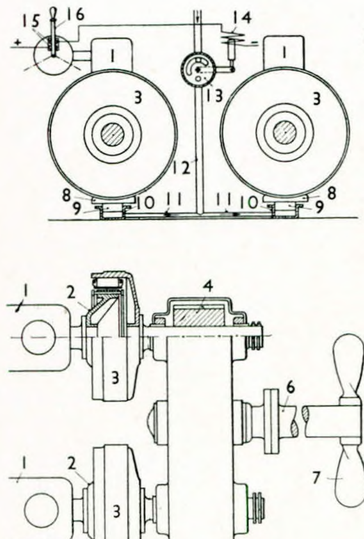

Fig. 2 (left).

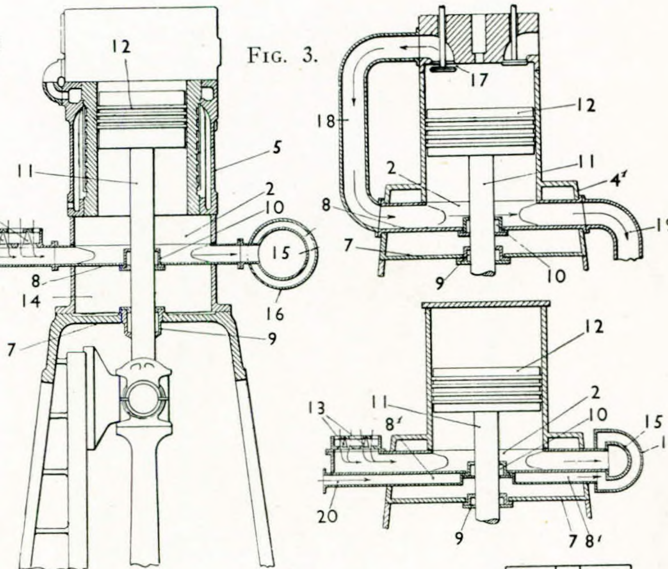

Fig. 3.

in Fig. 4, whereby it is possible to ensure tight closing of the valve without using excessive pressure and at the same time permitting the use of hard materials both for the valve seat and the body. In the left-hand diagram, the seat (1) is secured to the valve body (2) by a screwed sleeve (3) having an opening (4) for the gas or other fluid. Annular seating rings (5, 6) are provided for the valve (7), which has openings (9); a lifting rod (8) is fitted. Bearing on the top of the valve is a spring-loaded sleeve (11), the spring (10) having an adjusting screw (12). The body (13) is provided with openings (14) and the sleeve (11), which is pointed, slides on a pin (15). When the rod lifts, the valve is raised and the fluid passes through the openings (14, 9, 4). The pressures acting on the upper and lower surfaces of the valve are substantially counterbalanced, due to the openings (9). With the alternative design shown on the right, the valve is held in the closed position by the difference of the forces exerted by the spring (10) and the fluid itself. The construction is generally similar to the first arrangement, allowing for the reversed position of the valve. The lower end of the spring (10) bears on a sleeve (12) which closes the interior of the assembly. The sleeve (11) is provided with openings (17) for venting the space below and is secured to a rod (8) closely fitting in the sleeve (12). The rod in this arrangement being pulled down, the valve is removed from its seat due to the pressure above and fluid flows from the space above the seat through openings (4, 9), thence through a hole (18) in the body (2).

### A.S.E.A. Electric Slip Couplings.

An arrangement devised by the A.S.E.A. for propeller shaft braking in conjunction with the use of electro-magnetic slip couplings is illustrated in Fig. 2. The coupling member connected to the propeller shaft is provided with a mechanical brake; this brake is interlocked with the Diesel engines so as to be applicable only when the fuel supply is cut off. There are shown in the illustration two Diesel engines (1, 1) to which are connected the inner members (2, 2) of the electro-magnetic slip couplings. The outer members (3, 3) are secured to the smaller pinions (4) of a reduction gear having its large wheel adapted to drive the ship's propeller through the shaft (6). Below the outer coupling members are mounted brakes consisting of shoes (8, 8) having pistons (9, 9) moving in cylinders (10, 10). Air under pressure is admitted through pipes (11, 11) which are carried from a common supply pipe (12) provided with a slide valve (13). This valve is regulated electrically by means of a solenoid (14) so as to admit fluid into the cylinders when the solenoid is energized, the current being controlled through contacts (15) on the manœuvring lever (16) of the engines, when fuel is cut off.

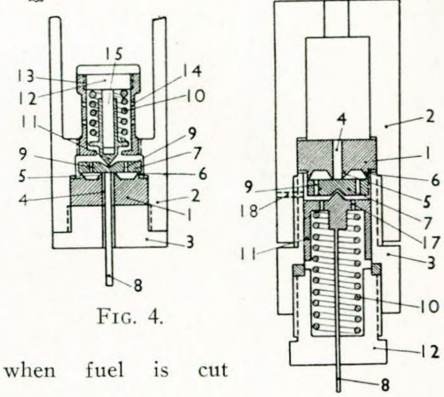

Fig. 4.

### Schichau Pulverized-fuel Engines.

Pulverized-fuel Diesel engines have been the subject of experiments at the Schichau works for many years. The builders have recently obtained a patent for a method of clearing accumulations of sludge from the bottom end of the cylinder and particular steps are taken to prevent it reaching the crank chamber. The patent comprises no fewer than 21 separate claims and the main features of the devices are shown in Fig. 3. Referring to the left-hand diagram, a space (2) is provided for collecting the sludge and the crank chamber is isolated by two partitions (7, 8), the piston rod (11) passing through a pair of stuffing boxes (9, 10). The sludge is discharged from the space (2) by the pumping action of the piston (12), non-return suction valves being provided. The outlet is uncontrolled, and the spaces (14) below the sludge-collecting area may be heated by exhaust gas. The sludge-loaded air is discharged through an exhaust-jacketed pipe (15, 16). In the upper right-hand diagram the arrangement is to discharge the sludge by the exhaust gas conveyed from the exhaust valve (17) through a pipe (18). The part $4^1$) carrying the pan (8) is attached to the cylinder. In the case of the arrangement illustrated in the lower right-hand diagram, the space (2) has a double bottom ($8^1$) heated by exhaust gas introduced through a passage (20).—*"The Motor Ship", Vol. XXI, No. 250, November, 1940, p. 275.*

***Neither The Institute of Marine Engineers nor The Institution of Naval Architects is responsible for the statements made or the opinions expressed in the preceding pages.***

The late Mr. John H. Silley, O.B.E.

*Portrait* *[Elliott & Fry, Ltd.*

# OBITUARY.

## JOHN H. SILLEY, O.B.E.

Members will learn with deep regret of the death of Mr. John Henry Silley, which took place on Friday, 24th January, 1941, at Port Navas, Cornwall.

John Henry Silley was born at the west country town of Chepstow in 1872 and gained his first engineering experience as an apprentice with Messrs. Edward Finch and Co. of that town. He came to London in 1892 and went to sea in a vessel belonging to J. P. Cory and Company's Star Line, attaining the position of chief engineer in the middle twenties. His practical experience afloat was of great value to him later and helped him to appreciate the problems of the sea-going staffs. Before he was 30 he came ashore and, displaying, as was his wont, immense energy, started an engineering business on his own account. His interests were then merged with R. and H. Green, Limited, who claim to be the oldest shipbuilders in the country, and a new company was formed entitled R. and H. Green and Silley Weir, Limited, of which John Silley became chairman and managing director. This firm undertook a great deal of repair work for leading shipping companies on the Thames under his general direction. During the last war he was closely identified, in conjunction with the late Mr. Allan Hughes, with important developments at Falmouth as a ship-repairing centre, and he became a director of Cox and Co. (Engineers), Limited, Falmouth, and of the Falmouth Docks and Engineering Company. In recent years he divided his time between supervising the work at the Companies' yards on the Thames and in Cornwall.

Mr. Silley was a member of the Institution of Naval Architects, a member of the North East Coast Institution of Engineers and Shipbuilders, and a Fellow of the Royal Society of Arts. He was elected a Liveryman of the Worshipful Company of Shipwrights in 1908. In 1892 he joined The Institute as an Associate, and in due course became a Member of Council, Vice-President, and then President. He was awarded the Denny Gold Medal in 1901 for a paper on the treatment of boilers under forced and induced draught. During his term of office as President, Mr. Silley earned the lasting gratitude of the Council and Members for the inspiration, energy and initiative he devoted to several projects then engaging the Council's attention, the foremost of which was the foundation and financing of the Guild of Benevolence.

To his inspiration and efforts were largely due the present building of the Y.M.C.A. Red Triangle Club at Plaistow, which cost about £100,000 to build and equip. The first visitors on the opening day were King George V and Queen Mary. Mr. Silley was also responsible for the laying-out of a model village near Falmouth, where the workpeople at the docks could live happily in delightful surroundings; he also built flats and bungalows near the works in London and Falmouth where retired workers could dwell with their wives at low cost. Later the scheme was extended to include others, such as elderly spinsters, for whom accommodation was also provided. Throughout his life Mr. Silley worked hard; he was always thinking how more efficient methods could be adopted in his businesses; he was the engineer of his own fortunes; and he had the greatest sympathy with the aspirations of good workmen whose conditions he aimed at improving.

Mr. Silley's character combined a charming personal modesty with integrity and firmness of purpose, and he was held in highest esteem in shipping and engineering circles in the City of London. He will be remembered not only for his remarkably successful work in engineering and industrial enterprises, but even more for his deep concern for the welfare of the men he employed and particularly his fellow marine engineers, to which he gave practical expression in various generous ways. At a special meeting of The Institute held on the 22nd April, 1936, Mr. Silley was presented, on behalf of the Council and Members, with an oil portrait of himself as a mark of esteem and appreciation of his outstanding service to The Institute.

Mr. Silley was extremely happy in his home life at Epping, Essex. He is survived by his widow, two sons, Jack and Bernard, who, possessing mutual aptitude, have been trained to carry on and develop work well begun, by two married daughters, and by a brother, Mr. Fred Silley, who was long associated with him in his commercial enterprises.