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Recent Welded Repairs of Marine Machinery.

By C. W. Brett, M.Inst.W.

Both electric and gas welding equipment have been essential in every shipbuilding and repair yard for many years past. Taking a general survey of the applications it is evident that until recently little has been done to take full advantage of the opportunities offered. In short, the work has been satisfactory but circumscribed.

Now and again some urgent need might arise calling for exceptional experience and a welding specialist might be called in to advise or perhaps carry out the work, but this was a comparatively rare happening. This lack of enterprise is a little difficult to explain, but it was in no way due to indifferent results for these were invariably good when backed by essential skill and experience.

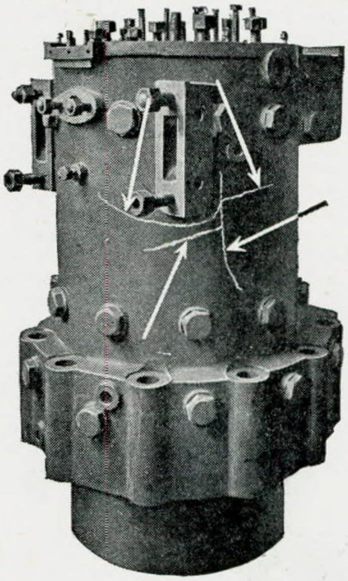


Fig. 1.—*This marine Diesel engine cylinder was extensively cracked in the water jacket. The fractures were dealt with quickly by scientific welding enabling much time and money to be saved.*

It is easier to understand the slowness with which the welded ship has come to be accepted. The methods of construction have nothing in common with riveting. Therefore such radical changes are desirable in yard layout and equipment that a wholehearted changeover is a major operation. Those best qualified to pass judgment on this particular branch of welding have disclosed that it is best to start afresh with an entirely new layout and have pointed to the advantages of this step in the production of welded merchant ships in America, mainly from yards which did not exist a year or two ago.

One must be practical however, and the changeover, if it comes to this country, must be far slower, for it is not feasible to jettison the large proportion of existing equipment in British yards or to convert an army of riveters and other skilled men into welding operators overnight.

Before the war one of the chief claims for the welded ship was that of weight saving and reduced resistance, due to butt-welded plates as against lap-riveted joints. Both these gains are important but an accumulation of evidence shows that the welded hull is less prone to damage from a near miss, whilst the risk of tearing bottom plates as a result of grounding is reduced substantially.

The British Admiralty were of this opinion before H.M.S. "Hunter", a destroyer of 245ft. o.a., struck a mine off the Spanish coast only a few weeks after she was first commissioned. Now much of the internal structure of the hull was welded including the bulkheads, deep frames, decks and so on. It was stated authoritatively that it was only by reason of the welded work so ably withstanding the shock of the explosion that this naval unit was able to reach Gibraltar for repair. Had the bulkheads and other parts been riveted there is no doubt that the ship would have been lost.

When the 500-ton motor coaster "Fullagar" was built in 1920 by Messrs. Cammell, Laird & Co., Ltd., Lloyd's classification was "100 A.1. Electrically Welded, subject to annual survey, Experimental". After sixteen years service her condition was considered so satisfactory that the notation "Experimental" was removed and the survey changed to biennial.

Lloyd's rules for welding work, at first tentative, became more clear-cut, but progress was slow and completely-welded ships were still objects of special interest mingled with the typical ingredient of mistrust, which repeated proof of dependability has now dissipated.

In order to get the atmosphere which has led to the extension of welding from the fabric of a ship's hull to intricate scientific repairs to the machinery, it is necessary to trace back briefly the progress and virtual standardization of procedure which is now accepted practice. Even in peace-time delay was costly, to-day it is accentuated in terms which go far beyond those of mere finance. New ships must be put into service quickly, but this need is not greater than the demand to maintain and repair efficiently those craft already available. The importance of such work is no whit less than new construction.

So far as the hull and installation work is concerned, most shipyards can tackle the welding that is needed. Attention to corroded decks, worn hawse pipes,

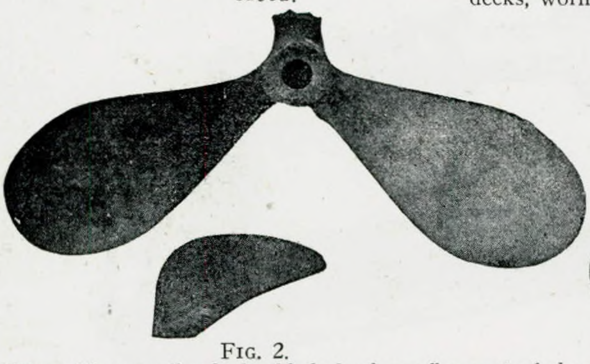


Fig. 2.

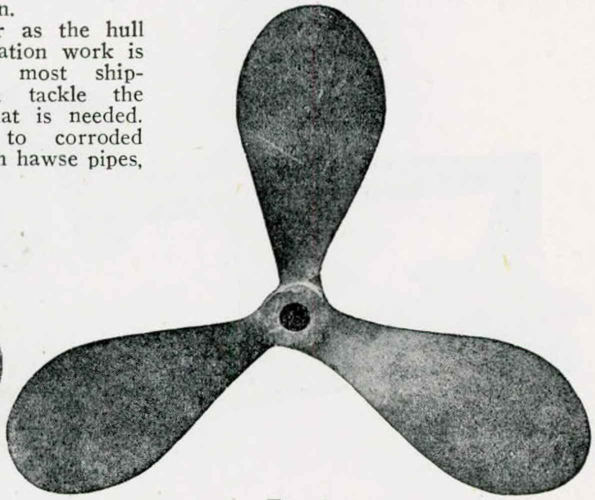


Fig. 3.

When this propeller had a blade broken off a part of the detached portion was recovered. This, together with a new piece, was made up into a perfect blade and welded to the stump on the boss. The pitch was carefully checked and a full measure of strength restored. The propeller bears no trace of repair.

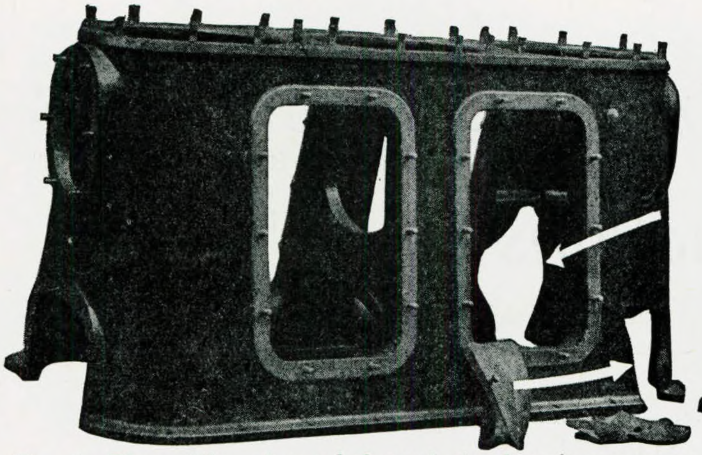


FIG. 4.—*The welding of smashed crank chambers is a common need. The example illustrated weighs 1 ton 6 cwts. and in common with most repairs of this kind accurate alignment and great strength are paramount requirements. A perfect result was obtained with scientific welding.*

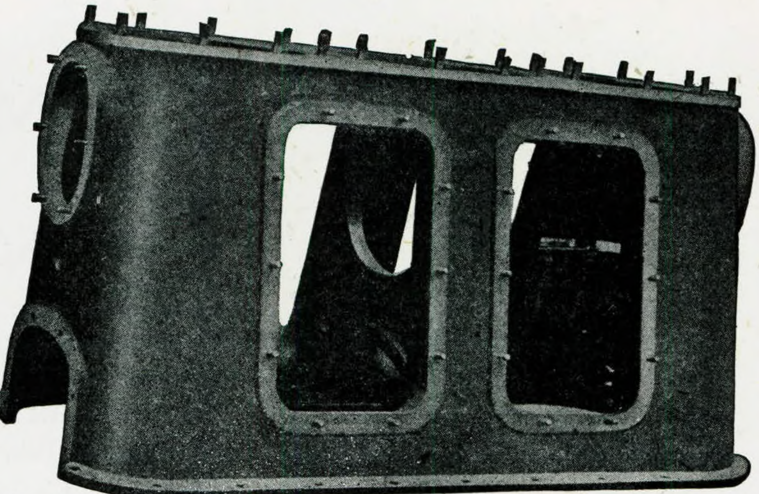


FIG. 5.—*Ready for re-despatch and in every way equal to a replacement, but with the saving of several months of delay and a substantial sum of money.*

the fitting of pipe work with the accompanying brackets are, with a multitude of similar tasks, relatively straightforward. Where rivets require attention it is always advisable to cut out, and weld up the hole ready for re-riveting in preference to welding on to the head of a rivet. Rudder repairs are often extensive. Gudgeons and pintles may need to be built up afresh whilst rudders of the built-up type may leak, in which event there is no better means for sealing than the application of the metallic arc.

Tankers may present an individual set of problems, particularly in regard to the actual tanks, for the corrosive effect of crude oil is well-known. Welded tanks prevent creeping and do not require periodic caulking.

The tremendous strains to which rudders are subjected are transmitted to the quadrant and stoppers, causing the need for another type of repair for which welding has proved particularly useful. Like most other ship repairs little can be done when the vessel is under way, hence the need for a considerable margin of safety.

In 1937 the s.s. "Rokos Vergottis", fully loaded, left a Bristol Channel port and soon after she ran aground. The chief damage was to her stern frame which was distorted and fractured in way of one of the original fire-weld scarves. The vessel was docked at Cardiff where a Newport, Mon., firm of engineers undertook the repair of the forged frame under the supervision of Lloyd's surveyor. The part concerned weighs 14 tons and it was removed from the ship and laid on its side before vee-ing the fracture as a preliminary to welding. The frame is 12in. by 7$\frac{3}{4}$in. with a back post measuring 36ft. 9in. and heel extending 17ft. 5$\frac{1}{2}$in. An excellent job was made of the welding, whilst the time saved was substantial, for a new frame of this size is not procurable at short notice.

The s.s. "Lydia N" provided a somewhat similar example. This vessel ran on the rocks of the breakwater off Necochia Harbour and she was not salvaged for three weeks. Upon being towed to Buenos Aires, where she was docked, it was found that both the stern frame and rudder post were broken in three places. In addition, about 150 sq. yards of plating and 42 frames had to be cut away.

The fractures were welded in the frame and rudder post whilst much of the additional repair work was welded, the vessel passing inspection and being ready for sea forty days after she had docked.

FIG. 6.—*This crankshaft is part of the propelling engine of a motor tug. It was removed in two pieces; one of the inner webs had fractured.*

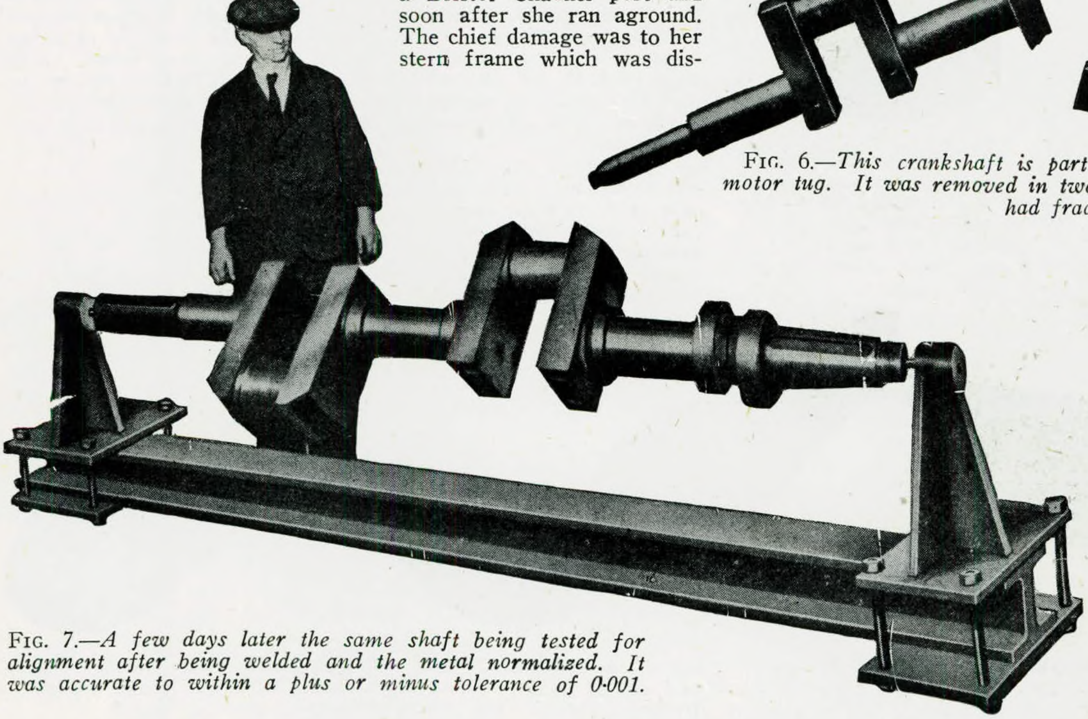
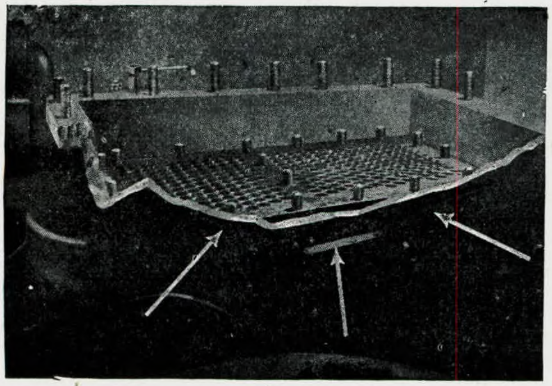


FIG. 7.—*A few days later the same shaft being tested for alignment after being welded and the metal normalized. It was accurate to within a plus or minus tolerance of 0·001.*

Often it is found that welded bulkheads have been the keystone of safety after an accident, whilst the way in which they remain water and oil tight in ordinary conditions of service may make this method of fitting bulkheads the universal procedure.

The welding of broken or merely worn machinery items is a different proposition. Partly this is due to the almost unlimited variety, which calls for a background of experience coupled with a high degree of skill. Obviously, very much of this work must be turned over to specialists, for the average yard does not have sufficient opportunity to grasp all its phases, whilst the need for precision machining to finish parts, after they have been welded, may be a further difficulty. Sometimes an analysis of the metal is helpful in deciding the method of operation, the electrode and so on.

Regarding the equipment used, whereas the shipyard uses gas for cutting purposes and applies electrical welding to both fabrication and repair, the scientific welding engineer uses oxy-acetylene for many constructive jobs apart from steel although, even in this respect, the line of demarcation is not rigidly defined, for the combination of problems offered by every repair determines the method.



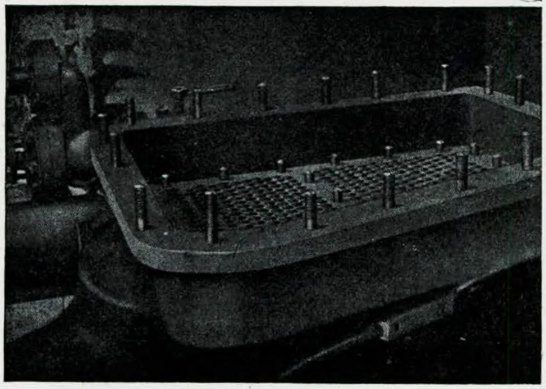


FIG. 8. FIG. 9.

The end plate of this condenser was blown off and some of the studs torn out by excessive pressure due to the overboard discharge valve being closed accidentally. Time saving was vital; to remove the condenser would have been a long job as it was built into a triple-expansion engine and formed an integral part of the cylinder supports. The welding necessary was not only completed in the ship, but permanent repairs were finished in three days.

For marine work portable equipment must be used but there is seldom need for that of the multi-operator type. All the same the capacity of the machines is considerable in view of the possibility of having to melt large electrodes.

An interesting sidelight upon the use of either a.c. or d.c. current for the actual welding is that either is permitted in British yards. This is in contrast to the specification laid down by the United States naval authorities who permit a.c. current to be used only if the welding is in the horizontal. Its use is not allowed for work that must be done vertically or overhead and for which a d.c. supply is laid down.

It is generally established that the cost of new welding is made up by labour 60 per cent., electrodes 30 per cent., power 10 per cent. For repair work the labour cost is usually higher in view of the special preparations that may be needed, whilst the use of the oxy-acetylene system for certain classes of requirements, mainly upon cast and malleable iron and certain non-ferrous metals, may cause a rise in cost, but even so, saving to the order of 90 per cent. is common in comparison with the price of renewals, even when such are readily obtainable.

If spare parts are not available, then the cost of welding is of little importance for its dependability is paramount.

The addition of so many foreign ships to the Allied Mercantile Fleet has introduced many problems of maintenance. Although many of these ships are comparatively new, such as Norwegian tankers and so on, the replacement parts required to be carried by Lloyd's or other authorities are inadequate when the vessel is cut off from the resources of replacement over a period of years. Moreover, special and unusual requirements, as a result of enemy action, are added to routine maintenance needs.

Welding has stepped into this breach with admirable results. The margin of strength that must be allowed is considerably greater than that which would be considered satisfactory for a land installation. There are two reasons for this. When a ship is at sea she is away from comprehensive repair facilities, consequently the failure of some part might have disastrous consequences to the vessel. The second factor is the introduction of stresses due to the motion of the ship, which are in violent comparison to the quiescence of stationary machinery ashore.

Shock fracture is a problem which has come into prominence of late. No provision to guard against this danger was taken in regard to merchantmen before the war, consequently certain types of skin fittings, pipe work and major components of the propelling machinery and auxiliary equipment were vulnerable. Welding methods have proved invaluable for overcoming actual breakage and also in some measure to provide additional protection by giving further support to suspended masses.

Some modern motorships are fitted with engines the main frames of which are fabricated from steel plate. The original reason for this departure from the use of castings was to gain strength and rigidity without a corresponding rise in weight. The practice has grown in several directions, even to the extent of welded rocker arms of box section. Engines embodying this form of construction are less vulnerable to damage from concussion.

Diesel engines require special consideration, and the application to machinery of this type will be dealt with later on after examining the problems peculiar to steam machinery.

The variety of welding work carried out upon boilers is most important, not as a temporary measure but as a permanent means for reconditioning. Recent examples vary from attention to those of the Scotch type to others of the Yarrow water-tube pattern, whilst in regard to auxiliary equipment the ubiquitous donkey boiler and its more modern counterpart the waste-heat boiler with supplementary oil firing, are equally amenable to welding attention. Defective areas in the neighbourhood of the furnace of a Scotch boiler might well necessitate the removal of the unit from a ship, which involves considerable delay and interference with the top hamper. The application of welding to major undertakings of this kind may include the fitting of an entirely new furnace. This is done by using the oxy-acetylene flame to cut the old one right out in sections convenient to handle. The new furnace is generally built in two parts which are finally united by welding, after the same method is used to fit them in position. One of the chief difficulties which may arise is that of reasonable accessibility being afforded the operator. In extreme

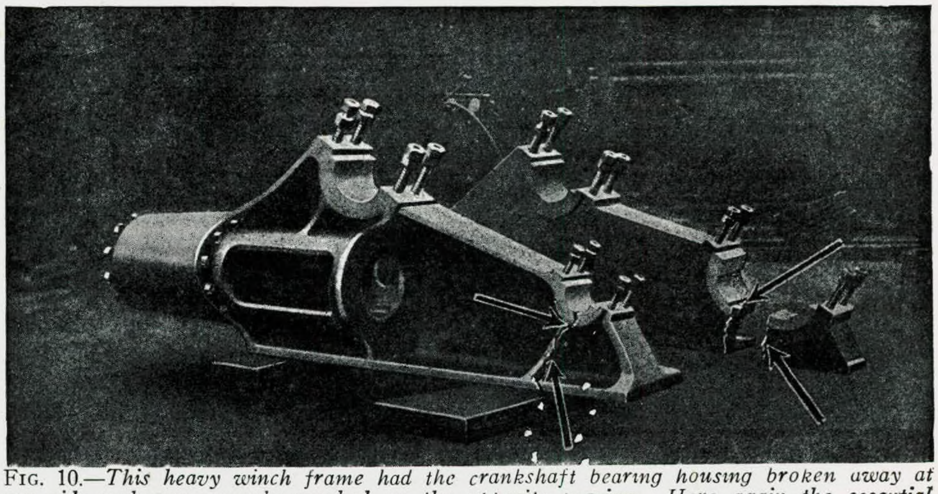


FIG. 10.—*This heavy winch frame had the crankshaft bearing housing broken away at one side and was severely cracked on the opposite bearing. Here again the essential strength and correct alignment were secured by thoroughly experienced scientific welding operators.*

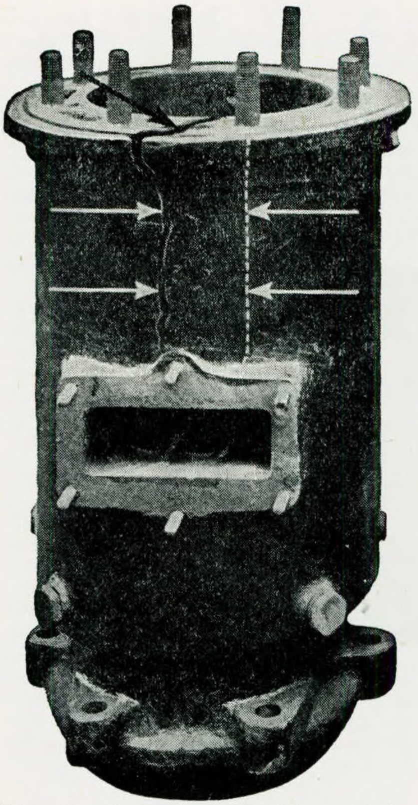


FIG. 11.—*A marine semi-Diesel engine cylinder of Continental make showing part of a crack which commenced in the bore and ran across the top joint face and down the jacket. The dotted line indicates the extent of the trouble in the bore. This cylinder was returned in first-class condition.*

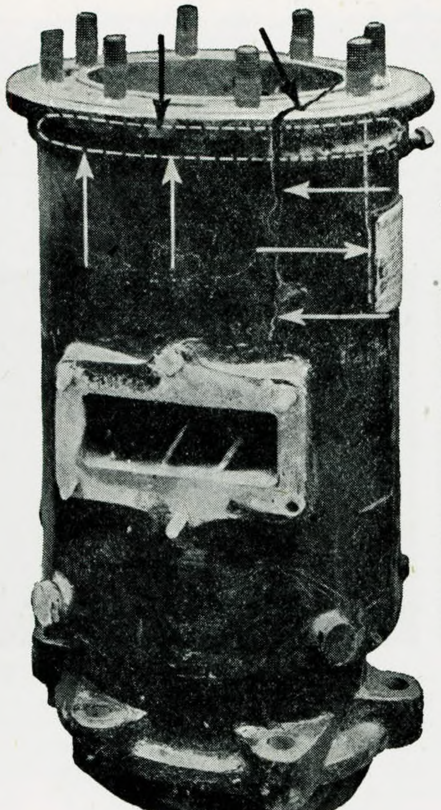


FIG. 12.—*Another cylinder from the same engine. This time the course of the crack in the bore is indicated whilst the fracture in the jacket can be seen clearly. It was repaired in the same manner as the first cylinder.*

cases of restriction it may be advisable to change the operator at the end of short periods of working.

Corrugated furnaces are strengthened sometimes by fitting semi-circular steel plates. In this event the size may be such that the plates cannot be welded on the whole line of contact. In practice it is found that tacking them in place gives satisfactory results.

Local faults such as grooving can be corrected by welding new metal on the weakened areas in order to restore the original thickness, but here again the seat of the trouble may be awkwardly placed. Sometimes this is overcome by careful positioning and then working upon the outside of the plate. If on account of age or situation such methods are inadvisable, then the doubtful metal is cut right out and an entirely new section is shaped and fitted in position, generally with butt joints and leaving a clean surface both inside and out.

Specialist knowledge may be needed to deal with the cracked tube plates of Yarrow-type boilers, but most satisfactory results have been obtained. As repairs of this kind are generally needed urgently, there is a danger that the operator may endeavour to complete the work too rapidly. The factor which limits speed to some extent with work of this kind, is the time that is necessary to allow of safe expansion and contraction without creating stresses in the metal. This can be avoided if the welding is done at the correct speed. Leakage of steam which cannot be overcome by caulking is being cured by welding; in fact new riveted boilers are sometimes welded along the seams but it is never advisable to weld over the head of a wasted or otherwise faulty rivet. It should be removed and then the hole should be welded and prepared afresh for a new rivet. The procedure followed in the welding of tanks, in order to re-condition them, is on lines similar to boiler work, but the metal is thinner and accessibility much better on the whole.

Cracks in steam-engine cylinders are dealt with in wide variety. Sometimes these fractures are complicated and extend into the ports. A typical instance of this type of occurrence arose with a large triple-expansion engine, all three cylinders of which were extensively damaged. The total length of the cracks was 14ft. 6in. To replace the damaged parts implied a delay of not less than twelve months. It was deemed advisable to remove the cylinders, and when this was done the welding necessary, including a considerable amount of preparation, occupied only five days. Some 21,000 cu. ft. of acetylene and 30,000 cu. ft. of oxygen were used and the task completed under Lloyd's supervision. This engine gave excellent service for a long period and the repair work, carried out under guarantee, proved satisfactory in all respects.

A few months ago the cast column of another steam engine was cracked for a distance of 5ft. through metal varying from 2in. to 3in. in thickness. This column was used not only to support the cylinder immediately above it, but also as a lubricating oil container; therefore it had to stand a pressure test. This job was completed in the ship with great success and with no recourse to plates or patches of any kind.

It is surprising how extensive are the welding repairs that can be undertaken without dismantling, so long as machining is not required. The example of a turbine gear casing, handled not many months ago, is a pertinent illustration of this. The fracture, which was at the rear end of the casing, was about 4ft. in length through metal an inch in thickness; moreover the repair was complicated by the fracture extending to a web of a bearing housing.

To seal the crack to withstand the heavy stress load was not easy; great care had to be exercised so that true alignment was preserved. Had it been necessary to take the damaged part from the ship it would have required the removal of a considerable amount of the superstructure, but this was avoided.

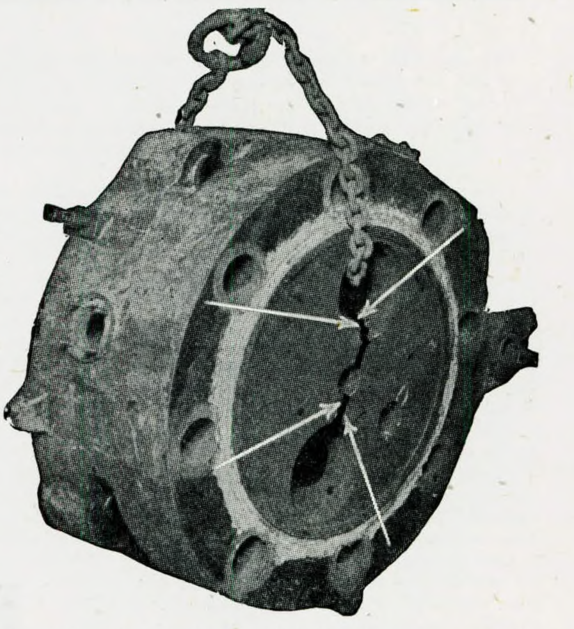


FIG. 13.—*A cylinder head belonging to a marine Diesel engine. The fractures ran from the exhaust to the air inlet valve seats via the fuel valve housing. The metal was found to be in poor condition, so a large section of the head, in the neighbourhood of the cracks, was cut away and replaced with new. After preliminary preparation the repair work was carried on continuously by relays of operators. The resultant re-conditioning was guaranteed in the usual way after accurate machining by the welding engineers.*

One of the most striking illustrations of how much can be accomplished in a short time is shown in the case of the s.s. "Villaperosa". This Italian vessel was interned at the Atlantic Basin Iron Works, New York. Her propelling engine was sabotaged by the simple but devastating expedient of placing heavy bars of steel beneath the throws of the 19in.-diameter crankshaft and then attempting to turn the engine by compressed air. The damage to the bedplate was most severe, for it was broken into hundreds of pieces, some of which could not be found; these were replaced by steel sections flame-cut to shape.

The edges of each fragment were vee'd to an angle of 45 degrees.

Electric welding was employed throughout, using 200 amp. shielded arcs. Each piece was first held firmly by tacking and when all the parts were finally in place the alignment was checked and the permanent welding commenced. No beads were continued for more than 3in. in order to give time for cooling and thus avoid any possibility of distortion. Each layer was peened with a hammer before applying the succeeding weld.

So soon as this part of the work had been completed satisfactorily, steel plates were made to embrace the entire bed. These were attached by drilling through both the steel section and the cast iron of the bedplate and fitting steel dowel pins, each about an inch in diameter and tapered at both ends to allow of the deepest possible penetration of the weld metal.

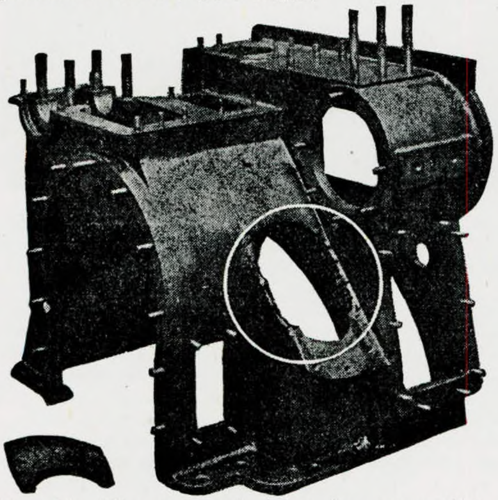


FIG. 14.—*The rear-end top casing of a high-speed marine engine from which an air pump seating was broken away.*

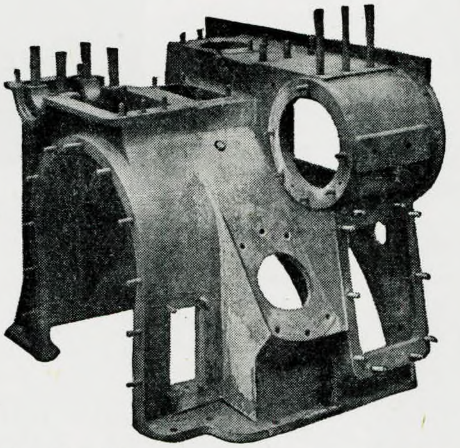


FIG. 15.—*The repaired top casing. In cases of this kind increased strength is indicated, and it is well within the scope of the scientific welding engineer to provide it.*

The entire repair occupied two months and has proved most dependable. It was estimated that to replace the engine or make the special parts needed would have required at least a full year.

It is obvious that highly specialized knowledge is required to deal with the intricacies of repair problems which are infinitely variable.

Of course satisfactory penetration of the weld, its purity and density are all important, but there is much more to the work than this. Only long and versatile experience can teach the reactions that may be expected in expansion and contraction; moreover this does not apply merely during the period that the work is actually being done but must embrace the performance and stamina of the part in actual service conditions. Experience of this type, together with painstaking research, have led to the possibility of welding perfectly metals that are totally dissimilar. At present this facility has a limited application in the field of marine repairs but it will extend. In at least one type of construction it is likely to prove important.

During recent years considerable effort has been directed toward lightening the top hamper of ships. In one merchant vessel of medium size, aluminium alloy has been used to a large extent in the superstructure with a saving in weight to the order of 200 tons. Nowadays the welding of aluminium to steel is a commercialised process and the advantages of welding in this particular application are obvious. Practically any combination can be made irrespective of whether the materials concerned are ferrous or non-ferrous. The effectiveness of the result has been proved by the numerous tests to destruction that have been made, for it is the weaker parent metal which yields first and there is no failure within the influence of the weld.

Condensers offer a wide variety of opportunities for welding repair; again concussion fracture is an added reason for trouble but there are many other causes of failure. The accidental closure of an outlet cock had the effect of tearing away the end plate and many of the studs of a tubular condenser, fracturing the main casting over a distance of 5ft. This condenser is of the type that is embodied in the propelling unit, in this instance a triple-expansion engine, and carries the three cylinder supports. For this reason strength and accuracy of alignment were of foremost importance.

It was decided to do the welding without removing the condenser as this would save time and fortunately accessibility was reasonably good. Only three days were occupied from the time the work was commenced until the re-conditioned casting was ready for a hydraulic test under Lloyd's supervision.

Another condenser, this time a separate unit from the engine, presented trouble because of a porous area of several square feet. The first advice given to the owners was to scrap the casting, which was 10ft. long, the height and width being 5ft., but as no defects could be found elsewhere, it was decided to weld. When trouble of this particular kind arises it is almost invariably best to cut away the faulty section entirely, and this was done. Then a new casting was made to fit the place of the discarded portion, this being welded in position after the usual preparation. Great care is needed to govern the heat flow in its effect upon the surrounding metal, otherwise there may be distortion and permanent stresses remaining in the casting; by skilled handling all such troubles can be avoided, although the thinner the metal the greater the difficulties involved. Here again the work occupied only three days and proved utterly dependable.

Condenser tube plates are frequently repaired by welding on account of local corrosion or fracture, and here again great care is needed to avoid distortion, but when the possibility and reasons for this sort of trouble are realized by the operator, then skill and experience combined with modern technique, can avoid such obstacles effectively.

Rather similar to the failures experienced with condensers but on a still larger scale was the breakdown of a water heater. This particular unit is of tubular design with a steel shell, whilst the tube plate is 2in. thick, a dimension the reason for which will be understood better when it is realised that it forms the end support for nearly 1,000 tubes. The crack which developed in this plate was roughly a right angle, running first in a horizontal direction and then taking a vertical path. The trouble was caused by the difference in the ratio of expansion of the steel shell and the cast-iron tube plate. In view of the fact that the root cause was known and could not be eliminated by welding, it is not surprising that this was one of the rare instances in which a guarantee could not be given, but it was decided to do the utmost possible towards effecting a permanent repair. The operators had to face the added obstacle of not being able to interfere with the tubes in any way.

After welding the full length of the crack a pressure test was applied; this showed the horizontal weld to be quite sound but the

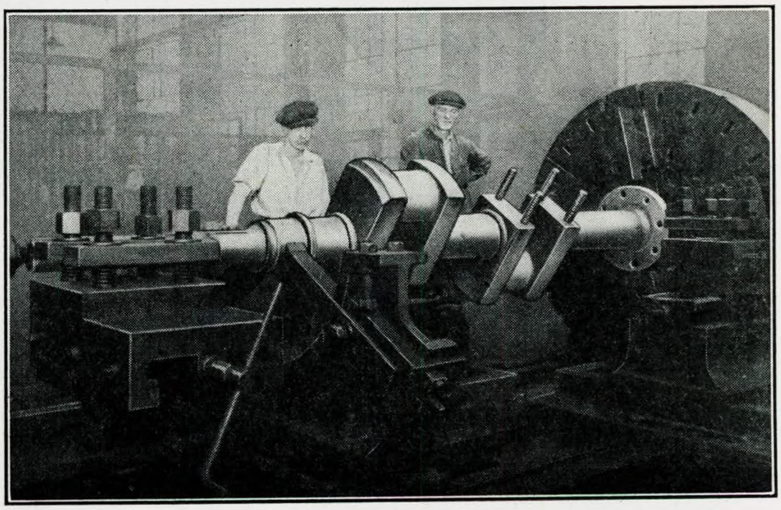


FIG. 16.—*A typical crankshaft repaired after breakage, usually through a web. Pins and journals were built up afresh in addition to re-uniting the damaged parts. The shaft is shown just after machining was completed.*

vertical section leaked slightly so this was re-welded and the next test proved the entire length to be dependable. Shortly afterwards some further welding was done on another part of the heater as a result of the satisfactory outcome of the previous repair.

Whilst dealing with fractured items, the variety of which is legion, it must not be forgotten that the addition of new metal to worn and corroded components is equally important. The application is probably greater in regard to internal-combustion engines than steam propelling and auxiliary machinery. In some instances such marked improvement has been noted that the part reconditioned in this manner can be regarded as being emphatically better than a replacement costing perhaps 90 per cent. more. The explanation is that the new metal can be of any particular grade of steel and this is chosen for its wearing qualities, whereas the core can remain relatively soft but tough. In this way desirable dual qualities are combined at the time of welding repair and the result may be likened to a form of case-hardening without the usual limit to the depth of the skin. On the same lines, equally important benefits are accruing from the combination of dissimilar metals to which more detailed reference has been made already. With the certainty of reduced cost of light alloys, which are also corrosion-resisting, it is likely that their use in combination with welding methods will be increasingly seen, not only in the structure of the ship itself but by direct application to machinery components.

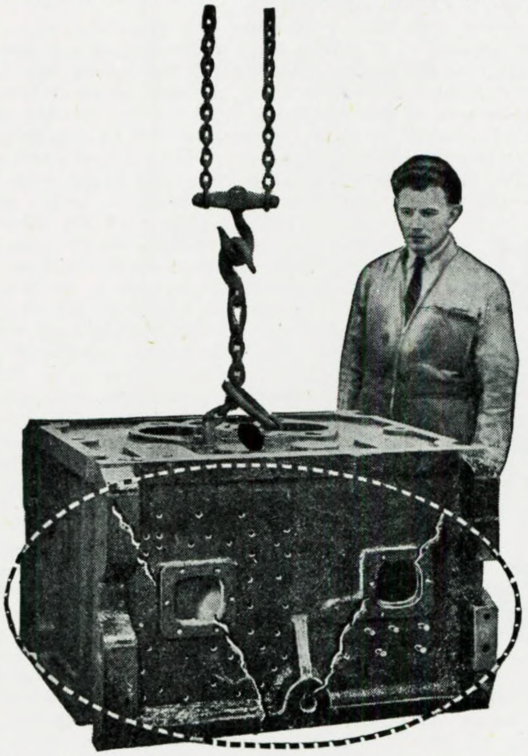


FIG. 17.—*One of six cylinder covers of a well-known make of marine Diesel engine, all of which were cracked on the water jackets. The crack on this cover commenced at the top corners of one side of the jacket and then ran diagonally across the flanges of the mud holes, forming an irregular "V".*

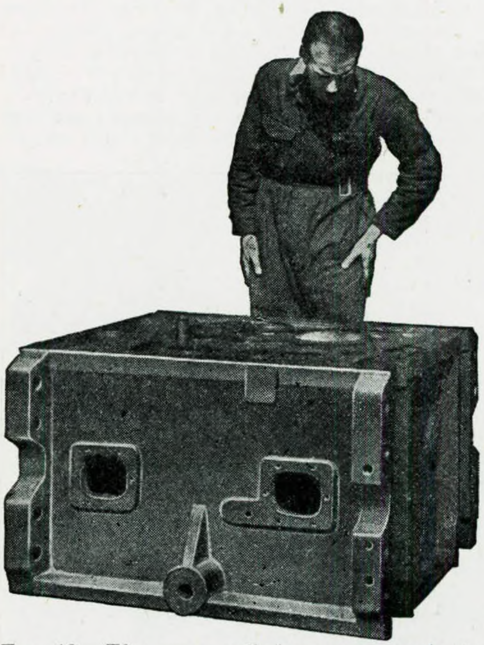


FIG. 18.—*The same cylinder cover, perfectly repaired by scientific welding and as sound as ever, ready for return to the ship. In addition to the cracks being repaired, the holes drilled when a patch was fitted to make a temporary repair, were also filled up.*

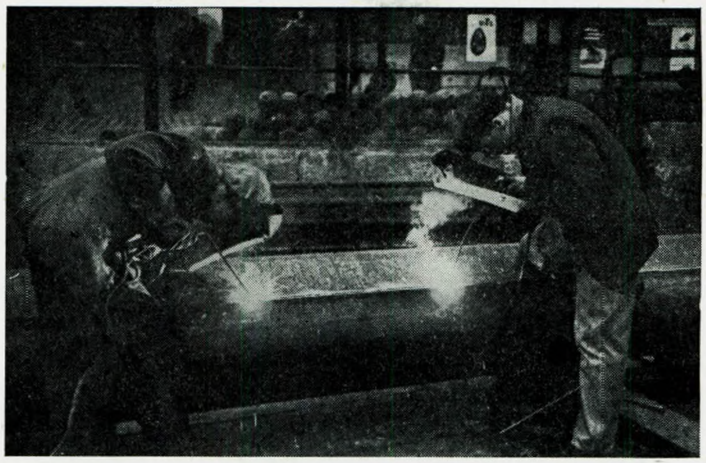


FIG. 19.—*Welders at work on an ash shoot for a new vessel in a modern shipyard. Welding means "clean" construction, due to the elimination of angle brackets and plates.*

From time to time there has been considerable controversy as to the permanent effectiveness of welding internal fractures in cylinder heads. Cracks in water jackets are somewhat more simple, but it is another matter when metal is subjected to the high temperatures of combustion. The most common form of trouble is failure of the metal between adjacent valve seats. As might be supposed, design has a lot to do with some engines being more prone to this fault than others. Designers could learn a lot by visiting the shops of welding engineers and ascertaining for themselves the reason for the identical failure of certain types of cylinder cover after more or less similar periods of running. It is not suggested that welding can cure faults which have their root in the drawing office, although a great deal can be done to lessen further risk of fracture, but welded heads can sometimes be made definitely superior to a renewal of the original type and invariably their equal.

FIG. 20.—*Welding is the recognized practice for the repair and construction of deck fittings.*

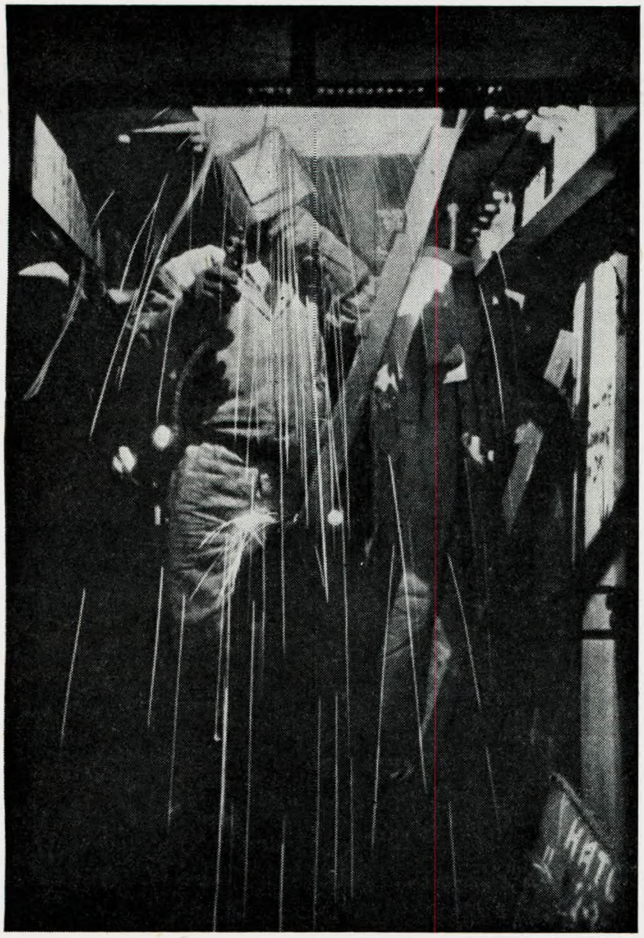


FIG. 21.—*Between decks of a vessel being prepared for sea. Breakdowns in machinery and damage to deck fittings are frequently repaired in a remarkably short time by welding, thus increasing the available tonnage when shipping is needed so badly.*

It is not uncommon to experience a crack which runs from the scavenge valve seat to the fuel injector housing and on to the seating of the exhaust valve or to the valve cage housing. It is because such fractures are merely vee'd and welded that similar trouble is repeated. Analysis proves that with certain grades of metal more than others, a definite denaturization takes place; the result is that the weld is robbed of a sound foundation. This fact does not prevent a dependable repair from being made, but the more drastic procedure of cutting out all defective metal and welding in position a new cast section is the sure road to lasting success. This has been done in innumerable instances, and although the cost is a little more it is still far below that of a replacement and is fully justified.

A great deal of attention has been given to deeply undercut valve seats. The use of valve cages in large engines renders maintenance relatively simple, but with smaller power units in which the seating is formed in the cylinder head casting, the position is quite different. Sometimes valve inserts of special heat-resisting steel are used. These may serve their purpose if they are not added as an afterthought, for time and again trouble has arisen from machining metal which is insufficiently thick to receive the insert. Another trouble which is apt to arise, is that of leakage. The inserts may appear to be gas-tight and satisfactory in every way when an engine is cold and yet prove a source of constant trouble when running temperatures are reached. For these reasons it is far better to weld up seats with heat-resisting metal and then re-cut them to the designed level. When this method is followed then high temperatures and hammer are rendered impotent.

Another trouble which can arise at several points is caused by an intense flow of circulating water which, if it enters in the nature of a jet that impinges directly on to a ferrous casting, causes erosion and when this is unsuspected perforation is sometimes the first notification of weakness. Dealing with a fault of this kind is apt to be troublesome as the weakened area is seldom accessible. The usual procedure of the welding operator is to cut away the covering metal, which can be replaced neatly and without the slightest loss of strength; then the primary fault is soundly welded and alignment preserved carefully.

It sometimes happens that engines of certain design develop identical faults after a more or less uniform period. In all probability some small change overcomes the trouble entirely, but in the ordinary course it may be some time before the weakness is brought to the notice of the designer. If an engine is out of its guarantee period it is likely that the owners will undertake the responsibility of putting the repairs in hand without reference to the builders of the machinery. In this way repair specialists are not only in a valuable position to correct faults that are apt to be repeated in similar engines, but accumulate a wealth of experience which would be invaluable to designers and is of great importance to shipowners and others called upon to deal with maintenance problems.

Errors of judgment and other mistakes on the part of the engine-room staff can bring about a striking similarity of failure. For example, a check in the cooling water supply, sufficient to cause overheating, may be the cause of cracks in cylinder covers which are almost identical in position and length.

This aspect of repair work was illustrated recently when six individual cylinder covers of a B. & W. engine were cracked in the water jacket; each weighs about 30 cwts. A temporary repair was made by patching but this could not achieve a permanent solution, nor was it intended to do so.

In each instance the crack commenced at the top corner on one side and then ran diagonally across the flanges of the mud doors, continuing round the casting and through similar faces on the opposite side. The cracks were prepared and welded with complete success and the alignment of all machined surfaces was preserved faultlessly. At the same time the holes which had been drilled and tapped to hold the patches were filled up and cleaned off.

Work of this kind is frequently undertaken as well as the repair of damage to castings due to studs being torn out because undue

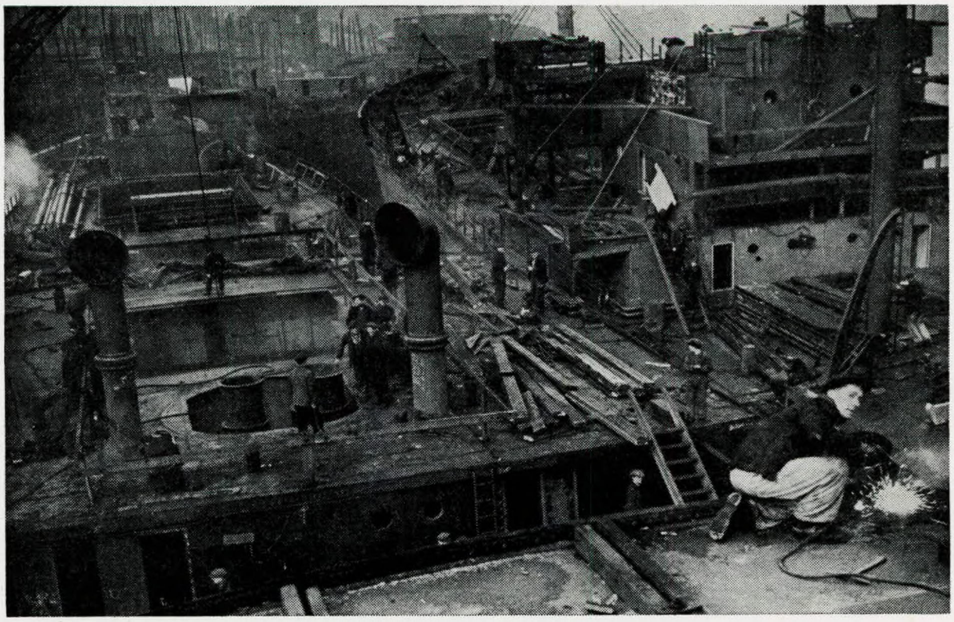


FIG. 22.—*Pre-fabrication, combined with welding, has done much to speed up the shipbuilding programme. This photo shows a welder just about to complete a "run" on the deck of a cargo vessel under construction in a British shipyard.*

pressure has been applied to the nuts. This trouble is, for obvious reasons, more frequently met in connection with smaller Diesel engines. The mistaken belief that the higher the pressure in the cylinders the tighter must be the holding down nuts, is responsible for most of this class of damage. Thoroughly experienced engineers do not make this mistake, but it is a prolific cause for welding attention and particularly common with auxiliary engines after examination and overhaul.

It is general practice in the case of large Diesel marine engines of a type in which the valves are carried in cages, to carry assembled replacements so that a changeover can be made with little loss of time and reconditioning carried out when opportunity permits. Sometimes considerably more than grinding and adjustment is needed, and often it is beyond the facilities of the engineering staff to deal with the matter themselves.

Two exhaust valve cages, each weighing 3 tons, were received for attention not long ago. It is only fair to say that the engine to which they belong is not of marine type and the example is mentioned merely to show that welding is not limited by the size of the part concerned. These particular valve cages each had a somewhat inaccessible crack of about 3ft. in length and running through metal 3in. in thickness. Here again careful control of temperature is essential toward a permanent result. At other times the valves which operate in these cages have been sent along for refacing on the seats with heat-resisting metal and also in order that the stems could be built up afresh by similar means prior to re-grinding. Incidentally these valves are nearly 7ft. from the head to the bottom of the stem, so that replacement is an expensive matter making the cost of reconditioning in the manner described negligible by comparison.

The facility with which parts are welded even when they are machined all over and produced to very small tolerances is most creditable. Some continental engines, in particular, have adjustable cams, and replacement of these is well nigh impossible apart from long delay and high cost; moreover special work of this nature calls for the use of high grade tools of a type likely to be occupied fully in other directions. Therefore the possibility of welding by building up the cam face or repairing damaged serrations, by which the adjustment is made, has proved most valuable, whilst the scientific welders' machine shop facilities are well able to undertake the task of final machining and grinding.

Some particularly fine work has been done upon crankshafts which are forged complete. Fortunately breakages are rare but, when they do occur, fracture through a web is the most frequent form of failure. In some quarters doubts have been expressed as to whether or not it is possible to regain a full measure of strength. Results covering a long period have proved that shafts handled in this way are utterly dependable and when failure has occurred a second time it has yet to be at the point of a sound weld. Experience shows that if the failure is due to a flaw in the forging it is advisable to examine the shaft for similar faults elsewhere, for when the writer has investigated the reason for a second failure the explanation, without a single exception, has been a flaw in the shaft some distance removed from the weld.

Provided a shaft is correctly positioned, welded with the most suitable electrode for the job and kept entirely free from slag inclusions from the electrode coating, a thoroughly sound repair can be made. Again it is desirable to stress the importance of the human element as being a primary factor bearing upon the result. In addition to being competent, the operator must be painstaking to a high degree. Every particle of slag must be removed after each layer of welding has been put down and it is advisable, so far as is possible, to encourage the welder to complete the successive circuits of operation without any interruption, progressing at the speed which experience has taught him is the most efficient for the repair in hand.

It is not known generally that one layer of electric welding has a valuable normalizing effect upon the previous run. This is the explanation for the much finer grain structure of a multi-layer weld and its greater reliability in comparison with a heavy single-layer weld which has a coarse crystalline structure. As the last run is not normalized as are the proceeding layers it will be appreciated that an adequate amount of surplus metal should be left on the shaft after welding is completed, so that after final machining the weld will consist solely of normalized steel.

A more frequent welding job than the repair of a fractured crankshaft is the building up of worn pins and journals. If these have become oval or are scored heavily after having been reground, possibly on more than one occasion previously, it may be most inadvisable to reduce the diameters still more. For this reason not only is it becoming more common to build up the defective bearing surfaces by welding methods, but to finish the final grinding with the pins and journals oversize, thus affording a useful margin when grinding again becomes necessary.

Turning to the wet liners of Diesel engines, curious things may happen, particularly if they are fitted too tightly at the intermediate land or lands, for contraction can take place in the bore and piston seizure result. Cracks sometimes occur in the lands and, although these can be handled without hesitation, it will be understood that the work calls for a seasoned experience on the part of the operator. When, however, this is forthcoming the risk of distortion can be dismissed.

Gear wheels and sprockets are another important field of welding activity. To get special wheel blanks and cut them may be a tardy process, particularly in these days, but fortunately it is unnecessary, for if the faulty gear is broken and teeth have been lost, there is still no reason why it cannot be reconditioned and made equal to new. Missing teeth are built up afresh, whilst worn ones have new metal welded to them so that after re-milling there is no difference in performance or efficiency of the welded component to a new one. Similar work is carried out upon keyways and splined shafts which have worn slack in course of time. Purely mechanical repairs are almost invariably unsightly and merely a stop gap lacking the permanent dependability which is so characteristic of good welding.

Refrigeration plant maintenance is an increasingly important marine requirement and, in broad outline, the needs of a compressor are, in many ways, similar to reciprocating steam or oil engines. Recent repairs to an ammonia compressor became necessary in unusual circumstances, for the cast base, weighing 8 tons, was damaged whilst in course of delivery. The plant was most urgently needed for installation and a new machined casting would have taken several months to produce. The damage consisted of a large piece being broken out of one end. It was welded in position and ready for installation in five days.

This job is interesting because of the thickness of the metal involved, although it did not approach the practical limit in this respect. Only a few years ago this factor limited and even prevented some welding repairs from being carried out; nowadays thinness can prove more troublesome for castings having a section of 8in., 9in. and even more are handled with facility. The technique which makes this possible has improved so steadily that this advance has come about practically unnoticed, but it still astounds some engineers who come upon it suddenly when they have been without opportunity or need to keep in touch with current welding developments.

From compressors one thinks, almost automatically, of pipework. The modern tendency is to reduce joints of all kinds by welding into continual lengths and in this way avoid potential sources of leakage. Of course coupled flanges cannot be eliminated entirely but a reduction is most desirable; moreover it does not interfere with renewal or replacement in the event of damage, for a pipe can be cut and a section renewed with little loss of time.

A great deal has been done to overcome the fracture of baseplate and other castings due sometimes to strain far beyond that for which they are designed and also to concussion fracture. Obviously those failures that arise can be overcome by welding but it does not eliminate the possibility of similar trouble arising elsewhere in the casting although the application of welded reinforcement can go a long way toward securing immunity. In many instances fabricated steel beds are being used, the greater tensile strength being equal to the burden of enormous and sudden stress without permanent fault arising as a consequence.

In this connection, and in fact in all cases where welded steel plate is used to replace a casting, it must be remembered that no advantage can arise from following a design that is indicated by foundry methods, in fact any such practice must limit the gain which is being sought. It is essential that the design should comply with the dictates and requirements of welding alone.

It is not suggested that progress of this kind will put foundries out of business. The cost of production is the equalizing factor. Welding is far cheaper for the manufacture of one or even a small number of identical components because it eliminates the cost of patterns. When this charge can be spread over larger quantities then the relatively low cost of the castings cannot be assailed by welding.

Undoubtedly there will be an extension of welding to marine propelling and auxiliary machinery on a larger scale than has been evident in the past. Steam deck machinery is in need of attention from time to time. Exposure is the initial cause of some troubles, particularly those brought about by corrosion.

A common failure of a different class but one which welding has been called upon to cure, is that of damaged cylinder flanges and slipper guides. There is no need to go into the cause of happenings of this kind, suffice it to say that apart from replacement, welding is the only effective and guaranteed cure. One of the largest castings of this type was handled recently. It embodies the main frame with integral slipper guides and the flanges to which the cylinders are bolted. These were broken extensively in addition to one of the guides being smashed.

In another case a ship was loaded and about to sail when it was noticed that a winch frame was cracked. It happened that some of the cargo had to go direct to a port where discharging facilities were very limited and the ship must rely solely on her own gear of which the faulty winch was an essential part. A replacement was out of the question.

A telephone message to a specialist welding firm brought both operators and portable plant. By dint of working night and day a thoroughly trustworthy repair was made. Lloyd's inspection and tests followed with entirely satisfactory results. It is of interest to observe that in common with certain types of Diesel engines an increasing number of winch frames and beds are being fabricated by welding.

Whilst hardly coming within the category of a welding repair nevertheless it was due to these methods that a ship was fitted with a new propelling engine in a very short time. The original Diesel unit was badly damaged and as it was of Continental origin it was considered best to replace it with new British-built machinery which happened to be available at the time. The ship was taken to a repair yard where, in order to save valuable days, a large opening was made in the forward bulkhead of the engine room by use of the cutting flame. Then the discarded machinery was jacked up and rolled out into the empty hold and the new power unit was moved into place in the same way after the seating in the ship had been modified, largely by welding. When the new engine was in position the bulkhead was sealed again by welding in the portion that had been removed temporarily. By doing the job in this way it was not necessary to interfere with the top hamper above the engine room and a great saving of time, cost and inconvenience was effected.

Propellers are repaired by welding to an ever increasing extent. In the case of those cast solid, chipped blades can be built-up and propellers with broken blades can have new sections fitted, whilst defective keyways are made sound once more. The economies effected may not be quite so great in connection with propellers having detachable blades but there is still the same general need for re-conditioning from time to time. Propeller erosion is known to all marine engineers; much has been written about the conditions which create this weakness in propellers. It is a remarkable fact that eroded surfaces welded in a specific manner, ensure that the trouble will be minimized vastly, almost to a point of elimination. One method which was used with considerable success on an eroded propeller of the s.s. "Europa" was to fill in the defective places by spraying metal into the holes, some of which were so large that a couple of fingers could be laid in them. The success of this method of reconditioning was remarkable.

Metal spraying which is an off-shoot of welding is a particularly useful possibility applied to all manner of work, mainly to overcome corrosion.

The method by which the spraying is done is relatively simple. A "gun" is the chief item of the apparatus. It is rather larger than the hand piece of a paint spray and is provided with a feed for wire (or sometimes powder) of the metal it is desired to spray. As the wire or powder is passed through the oxy-acetylene flame it is instantly melted, the molten particles being ejected by a stream of compressed air which, in addition to the gas pipe lines, is also led into the gun.

A matt surface can be coated with almost any metal with the same facility as a liquid, the surprising thing being that by the time the particles of metal reach their destination they are relatively cold. This is shown by the ability to coat thin paper without burning it. Although adhesion is therefore mechanical and not fusive, it is extremely good. When steel is sprayed with zinc in this way the result is equal to the best galvanizing whilst the appearance is better owing to the evenness of the layer.

When galvanized plates are riveted the zinc is destroyed locally, but after the work is done these places, together with the rivet heads, can be made impervious to salt-water corrosion to the same extent as galvanizing by the application of the metal spray, which can cover a large area in a short time.

This method is used to build-up afresh worn components, but scientific welding engineers prefer to apply new material in the more usual form of feed rods, arguing that in this way both grafted and parent metal have a homogeneous unity that is otherwise impossible.

The versatility of welding as it refers to repair work is far greater than is generally understood. Present achievement is underlining the importance of this efficient branch of engineering which is doing so much to maintain a high standard of mechanical efficiency, often with the handicap of incredibly difficult conditions.

The author wishes to acknowledge Messrs. Barimar, Ltd., of which Company he is managing director, as the source of the information and illustrations contained in this paper.

CORRESPONDENCE.

"Erosion of Propeller Blade Surfaces."

Mr. G. R. Unthank (Member) has written: References to erosion of propeller blades at once arouse interest, possibly because it has proved such a baffling problem.

The abstracts from the Parsons Memorial lecture by Sir Stanley V. Goodall, which appeared in the July issue of the TRANSACTIONS, giving the theory as to the causes of erosion, are most interesting. It is known that the question has had the attention of many engineers and scientists and that great headway has been made, but there are occasions when, for some unknown reason, the trouble crops up again.

As mentioned in the abstract, some success is looked for in the production of a harder material for propellers.

It hardly seems to the writer to be necessary to produce the whole of the propeller in a harder metal, if the trouble could be eliminated by treatment of the surface only. There have been experiments carried out in an attempt to produce the hard surface required on the blades by the process of depositing metals, but according to the theory put forward one can quite understand why these attempts were not satisfactory, since there is no real connection between the skin of the metal deposited and the material of the propeller itself. If, however, a surface of sufficient hardness and with depth enough, could be produced on the present material in use, which would stand up to the hammering due to the bursting of the small vapour bubbles as they pass across the surface, it would appear to be all that is necessary.

Some years ago the writer was faced with a problem of producing some bronze moulds, being the only material suitable for the work. It was also essential that certain moulding surfaces had a hard smooth face. A number of experiments were carried out before results were produced.

Eventually, a method of case-hardening the bronze was devised. The moulds were machined and finished with a fine surface and were then dipped and thoroughly cleaned. The surface required to be hardened was then tinned, and the whole mould was placed in a muffle and brought up to a temperature of about 1,100° F. The amalgamation of the tin with the bronze certainly produced a hardened surface.

It would be interesting to know if any attempts on similar lines have been made in respect of propellers. Possibly some Members would like to give their opinion on this matter.

ADDITIONS TO THE LIBRARY.

Presented by the Publishers.

The following British Standard Specifications:—

No. 13-1942. Structural Steel for Shipbuilding.
No. 1,044-1942. Recommended Designs for Gauges.
No. 1,016-1942. Methods for the Analysis and Testing of Coal and Coke.
No. 1,017-1942. Methods for the Sampling of Coal and Coke.
No. 1,054-1942. Engineers' Comparators for External Measurement.
No. 1,034-1942. Test Code for Continuous Vertical Retorts.

Preliminary Mathematics for Engineers. By W. S. Ibbetson, B.Sc., M.I.Mar.E. E. & F. N. Spon, Ltd., 2nd edn., 170 pp., illus., 5s. 6d. net.

This is the second edition of a useful book which is quite up to the standard of excellence the author's earlier publications have led one to expect from him.

The author's aim has been to give a good grounding in fundamental principles, so as to give the student a proper understanding and appreciation of the more advanced books available. It can be said that he has succeeded in his aim.

The book is well written, is compact, and there is a liberal supply of examples suitable for class work at the end of each chapter. Answers are provided.

While primarily intended for use in first-year classes in engineering and electrical trades courses, the book would also be admirably suited for adoption in junior technical schools.

Producer Gas Plant for Industrial Purposes—Its Operation and Maintenance. Issued by The National Federation of Gas Coke Associations, The British Hard Coke Association, and the South Wales Anthracite and Dry Coal Committee, 88 pp., illus., 5s. net.

This is a particularly excellent publication which will be warmly welcomed in view of the greatly increased use which is being made of producer gas plants owing to war-time conditions.

The book has chapters on: gas production; the gas generator; washer-coolers and filters; fans, boosters and gas pressure control; plant control instruments and the analysis of gas; sulphur removal; utilization of producer gas; and typical producer gas plants. There is also an appendix describing precautions which should be taken against carbon monoxide poisoning and the treatment of casualties.

Excellent illustrations complete a valuable book, which contains, it should be stressed, a great deal of useful information not readily obtainable elsewhere, *e.g.,* selection of pipe sizes, flow through orifices and descriptions of typical producer gas plants.

If one criticism may be made, it is that the title is misleading. The book does not deal with and hardly touches on high volatile coals. It is confined to solid smokeless fuels such as anthracite and coke, and it is suggested that this should be indicated in the title.

Practical Mathematics for Marine Engineers, First Class. By P. Youngson, B.Sc. and T. A. Bennett, B.Sc. James Munro & Co., Ltd., 13th edn., 725 pp., copiously illus., 20s net.

That this—a technical—book is now in its 13th edition implies that it is of exceptional excellence and that it fully satisfies the demand for which the authors set out to cater.

Under the general heading of "Mathematics" there are chapters on: Indices, equations and variation; logarithms and trigonometry; mensuration of areas; and mensuration of solids. This is followed by a section on "Engineering Science" which contains chapters on: Graphic statics; mechanics; the simple machines; strength of materials; bending; torsion; boiler formulæ; hydrostatics and hydraulics. The subsequent section on "Heat and Heat Engines" comprises chapters on: Heat and steam; expansion of gases and steam; power and density of boilers; and mechanism. A chapter follows on stability and propulsion under the heading of "Naval Architecture" and the final section on "Electrotechnology" is composed of chapters on direct and alternating current.

The price of 20s. for this well-produced and substantial book represents very good value in existing circumstances.

Battle of the Seaways—from the "Athenia" to the "Bismarck". By George H. Johnston. Victor Gollancz, Ltd., 148 pp., 13 illus., 8s. 6d. net.

The first part of the book deals mainly with the Merchant Service. We are told of the first submarine attacks in the early days of the war, and the attacks on isolated vessels before the convoy system could be organized. Chapter 3 deals with the difference in the methods of submarine commanders—the "Athenia", with its 1,103 passengers torpedoed without warning—and the other side of the picture, the boats which were treated with quite quixotic consideration by U-boat commanders.

The author next considers the British blockade of Germany—its present weakness as compared with the blockade of 1914-1918, how it works, the German counter-blockade, the "City of Flint" affair, the "Rawalpindi's" battle with the "Deutschland" and the "Admiral Hipper". There are also chapters on the British contraband control system, German attacks on neutral shipping, mine warfare and the German shipping losses.

Then comes the story of the Navy, which deals with such matters as the size and strength of the British, French and German fleets in 1939, the sinking of the "Royal Oak" in Scapa Flow, destroyers versus U-boats, the work of British submarines and the "Graf Spee" battle. There is an interesting account of the part the Navy played when the Nazis invaded Norway, and of how the Norwegian bullion of £15,000,000 in gold was smuggled by thirty lorries from Oslo to Aandalsnes and thence by a strange assortment of little craft to a waiting British cruiser. This section ends with a description of the work of the British fishing trawlers as minelayers and mine-sweepers, of the bombing attacks on unarmed trawlers, and the success of the small defensive guns once they were fitted.

Part Three, headed "The Battle Develops", tells of the increasing difficulties of the British Merchant Navy during the winter of 1940 and the spring of 1941, and of the desperate adventures which the crews of some of the vessels experienced. The book ends with an account of the convoy system, surface raiders, Lisbon and its network of espionage, and a summing up of the progress of the Battle of the Atlantic to the loss of the "Hood" and the sinking of the "Bismarck". It is a highly interesting and easily read book.

Inchley's Theory of Heat Engines. Edited and revised by H. Wright Baker, D.Sc. Longmans, Green & Co., Ltd., 455 pp., 170 illus., 16s. net.

This established work was thoroughly revised and brought up-to-date in 1938. In the present edition Dr. Wright Baker has incorporated from many sources figures, diagrams and ideas which experience has shown specially helpful, while adhering to the main purpose of the original author in giving a complete and concise account of the thermodynamical principles.

This new edition has provided an opportunity for the correction of a number of errors and for the clarification of certain sections of the book. A considerable extension has been made to the section dealing with the important and difficult subject of heat transference by convection.

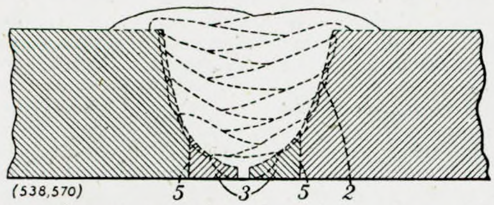
There are eighteen chapters in the book and they deal with: The laws of state and of thermodynamics; laws of expansion and compression; theoretical heat engine cycles; factors of state—entropy; curves of state; irreversible processes; hot air engines; theory of air compressors and motors; the properties of steam; steam engine cycles; the reciprocating steam engine; flow of steam through orifices and nozzles; the steam turbine—design of blading, etc.; the internal combustion engine; mechanical refrigerators and reversed heat engines; heat transfer by radiation, conduction and convection; combustion; the testing of heat engines and plant.

No rigorous statement of thermodynamics has been attempted, but the editor's hope is that enough has been said to enable the student of engineering to visualize the mechanism of the processes which he seeks to control. The classification of text-books as elementary or advanced has often given readers of the former an entirely false impression of security which has been rudely shattered when the real deviations from the simpler laws and theories have had to be considered. As such a classification is entirely arbitrary, any permanent separation of the subject on these lines has been avoided in this book; limits and deviations have been stated in their logical places, and the more difficult sections of the work follow those of a simpler nature. Naturally the student is advised to read the simpler sections first, and a selection of these has been marked with an asterisk for guidance.

Abstracts of the Technical Press

Butt Welded Seams.

A new British patent granted to Babcock and Wilcox, Ltd. (and other parties) covers an improved method of welding butt joints of non-austenic alloy steel plates. The liability to cracking of such butt-welds in alloy steels containing up to 3 per cent. of nickel, chromium, tungsten, vanadium, or molybdenum, has, it is claimed, been found to be reduced if at least the metal defining the base of the welding groove is of an alloy of the same character, not in a forged or cast condition, but deposited by welding. The figure illustrates a section through a butt-welded seam between two plates of a non-austenic steel alloy. The base of the U-shaped groove (*2*) is formed by retaining lips (*3*) of an alloy of the same character, *e.g.,* 0·5 per cent. molybdenum alloy steel, deposited by welding on the surfaces (*5*), which have been first machined on the edges of the plates. The sides of the U-shaped groove are then machined on the edge formed by the plate metal and the deposited metal to form the sides of the final groove (*2*), after which the two plates are butt-welded in the usual way with layers of the same alloy. The first layer of weld metal deposited in the groove can, however, be of mild steel, since the presence of such a layer is also of advantage in minimizing cracking.—*"Engineering", Vol. 153, No. 3,981, 1st May, 1942, p. 360.*



Method of Welding Seams and Butts.

Instead of shearing and planing plate edges in the fabrication shops, the present practice in American shipyards is to flame-cut them with acetylene torches. As a result the finish of the edges is not nearly accurate enough for seams and butts that have to be machine welded (Unionmelt) where plates should be tight and where $\frac{1}{8}$-in. openings in $\frac{3}{8}$-in. plates cause the latter to burn through. In such cases it is therefore found necessary to leave a $\frac{1}{4}$-in. opening which is welded by hand. The writer declares that over 50 per cent. of the plate joints for Unionmelt welding in the yard with which he is associated have to be recut with an acetylene burner in place. This, he suggests, may be due to inaccurate templates, defective workmanship or distortion from burning. It has been found possible to avoid the extra expense involved in recutting by the use of a copper backing-up bar which prevents the molten material from running through. A bar $\frac{1}{4}$in. by 4in. has proved satisfactory when supported at 18-in. intervals, but a bar of $\frac{1}{2}$in. by 2in. or 3in. supported at intervals of 3ft., might be better. The Unionmelt process applied to $\frac{3}{8}$-in. plates $\frac{3}{8}$in. apart has proved highly satisfactory when the machine speed is varied to suit the opening and to give a uniform weld surface. One pass of welding on each side of the seam is all that is necessary to finish the job. Samples cut across $\frac{3}{8}$-in. welds on $\frac{3}{8}$-in. plates have been bent through an angle of 90° without showing any indication of weld weakness. The direct saving in labour on 10 slabs assembling 150 tons per 10-hour shift is stated to be about \$35, but the indirect saving is probably twice as great. The writer points out that although the idea is not new, it is not commonly used in American shipyards.—*"Marine Engineering and Shipping Review", Vol. XLVII, No. 5, May, 1942, p. 123.*

Patch Plate Repairs in Ship's Side.

A considerable number of Great Lakes ore carriers are being converted into ocean tankers to meet heavy war-demands. In most of these vessels it has been found necessary to remove all the sea valves in the engine room and to close the resulting 8 to 10-in. holes in the bottom or side plating of the hull by welding. The procedure adopted by the Dolomite Marine Corporation, of Rochester, N.Y., is to flame-cut the hull in order to cut the attachment holes out of the plate. The edges of the circular opening are then bevelled from the inside to a 30° angle, leaving an $\frac{1}{8}$-in. shoulder on the outside edge of the plate. A piece of plate of corresponding thickness and of $\frac{1}{4}$in. smaller diameter is then prepared for blanking the opening, the edges of the blank being bevelled to the same angle (30°) with an $\frac{1}{8}$-in. shoulder at the outer rim. This plate is then fitted into the hull opening and tack-welded into place, leaving a $\frac{1}{8}$-in. gap between the hull plate and the patch plate. This opening is then welded up, the weld being started at the highest point on the V-joint and continued round the circumferential gap to the lowest point of the latter—the other half of the patch being welded in exactly the same manner to the opposite hand. The welding is started with an $\frac{1}{8}$-in. all-purpose electrode and finished off with a $\frac{5}{32}$-in. rod of the same type. Each pass of the multiple bead is run from top to bottom opposite the last one completed, not more than $\frac{5}{16}$in. of weld metal being deposited at a time and each pass is cleaned thoroughly before depositing another. The last bead is built up to a height of not more than $\frac{1}{8}$in. above the shell plate. The inside of the patch is finish-welded before the outside joint is dealt with, the latter being chipped free of slag and small weld distortions before the first outside bead is run. The same welding procedure is then used on the outside joint, except that only two passes with an $\frac{1}{8}$-in. all-purpose electrode are necessary to finish the weld. After grinding and painting the repair is invisible on the outside of the hull. Where the holes to be blanked are in the curved portion of the bottom plating, the patch plates are, of course, shaped to conform with the curve of the hull before being tacked into place.—*R. Wagner, "Canadian Shipping and Marine Engineering News", Vol. 13, No. 10, May, 1942, p. 56.*

Half a Tanker Launched.

A few months ago a 12,000-ton tanker of Scandinavian construction was mined and broke in two. The after portion, with the engines undamaged, was towed a considerable distance to a North-East Coast shipyard, where it was decided to save time and material by building on a new fore part, some 200ft. in length. The new section was built so that the bulkhead end would enter the water first, and this raised the problem of whether the section would stop before completely clearing the ways. The building took place at the top end of a berth, leaving a good run, and after being specially trimmed, the new bow, with a breakwater of baulks of timber, moved into the water without mishap. The trim was then altered before the section was towed to a dry dock and docked about 10ft. from the after part for final assembly. The new bow was built as far as possible to conform to the original design, and was partly welded, although there is slightly more welding in the salved stern half. The entire job was completed in less than eight months, this being four months less than the time required to construct a new vessel of similar tonnage in this shipyard, in addition to which the repair represented a saving of from 1,000 to 1,500 tons of valuable steel. The tanker is now as good as new and ready for sea.—*"The Shipping World", Vol. CVI, No. 2,551, 6th May, 1942, p. 333.*

Surface Hardening of Crankshafts and Camshafts.

The high rubbing speeds and increased brake m.e.p. of the present-day Diesel engine make it essential that the crankpins and crankshaft journals, as well as the eccentric cams for the air-inlet valves, exhaust valves, fuel-injection pumps and starting-air valves, should have a surface hardness capable of withstanding the heavy abrasion to which these parts are subjected. Moreover, the lining metals frequently specified for the crankhead and main bearings necessitate crankpins and journals of relatively high Brinell numbers without sacrificing shaft core toughness. One of the most successful methods of quickly and cheaply achieving these ends at a single hardening operation is by the use of the Shorter patented process, which consists of local heating of the parts by an oxy-fuel blowpipe, quickly followed by quenching with water or other cooling medium. The process has now been developed on a mechanised basis for treating small and medium-sized shafts by a controlled consecutive system, although large crankshafts and one-piece camshafts are generally treated by the so-called progressive system. In the case of an oil-engine crankshaft, the latter is set up between centres and set in motion, as for a turning operation. For heavy shafts, each pin and journal has to be treated separately, but in light shafts several are treated at once. When the heat is applied any temporary increase in the length of the shaft, due to expansion, is accommodated automatically by a compensating device in the machine, so avoiding distortion. The blowpipe is carried at one end of a cross slide and the quench at the other; thus a simple motion at right angles to the treated part brings either flame or water jets into action, and this may be controlled automatically. The design of the machine provides for speed selection to suit the dimensions of the crankshaft concerned, in order that the required heat input may be attained in the proper period. The penetration depth is about 5 per cent. and the toughness of the previously heat-treated shaft is not affected. Iron as well as steel cast or forged crankshafts can be treated, but case-hardening steels are not treatable. For straight carbon steels the carbon content should preferably be not less than 0·45 per cent., giving, under Shorter processing, a Brinell hardness number of 600 or over. Alloy steels of medium carbon content

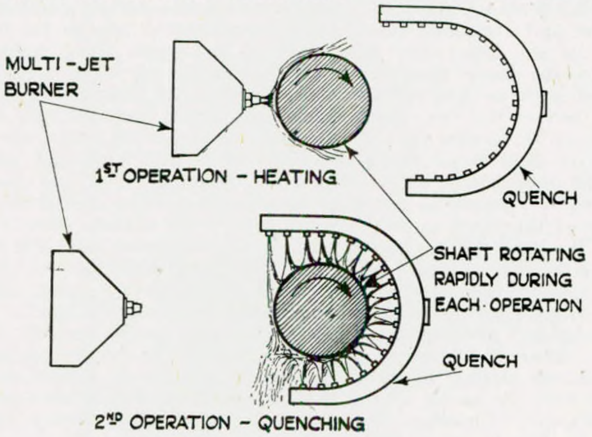


FIG. 2.

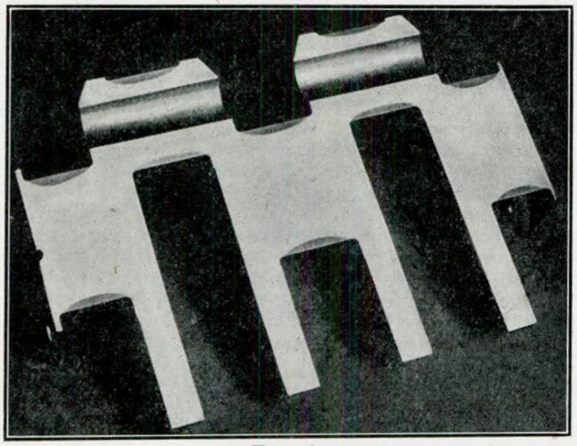


FIG. 3.

may be Shorterized. Fig. 2 is a diagrammatic representation of the consecutive method of applying the Shorter process to a revolving part, whilst Fig. 3 illustrates a section of a treated crankshaft showing the local hardening of the journals and crankpins. The Shorter process is applicable to a wide variety of engineering components other than crankshafts and camshafts, large numbers of gears being among the items also treated. Many manufacturers of oil-engine parts have arrangements to carry out the process in their own works, where the flow of components justifies the installation of one or more machines for the purpose.—*"The Oil Engine", Vol. X, No. 110, June, 1942, pp. 49-51.*

Bearing Breakdowns in Diesel Engines.

The failure of Diesel-engine bearings in general may be classified under two headings—firstly, those caused by overloading of the engine, whether from pre-ignition, unsatisfactory fuel distribution, design and construction, or faulty alignment. The second type of failures comprise those directly connected with the whitemetal linings, and is usually due to one of three principal causes—fatigue cracking, wiping and seizure, and corrosion. The requirements of present-day connecting-rod bearings for Diesel engines must be considered from the aspect of retention of Brinell hardness and strength at high temperatures, tensile and compressive strength. The mechanical properties of the lining metal affect its service, permanent hardening of the metal being undesirable and one of the greatest faults to be avoided in a bearing. On the other hand, one of the most valuable characteristics of a successful bearing metal is its capacity for self-annealing, and a low melting point tends to afford this quality. There are, however, many other factors relating to the engine to be considered, and variations in one or more of these often have a profound effect on the life of the bearing. Fatigue cracking is probably the most common cause of bearing failure, whereas corrosion does not occur in tin-base and lead-base alloys with a high tin content. Corrosion is, however, liable to become an acute problem with copper-lead and cadmium-base alloys. Lubrication is likewise something of a problem, as cadmium alloys seem to be very susceptible to any trace of acidity in the lubricating oil, so that the compound or vegetable oils generally regarded as being the most suitable for use with bearings subjected to high temperatures and pressures, cannot be employed for cadmium-base bearings. Another disadvantage of such bearings is a marked increase in crankshaft wear under certain conditions. Scoring and grooves are usually caused by metallic particles present in the oil stream, and it is this which is primarily responsible for the trouble experienced during the "running in" of lead-bronze and other such bearings. Seizure and damage to the machinery does not occur with whitemetal bearings, whilst local heating due to incipient seizure will also be much less intense owing to the fact that the lining beds down. Furthermore, the softening of the whitemetal produces the requisite clearance instead of welding on to the journal. An important point in the lining of large or small bearings is the pre-heating temperature of the shell at the instant of filling. The tinning on the inner surface of the bearing should be just fluid when the whitemetal is poured, and a distinct advantage is gained by using a jigging arrangement which permits the metal to be kept liquid for an appreciable period, thereby enabling "puddling" or "feeding" to be carried out, and "topping up" of the head, so that any shrinkage during cooling is made up with liquid metal from a hand ladle. Insufficient attention has often been given the actual process of lining, and too much reliance appears to have been placed on elaborate dovetails or anchor holes as a means of securing the whitemetal in the bearing shell in the erroneous belief that by this means loose linings are avoided and freedom from cracking is assured. Where cast-steel steps are used the provision of anchorage should never be regarded as an adequate means of holding the whitemetal securely. In point of fact this may be dispensed with entirely, as when the metalling is carried out correctly a bond of great strength is obtained with high tin-base metal containing a small percentage of cadmium, which undoubtedly gives it additional properties of resistance at high temperatures and obviates any risk of the metal becoming detached from the shell, even under the most arduous conditions of service. A belief exists that all whitemetal can be bonded to bronze more effectively than to steel shells, but this fallacy has been disproved by tests which have demonstrated that a bond to steel is always much stronger than one to bronze. Cast-iron steps are usually difficult to tin. Special care must be taken to prepare a tinnable surface on the shell by freshly turning it, using a fine cut. Dovetail grooves should be machined and utilised with discretion. Abrasive treatment, grinding or sand-blasting, should be avoided, as these processes cause non-tinnable particles of grit to become embedded in the surface. It is essential that the lining should be bonded to the steel shell as strongly as possible, since lack of adhesion causes the lining to be subjected to excessive stresses. Preliminary bonding is necessary in order to ensure that a whitemetal lining is firmly secured to the body of the shell into which it is cast, and this is achieved by the formation of an intermediate layer of solder. For this purpose pure tin, or solders of cadmium-zinc, produce a stronger joint than tin-lead solders. In the case of satisfactorily metalled bearings, bonds of great strength can be obtained. To secure a really efficient bond between the bearing shell and the whitemetal lining, the shell should be preheated to such a temperature that the tinning on it becomes molten, so that the oxide coating on the tinned surface is released, and rises as the bearing is filled, thus ensuring metal-to-metal contact of the alloy and the tinning without exposure to the atmosphere. The rate and direction of cooling should be carefully controlled, very rapid cooling improving both the bond strength and tensile strength. Crystallisation and brittleness in remetalled bearings is usually the result of overheating the whitemetal before pouring, but it may also be partly due to the use of old metal or of a mixture of unknown alloys from other bearings, for the sake of imagined economy. Many firms of ship repairers, when remetalling bearings, melt the whitemetal in a crucible in a pit fire. This practice cannot be too strongly condemned. Whitemetal should be melted in an iron pot or "shank" over a gas flame and *not* in a crucible, as the whitemetal will either be burnt or very much overheated by the time the crucible is lifted out of the pit fire. The practice of sinking a large bearing shell in the foundry floor and bedding it in floor sand for metalling is also to be deprecated, as this method greatly reduces the pre-heated temperature of the shell, whilst the cooling range of the cast lining is greatly delayed, causing too coarse a structure and segregation. All such work should be carried out on a lining table.—*"Mechanical World", Vol. CXI, No. 2,891, 29th May, 1942, pp. 482-483.*

Paddle Motorships on the Danube.

Some new paddle ships which have recently been placed in service on the Danube are equipped with Diesel engines, as these are considered to be particularly suitable for this type of service. The latest ship of this class is the "Stadt Wien", a vessel of 550 tons displacement, 250ft.×27ft. 6in., with a draught of 4ft. 9in. when carrying 1,400 passengers. The propelling machinery consists of two 8-cylr. Sulzer four-stroke engines of 450 b.h.p., running at 500 r.p.m. and driving the paddle wheels through reduction gearing.—*"The Motor Ship", Vol. XXIII, No. 268, May, 1942, p. 46.*

Four Ice-breakers with 10,000-h.p. Diesel-electric Machinery.

The U.S. Coastguard Department has placed contracts for the construction of four large ice-breakers by the Western Pipe and Steel Co., of Los Angeles. The ships will be 260ft. long with a beam of 64ft. and a draught of 28ft., the displacement being 5,000 tons. They will each carry a crew of 268 officers and men, and are intended to operate in field ice and pack ice. The propelling machinery is to be Diesel electric, using alternating current. Six Fairbanks Morse engines will drive the generators for supplying the current to three motors directly coupled to the propellers. Two are arranged aft and one forward. The total output of the installation will be 10,000 h.p., and the cruising radius about 1,100 miles. The cost of the propelling machinery of each ship is to be one-and-a-half million dollars. The vessels will be named "North Wind", "East Wind", "South Wind" and "West Wind".—*"The Motor Ship", Vol. XXIII, No. 268, May, 1942, p. 47.*

The Largest Great Lakes Ore Carriers.

Five new ore carriers recently completely for the Pittsburgh Steamship Company at Ecorse, Mich., and Lorain, Ohio, are stated to be the largest ships ever built on the Great Lakes. They are 10,450-ton vessels with a length of 639ft., a beam of 67ft., and a depth of 35ft., with an ore-carrying capacity of 18,600 tons on a draught of 24ft. The propelling machinery consists of a D.R. geared turbine having a normal power output of 4,000 s.h.p. at 90 r.p.m. of the propeller, and supplied with steam at a pressure of 400lb./in.^{2} and 750° F. total temperature by two coal-burning watertube boilers equipped with mechanical stokers and automatic combustion control.—*"Marine Engineering and Shipping Review", Vol. XLVII, No. 5, May, 1942, pp. 124-126.*

The Erection of Heavy Reciprocating Machinery on Concrete Foundations.

The three main purposes of a foundation are: (*1*) To support the weight of the machinery; (*2*) to maintain the alignment of the engine or motor and the driven machine in a perfect state; and (*3*) to absorb the vibrations caused by unbalanced forces due to the reciprocating and revolving masses. After explaining how the nature of the subsoil affects the design of the foundations, the author deals with the special features of (*a*) mass concrete; (*b*) concrete reinforced in certain directions; and (*c*) wholly reinforced concrete. The technical qualifications of the person designing the foundations and supervising the erection of the machinery are of the utmost importance, and the author points out that although this work should always be undertaken by a shop-trained engineer of adequate practical experience, it is all too frequently entrusted to men who imagine themselves to be "born erectors" despite their lack of proper qualifications. The various methods of erection described in the paper comprise: (*1*) The erection of a vertical compressor on plates and wedges; (*2*) the erection of a vertical compressor on parallel packings; (*3*) the erection of an oil engine of the dry-sump type on parallel packings; (*4*) various methods of grouting-up engines of this type, including liquid grouting; and (*5*) an alternative method of erecting engines of the dry-sump type. Although a combination baseplate beneath both the engine and the driven machine, whether it be a compressor, generator or motor, is usually very desirable, the author remarks that the employment of a baseplate adds to the height of the machinery and therefore involves a higher crane gantry, building, etc. Furthermore, baseplates increase the capital cost of the installation. Other points dealt with in the paper concern methods of alignment and slinging. The author concludes by stating that although the bedding of an engine directly on to the foundation block is the ideal method, it is a slow one and, except for very small and light plants, one that cannot be considered in these days when man-power is limited and speed essential.—*Paper by A. Morcom, presented to the Diesel Engine Users' Association for written discussion in 1942.*

Preventing Boiler Scale by Electrolysis.

The excellent results obtained by the use of electrical methods for preventing scale and corrosion in boilers are accounted for by the fact that the corrosion of steel is due to electro-chemical activity. If at two different points connected by both metal and solution there are different states of potential in the metal, or different materials, or even different concentrations of oxygen or of substance dissolved in the solution, the entire arrangement constitutes an electric cell, at the anode of which dissolution of metal takes place. The strained part of the metal will be an anode because its dissolution will take place with decrease of the energy content of the system. For many years zinc slabs were employed in marine boilers to reduce pitting and corrosion, the electro-positive zinc anodes being corroded away by electrolytic action and thus protecting the boiler shell and tubes which formed the cathode of the zinc-iron battery. Various modifications in the use of zinc have been proposed in a number of patents, but at the best this is a wasteful process. Instead of zinc slabs, it is possible to make use of an insulated electrode suspended in the boiler as an anode and to impose an electrical potential from a d.c. circuit between the electrode and the boiler shell and tubes in order that these may constitute the cathode. The resulting electrolytic action should reduce, if not eliminate, corrosion. When steam is generated in the boiler, the concentration of calcium and magnesium salts increases until supersaturation is reached, and this may of itself account for the formation of scale on the heating surface. It is possible that when supersaturation occurs the salts of calcium and magnesium are precipitated within the solution as a colloid which becomes electrically charged for some reason, such as the release of energy by the formation of colloids from irons originally present in the solution. A system which provides electrical means for reversing the polarity of metallic water containers and maintaining it at the correct value has been in successful use at sea for many years. The containers, normally anodic, are thus made cathodic: and a new anode, comprised of a number of insulated bars or discs, is introduced into the water. The installation is simple, consisting of mild steel or carbon rods mounted within, but electrically insulated from, the surfaces to be protected; an electric motor-generator; an automatic current controller; a control switchboard; and the necessary wiring to complete the circuit. The voltage in the latter is 5-10 volts, according to conditions, whilst the current consumption is negligible—from 0·4kW./1,000ft.^{2} per day with salt water, to 0·2kW./1,000ft.^{2} per day with fresh water. An important corollary to the prevention of corrosion is the elimination of scale formation. Acid radicals, such as carbonate, sulphate and silica, are carried to the anodes, away from the container walls, rendering scale formation impossible, and the thin film of free hydrogen forming on the cathodic container walls soon loosens and removes existing scale. Algæ and slime are repelled electrically, just as a pitch ball is repelled by a charged stick of sealing-wax. Corrosion reductions up to 98·8 per cent. are claimed, scale- and slime-removing operations being replaced by periodic flushing-out of residue, and much lower fuel consumption made possible by improved heat-transfer efficiency. In several ships this scheme is said to have paid its cost in less than six months. In another system one terminal of a 110-volt a.c. generator is connected to a distributor set on insulators at the bottom of the steam drum of a watertube boiler, while the other terminal is joined to the blow-off pipe. By a transformer, a second alternating current 180° out of phase with the first one is made to flow through the metal of the entire boiler under a potential drop of 2-3 volts by connecting the terminals of the transformer to the top of the steam drum and the blow-off pipe respectively. It was claimed that the use of this system prevented the formation of scale and loosened that already in a boiler, but it caused the formation of a non-settling sludge which remained in the steam drum instead of collecting in the mud drum from which it could have been removed by blowing down. An external system in a typical installation is placed in the shell of a feed-water heater about 30in. in diameter and 6ft. high, from which the steam heating coils have been removed. Mounted within this shell are electrodes, consisting of two horizontal Duriron plates serving as anodes and several wire screens as cathodes between the plates. The lower anode is set on insulation about 2ft. above the bottom of the shell.

It is approximately 24in. in diameter, ½in. thick and perforated with ½-in. holes. A wooden cross on this anode plate supports several 10-mesh wire screens spaced about 1in. apart to serve as the cathode. Electrical connections to the anode and cathode are made by insulated wires passing through the shell. Feed water enters the bottom through a horizontal pipe from the hotwell, and is heated up to boiling point by the addition of live steam. The outlet is at the side of the shell near the top. At the top of the shell is a valve for removing non-condensable gases. In its original form, one system had a thermocouple clamped to the steam header with the negative lead connected to the blow-off pipe and the positive lead attached to several remote points of the boiler, thus causing a very small direct current to pass through the metal of the boiler. Through an accidental loose connection which swung back and forth against the boiler, it was discovered that a pulsating current was much more effective than a steady current, and this led to the filing of a second patent covering the application of a pulsating current and the design of a vibrator to produce pulsations automatically. This vibrator proved unreliable and was replaced by a motor-driven interrupter with metal contacts producing about 7,000 pulsations per minute. A sufficient number of thermocouples are placed in parallel to give an electric current of about 50 milliamperes per 100 boiler h.p. In the latest installations a small condenser is connected as a shunt around the interrupter, and it is claimed that oscillations of radio frequency are set up, which assist materially in preventing scale formation.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 35,663, 28th May, 1942, p. 1.*

"The Soot Blower, with Special Reference to the Present Position of Power and Automatic Operation of Mechanical Blowers".

The nature and extent of the deposits on the heating surfaces of a boiler unit are examined and the development of the use of soot blowers, particularly the single-nozzle blower, is considered. The design of the boiler to enable full use of different types of soot to be made is discussed in relation to the effect on furnace walls, furnace and boiler tubes, superheater, economiser and air-heater surfaces. A description is given of the essential features and utilisation of power-operated mechanical soot blowers, with special reference to automatic operation. The paper concludes with a general indication of the trend of modern design of blowers, both electrically and hydraulically operated.—*Paper by R. J. Glinn, presented at a joint meeting of the Institution of Electrical Engineers and the Institution of Mechanical Engineers, on the 25th June, 1942.*

Problems of Mechanical Stoking.

What is to become of the coal-fired ship after the war? According to Lloyd's Register, just over half the world's tonnage at the outbreak of war, as regards vessels of 100 tons and upwards, was oil-burning. Furthermore, over 80 per cent. of all ships built to the classification of Lloyd's Register of Shipping at that time, were oil-engined or oil-fired. This proportion has grown from under 40 per cent. at the end of 1918, or, as regards all ships of 100 tons gross and upwards, from about 26 per cent. The gradual decline of coal burning has, to a certain extent, been due to lack of mechanisation. Some very fine examples of coal-burning installations comprising watertube boilers fired with mechanical stokers were to be found in the Southern Railway Company's cross-Channel ferry steamers, and similar installations were a feature of two B.I. passenger and cargo steamers built for the Calcutta-Rangoon service just before the outbreak of war. Mechanised coal-burning was, therefore, beginning to establish itself for the high-grade, rather than the ordinary tramp class of ship, although it is the latter type which represents the largest market for producers of coal in days to come. Amongst the factors which have militated against the adoption of mechanical stokers for tramp steamers is the difficulty of obtaining really good mechanical gear suitable for use in the furnace front of a Scotch boiler, which appears likely to remain the standard steam generator in tramp steamships if reciprocating steam engines are to be employed. Another factor is the additional first cost. There is also the question of maintenance and the possible effect upon the E.R. staff to be considered. For many years tramp steamer owners fought shy even of superheaters, on precisely these grounds. Nevertheless, in spite of these difficulties, there should be a potential market for mechanical stokers in tramp steamers of the future. There is also scope for improvements in the machinery installations of the East Coast colliers trading between the N.E. Coast or Scottish coal ports and London. Thanks to economy forms of hull very good fuel performances in tons-per-24 hours have been put up by some of these vessels; further improvements should be feasible if mechanisation of stoking took place. There is also the tug market. Attention has already been drawn to the savings which would accrue from the fitting of hoppers and mechanical stokers to an ordinary Thames tug. Similar considerations should apply to ship-handling tugs of the type that are now so frequently being equipped with oil engines. Lastly, there is the fishing industry. Even prior to September, 1939, there were signs that the confidence in coal, which had been a cardinal policy of the fishing industry, even in such strongholds of conservatism as Hull and Grimsby, was being shaken. This was partly due to the difficulty of getting the coal, and partly because of its fluctuating price, but mainly, because of the greater range of oil-burning vessels. In this case, too, mechanisation with a consequent reduction in the tons-per-24 hours would be of enormous value in a type of ship which is essentially a steam user. The foregoing remarks apply to mechanical stokers, but there is still scope for pulverised-coal firing, from a technical aspect, if there is room in the ship for it from a space point of view. Pulverised coal was handled badly by those who had to find the money to build the necessary equipment rather than by the engineers associated with it, and it never attained the success or even respect it deserved.—*"Lloyd's List and Shipping Gazette", No. 39,801, 15th June, 1942, p. 6.*

Engineer Officers in the Luftwaffe.

No new entries into the existing engineer corps of the Luftwaffe are taking place and the corps will be abolished in due course. In its place an engineering branch has been created with ranks corresponding to those of the G.S. officers with the addition of the letters (Ing.), and subject to the same rules and regulations. The new branch is to be mainly recruited from officer students holding leaving certificates of higher schools, who will be appointed to the Luftwaffe in the rank of Ensign (Ing.) and will undergo exactly the same training as ordinary flying officers of corresponding grade until they are promoted to Lieutenant (Ing.), after which they go through special courses of technical instruction. Engineer officers of exceptional ability have the opportunity of being selected to undergo further specialised training. Engineer officers wear the regulation Luftwaffe uniform with a pink distinguishing badge. Members of the former engineer corps may be permitted to transfer to the new engineering branch under certain conditions.—*Abstract of article in "Flugsport", reproduced in "The Journal of the Royal Aeronautical Society", Vol. XLVI, No. 377, May, 1942, pp. 131-132.*

Utilisation of Spare and Stand-by Boilers.

A new system which enables stand-by or spare boilers to be adapted for service as steam accumulators working on the drop-pressure principle, has been developed and put on the market in this country. The arrangement of such an installation is illustrated in Fig. 3, whilst the lay-out of the boiler accumulator connections is shown in Fig 5. The only internal or structural alteration involved is the fitting of a charging device containing two nozzles. By admitting live steam to this charging device a circulation of the water in the accumulator boiler is set up, whereby water is drawn from the lower part of the latter, is heated in the charging nozzles,

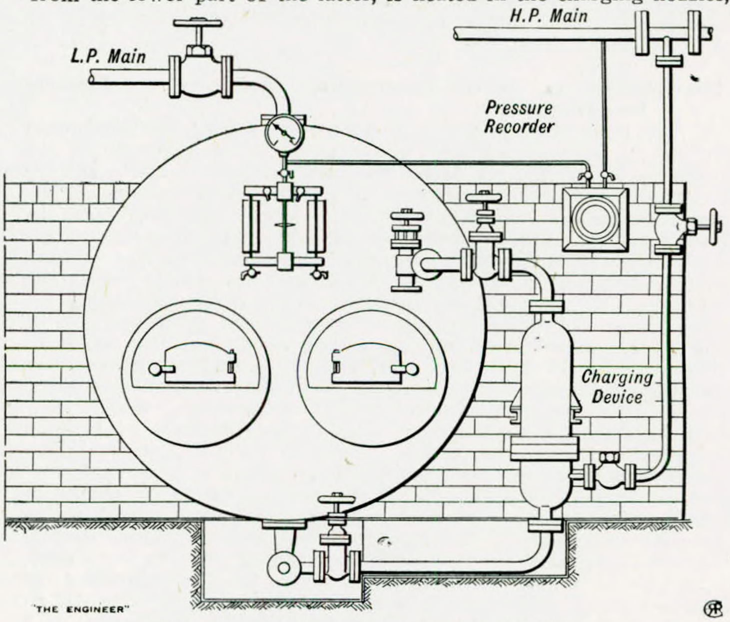


FIG. 3.—*Arrangement of adapted boiler.*

and is then returned to the upper part of the accumulator, thereby gradually raising the pressure and temperature inside it. Discharge is effected through the boiler stop valve into the low-pressure steam main. A reducing valve is generally fitted in the discharge line. The charging nozzles may be hand operated or automatically controlled by a surplus steam-charging valve worked by the pressure in the H.P. main. The initial cost of such an installation is low, and the storage capacity is only limited by the water space of the boiler available for use as an accumulator and the pressure drop which can be obtained. A large Lancashire boiler used as a steam accumulator on this principle has proved capable of dealing with 7,000lb. of steam per hour. The arrangement shown in Fig. 5 is that which was adopted in a Yorkshire factory where one boiler was in constant operation, whilst a stand-by boiler of the same type was only used on rare occasions. The boiler pressure was subject to heavy fluctuations and it frequently happened that sufficient steam could not be raised to meet the peak load demands. The stand-by boiler was converted into an accumulator with a hand-operated charging valve, with the result that there was no longer any shortage of steam. A 10 per cent. increase in production was attained, coupled with a 5 per cent. saving in fuel. The accumulator boiler does not, of course, lose its capacity to work as a primary steam generator, should it be required for use. It is kept constantly hot and under pressure, and in practice it has been shown that a Lancashire boiler of this kind can be steamed within 30min. after lighting the fires. In some instances the total saving in fuel consumption which can be attained by the means described may, it is claimed, be as much as 20 to 30 per cent.—*"The Engineer", Vol. CLXXIII, No. 4,511, 26th June, 1942, pp. 534-535.*

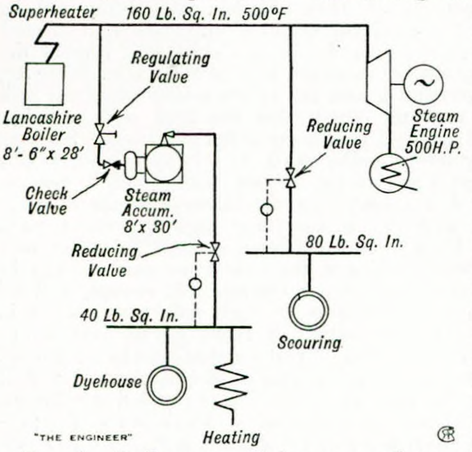


FIG. 5.—*Boiler-accumulator connections.*

Thames River Police Boats.

The River Patrol of the Metropolitan Police consists of about 50 river craft, most of which are teak-built 30-ft. launches driven by 80-h.p. Perkins Diesel engines. These craft are specially designed for this duty and are replacing various private motorboats requisitioned by the authorities at the beginning of the war as an emergency measure. The police boats are maintained and serviced by a special technical staff who have workshops and stores available for the purpose. Much of the smaller mechanical equipment for the boats is made in these workshops, and the work carried out by the latter includes the provision of a closed cooling system for each boat, on account of the quantities of mud in suspension in the waters of the tidal Thames. Two 1-in. bore tubes, each 17ft. long, are fitted alongside the keel and connected to a drum-type circulating pump and a header tank of 2 gall. capacity. The boats' electric generators and starters are fitted with suppressors, designed and made in the police workshops, to cut out spark discharge and prevent interference with the W/T equipment. The front windows of the cockpits are provided with vacuum-operated wipers actuated by a diaphragm pump driven by a neat form of eccentric, made in the shops, direct from the engine. A large stock of spare propellers and shafts is maintained owing to the risk of floating débris damaging the boats' propellers, shafts or rudders. The shafts are of mild steel protected by a sprayed-on zinc coating and run in cutless rubber bearings. Trouble was formerly experienced from electrical leakage between the cooling pipes, W/T earth and propeller shaft and from other factors causing electrolytic corrosion of the shafts and propellers, but this difficulty has now been overcome by efficient bonding and the fitting of zinc plates to the hull. All the boats undergo a routine inspection and machinery overhaul after every 300 hours of running.—*"The Motor Boat", Vol. LXXV, No. 1,895, May, 1942, pp. 122-123.*

Spray-painting for Ships.

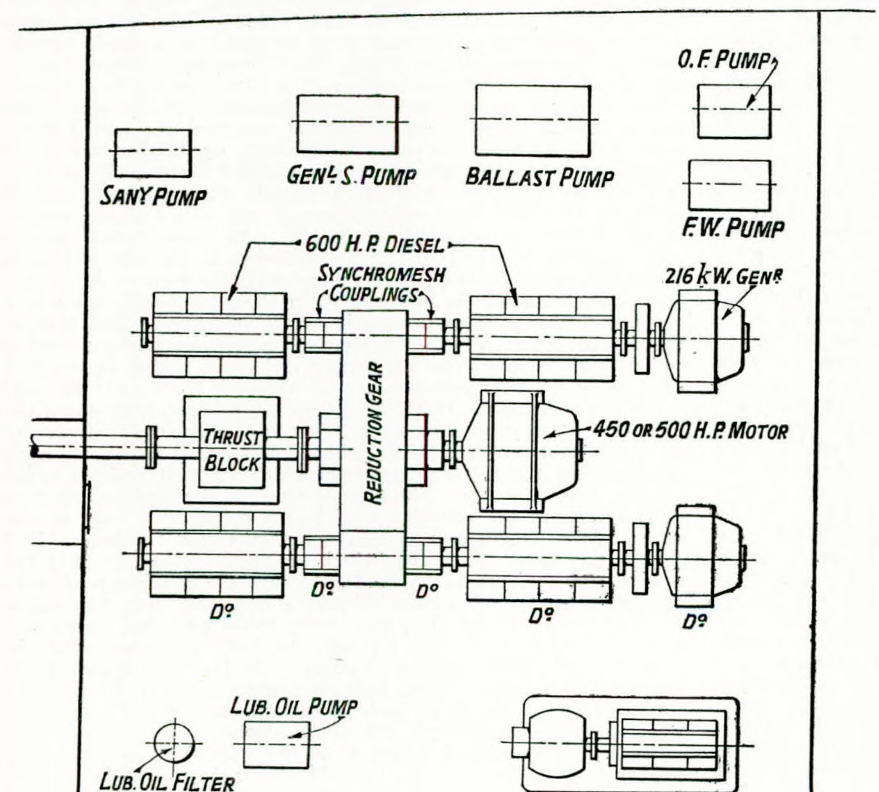
Despite the increasing use of spray-painting during the past ten years, its application to ships' hulls has hitherto been limited. Present circumstances, however, make it probable that this system of painting will be adopted by the shipbuilding industry to an ever-increasing extent. There are no real technical difficulties involved in spray-painting the hulls of merchant ships, although wetness of the plates may not allow the best results to be achieved. But there is no reason why spray-painting should not prove, on the whole, superior to hand-painting. Ships' painters will probably not take too favourably to spray-painting at the outset, but since there need be no diminution in wages, it is unlikely that this will constitute an insuperable obstacle. To judge by experience in other industries, ships' painters will probably prefer spray-painting after they have grown accustomed to it.—*"The Motor Ship", Vol. XXIII, No. 268, May, 1942, p. 39.*

Economical Machinery Space and Merchant Shipping Acts.

Among the improvements made in the design and arrangement of propelling machinery installations during the 15 years preceding the outbreak of war, one of the most important was in the lay-out of oil engines. The normal twin-screw lay-out of 1924 was largely superseded by a single screw on vastly improved lines, achieving an increase in power of over 100 per cent., coupled with a space reduction of 15 per cent. and a saving in weight of 47 per cent. This striking progress in marine Diesel engines has, to some extent, been paralleled by corresponding developments in steam installations, more especially in Germany, the U.S.A. and the Scandinavian countries. The adoption of higher steam pressures, together with other improvements, has resulted in a reduction of up to 20 per cent. in the overall length of the machinery space without any radical departure from what may be regarded as standard practice. It is now by no means unusual to find the engines and boilers sufficiently compact to be arranged in the same compartment; sometimes with a light intervening bulkhead for the purpose of checking heat, but often without. In 1938 the Hamburg-Amerika cargo liners "Gran Canaria" and "Santa Cruz" entered service with very compact H.P. turbine installations of 6,000 s.h.p. and two La Mont boilers in a single compartment of relatively small dimensions, whilst the 16½-knot U.S. tanker "Corsicana" obtained three times as much horsepower as similar vessels with exactly the same machinery space. The same year saw the appearance of the little Finnish steamer "Bore II", a vessel of under 2,000 gross tons with a double-compound engine of 2,500 i.h.p. and two Velox boilers, which together with the necessary auxiliaries, were arranged in a single compartment of less than 50ft. in length, thereby saving sufficient space to accommodate 20 extra passengers. The Dutch steamship "Batavier III", completed in 1939 and designed specially for the night packet service between London and Rotterdam, was equipped with a Werkspoor Meyer-Mattern compound three-crank engine developing 3,000 i.h.p., which was so compact that it enabled between 25 to 30 per cent. of the machinery space to be saved. It is probable that this saving would have been still greater if the ship had not had two Scotch boilers of conventional design, with superheaters, working at a pressure of 240lb./in.^{2}. The reduction in the size and weight of modern boilers, due in a great measure to the increase in pressure, has made it possible to locate them in the shelter-deck space amidships, with a consequent saving in machinery space. This plan was first introduced in 1934 by the Norwegian shipyards, who turned out some tramp steamers for the timber and grain trades, in which the location of the two boilers in the shelter-deck space over the engine room provided about 10,000 cu. ft. of additional cargo space on a total d.w. capacity of 2,410 tons. This arrangement was particularly convenient for timber carriers, whose holds had a far longer rectangular section, and for ore carriers in which the higher placed weights improved the stability. The firemen work in daylight in better conditions than in the usual type of boiler room, it is easy to dump ashes, and in war-time they can maintain steam far longer if the ship is damaged. A serious disadvantage, however, is that there are no trunk spaces to be used to secure the maximum allowance of net tonnage. It has been officially stated that, since the outbreak of war, British yards also, have built ships with their boilers disposed in this manner. As a result, the total machinery space in a ship of nearly 5,000 tons d.w. occupies only 11 frame spaces, excluding the thrust recess. American shipbuilders favour the placing of the boilers on a platform deck abaft and just over the turbines, a lay-out which permits efficient short steam pipes. This arrangement has been adopted in many of the turbo-electric tankers now under construction for the U.S. Maritime Commission, a further saving of space being achieved by putting both boiler units in the same casing. Many of the U.S. Government's new cargo liners have similar machinery installations, whilst others have the boilers in the same compartment as the engines, their casings being shaped to the turn of the bilge. In the 8,000-ton 16½-knot liners of the American President Lines this results in a machinery space only 50ft. long, with ample room for auxiliaries, etc. In Germany, the Hamburg-Amerika Line built a turbo-electric ship with the generating machinery in the centre of a group of high-pressure Benson boilers, whilst recent developments in the Lentz radial engine have made it possible to place the boiler plant between the engines. A lay-out adopted by the Nylands Yard of Oslo, for cargo tramps, comprises compound engines with exhaust turbines having one boiler on either side of the machinery, and is claimed to increase the cubic cargo capacity of the ship by 4·7 per cent. The promised revision of the Merchant Shipping Acts with their present pernicious minimum, as well as maximum, machinery space in order to obtain the full allowance of net tonnage deductions, should make a great difference to the economical design of British ships after the war.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 35,675, 11th June, 1942, p. 1.*

The Propulsion of Cargo Ships.

A scheme for employing light-weight high-speed Diesel engines of moderate power, manufactured by firms not engaged in the production of steam or heavy marine oil engines, for the propulsion of cargo vessels, has been put forward by Mr. J. D. Dean, who makes a number of claims regarding the advantages to be gained by its adoption. The idea is to use high-speed Diesel-electric drive on the lower range of powers sufficient to manœuvre in port, and to utilise direct drive through reduction gear for normal full power. The scheme envisages the use of a mass-produced type of Diesel engine, mass-produced standard generators and motors, Legge synchromesh couplings for changing over from Diesel-electric to direct Diesel drive, and the Ward-Leonard system of control from the bridge. With the assistance of a consulting naval architect, Mr. J. H. Clarke, who has worked out the general arrangements of a suitable cargo vessel of 330ft.×44ft.×27½ft., with a d.w. capacity of 4,200 tons and a service speed of at least 13 knots, Mr. Dean shows how he proposes to apply his method of propulsion. As may be seen from the accompanying drawing, the machinery installation comprises four Diesel engines, each developing 600 b.h.p. at 1,300 r.p.m., disposed in tandem on the port and starboard sides of a single reduction gear. The forward engine of each pair is coupled to a 216-kW. generator (designed to give full output at 900 r.p.m.) at one end, and through synchromesh coupling to the pinion of the reduction gear at the other. The aftermost engine is coupled through a synchromesh coupling to the opposite end of the pinion shaft. Each generator is electrically connected to a single propulsion motor developing 500 h.p. at 900 r.p.m. As all the electrical units are designed for this speed, it will be seen that if the engines are run up to 900 r.p.m., both generators will drive the propulsion motor which in turn will operate the reduction gear, the big wheel of which turns the propeller shaft. With two such units, arranged as shown, a total of 500 h.p. will be imparted to the propeller, sufficient to manœuvre the ship at about 7½ knots. To go astern, it is merely necessary to reverse the current between the generators and the motor. This arrangement of Diesel-electric propulsion will be maintained up to 900 r.p.m. of the engines, and each unit—Diesel engine, generator and motor—will be in synchronism. Should the speed of the Diesel engines be increased beyond 900 r.p.m., however, this synchronism is interrupted, and the synchromesh couplings will come into operation, with the result that the load will be taken direct from the Diesel engines to the propeller shafting. So long as the motor is driving the propeller shaft its synchromesh coupling will be engaged, but as soon as the Diesel engines are connected directly to the pinion shafts, owing to the increase in speed above 900 r.p.m., the motor becomes a generator and its synchromesh coupling disengages. Both forward Diesel engines will therefore be driving the propeller direct, and the two after engines can be synchronised so that their respective couplings will engage, and all four will then be driving the propeller through reduction gearing in synchronism, developing a total output of from 500 to 2,400 b.h.p., as may be required. Fast-running Diesel engines of the type used in the Dean system have a low torque value at low powers, and it would be impracticable to start up under direct-coupled conditions, but with the electrical system a high torque is developed in the propulsion motor at low power, and this lends itself admirably to starting up and slow running. Conversely, at high speeds the Diesel engine torque is considerable, and its efficiency for driving the propeller is high. The advantages claimed for the Dean machinery system may, therefore, be summarized as follows:—(*1*) The employment of high-speed Diesel engines, many types of which can be mass-produced in Great Britain and in the U.S.A. more rapidly and cheaply than heavy Diesel engines or steam engines; (*2*) the use of comparatively small generators and motors for the lower ranges of power; (*3*) the advantages of Diesel-electric propulsion (for low powers and greater torque) and direct Diesel drive (for high powers and high torque); (*4*) the exceptionally light total weight of the propelling machinery; (*5*) as the synchromesh couplings can be locked either in or out of gear, any one engine can be cut out while running on the rest; (*6*) the rapid replacement of any Diesel engine if a heavy overhaul is necessary after a long voyage; (*7*) the small E.R. staff required; (*8*) complete control of the main engines and propelling machinery from the bridge, by the Ward-Leonard system of control; and (*9*) elimination of a reverse gear box, the undesirable characteristics of which, in order to achieve reverse for very short periods, would be in constant service on the forward drive for, possibly, weeks at a time. Another important feature of the Dean system is that although an engine speed of 1,300 r.p.m. could be maintained indefinitely, this could be increased to 1,500 or 1,600 r.p.m. for short periods (3-4 hrs.), thus improving the ship's chance of escape from attack by hostile submarines and aircraft.—*"Shipbuilding and Shipping Record", Vol. LIX, No. 26, 25th June, 1942, pp. 660-662.*



Suggested lay-out of engine room and machinery arrangement.

Direct Injection.

In an article by J. E. Tuscher, which appeared in one of the issues of the *Publications Scientifiques du Ministère de l'Air* a short time ago, the author claims that his study of retarded cycles during which combustion in the cylinders of oil engines takes place entirely during the expansion stroke, has provided a means for reducing the combustion speed and for increasing the concentration of the air-fuel ratio up to saturation while maintaining a high thermal efficiency. He states that the combination of a short injection period and retarded cycle will produce the greatest specific power from a Diesel engine, while reducing, at the same time, the fatigue of its parts to within acceptable limits. Researches on a single-cylinder two-stroke Diesel engine (bore 125mm., stroke 170mm., normal output 8 h.p. at 800 r.p.m.) having adduced a solution for reducing the fatigue of the Diesel engine by permitting the preservation of its components and, at the same time, raising its specific h.p. to parity with that of carburreter engines, whilst maintaining for the Diesel engine its prerogative of burning heavy fuel under optimum economical conditions. The feeding of Diesel engines by injection pumps actuated by engine compression readily achieves the required high speeds of injection and permits rigorous control of the combustible charge introduced into each cylinder and of the peak pressure in the resultant cycle. The elimination of the mechanical control of the fuel pumps and pressure lines simplifies the construction of direct-injection engines and improves their reliability in service.—*"Flight", Vol. XLI, No. 1,746 11th June, 1942, p. 593.*

Producer-gas for Spanish Fishing Craft.

A medium-sized Spanish sailing ship was recently equipped with a producer-gas engine and made an experimental voyage from Valencia to Castellon. The results were unsatisfactory, however, owing to the absence of adequate cleaners. It is reported that the present shortage of petrol has caused Spanish fishing interests to consider a proposal to install producer-gas engines in all petrol-engined fishing vessels to enable them to be kept in service after they have consumed their petrol ration.—*"Lloyd's List and Shipping Gazette", No. 39,801, 10th June, 1942, p. 5.*

Dam Expert Becomes Builder of Cargo Steamers.

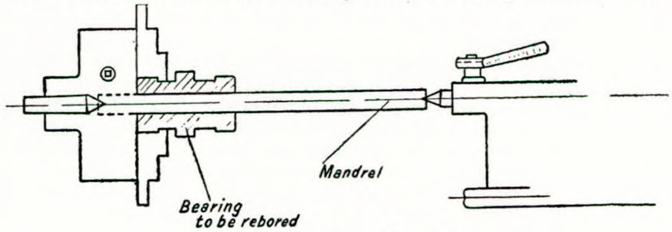
The Portland yard of the Oregon Shipbuilding Corporation is now launching a ship of 10,000 tons d.w. every six days and has reduced the time taken to complete and deliver such a vessel to 48 days after the laying of her keel. These outstanding performances are stated to be due to the genius of Mr. H. J. Kaiser and his associates who, although they had no previous experience whatever of ship construction, were the builders of the Grand Coulee Dam and numerous other dams, bridges and highways. The Kaiser organisation had 5,000 veteran construction workers and a number of expert structural engineers at their disposal, and it was these men who built the Todd-California shipyard in a swamp near San Francisco, in three months. After this Mr. Kaiser built several other yards, on the Pacific and Atlantic coasts, designed expressly for the construction of cargo ships of the EC-2 type. The Kaiser organisation subsequently undertook the building of several hundreds of these vessels by methods which constitute a radical departure from the traditional technique of shipbuilding. A Kaiser-operated yard takes up three times the usual area and the ships are assembled from prefabricated sections, some of which may weigh as much as 150 tons. Great cranes on tracks pick up a bow or stern section and lower it gently into place, whereupon welders make it a part of the ship. Under traditional methods, 800-900 men crowd into or around a hull, often in cramped positions, welding, riveting, painting, fitting, plumbing and wiring. In the Kaiser yards, while 500 to 700 men labour in and on the hull, 800 more scattered over several acres can work on parts of the same ship. Deckhouses are assembled upside down to enable downhand welding to be carried out, whilst propeller-shaft tunnels are built and painted in the yard, each being completed before it goes into the ship. A new fabricating plant between the Todd-California and the Richmond shipyards is now nearing completion, and here finishing work on galleys, deckhouses, forecastles and engine rooms will be carried out, 2,000 men working simultaneously on each ship. It is anticipated that the Kaiser organisation will shortly have 40,000 men building ships on San Francisco Bay and an equal number in the Columbia River shipyards. Work is already proceeding continuously on the three-shift system.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 35,675, 11th June, 1942, p. 2.*

Shale-oil Production in Sweden.

Some ten years ago the Swedish Admiralty started experimental production of shale oil, in order to create a domestic fuel reserve for its own requirements. The director of the works, the mining engineer Sven Bergh, recently gave a press representative some details of what has been accomplished in this direction. After the oil and a gas of high thermal value have been extracted from the shale, the residue coke, although containing 90 per cent. ash, is burnt, and suffices to supply the works power requirements. Furthermore, several tons of steam per hour are obtained from this source for the gasoline and sulphur plants attached to the works, which depend on cheaply generated steam for their economic operation. The most important by-product obtained at the present time is high-grade sulphur, of which a considerable quantity is produced and for which there is a good demand by the Swedish rayon mills and other industrial undertakings. Another shale-oil works of considerable size, built by the Swedish Government and situated in the province of Narke, started operations quite recently. At these works the Bergh extraction process as well as other methods are in use, and the annual output of oil will, it is estimated, reach 30,000 tons. All Swedish shale has a low oil content, and in this locality it amounts to only about 6 per cent., *i.e.,* to less than one-third of the content of the shale deposits in Esthonia which were exploited by means of Swedish-built plants before the war. Some interesting experiments are now being carried out in Sweden in connection with a novel electrical process for extracting the oil from the shale, invented by the well-known engineer F. Ljungström, in which the shale deposits are heated by electric elements sunk down in boreholes. The heat generated by these elements causes the shale to give off oil gases which are collected in tubes. It is stated that 600 such elements are now being placed in a shale-bed 50ft. in thickness preparatory to trial operations on a large scale. The total output of the Swedish shale-oil industry is, however, only large enough to cover a minor part of the country's most urgent needs of motor, Diesel and bunker oil. In normal times Sweden's annual imports of oil products amounted to about one million tons, whereas present imports are only a small fraction of this quantity. The fact that the country has contrived to keep its motor traffic running at all, is largely due to the widespread adoption of producer gas as motor fuel.—*"Gas and Oil Power", Vol. XXXVII, No. 441, June, 1942, p. 108.*

Setting Old Bearings True.

The writer describes how he set up a bearing which was to be bored out $\frac{1}{16}$in. above the original size. The outside of the bearing was rough cast and the countershaft on which it had to run had worn it so oval that there was no more than 0·015in. to be taken out at some parts of the bore. The length of the bearing was about 6in. The writer turned a piece of steel bar parallel to as good a sliding fit in the bearing as was possible under the circumstances. This mandrel was about a foot long and had two good centre holes



Setting worn bearings true.

at its ends. Having inserted the bar into the bearing and put the assembly between the lathe centres, the latter were tightened up on the bar, the chuck jaws were tightened down on the bearing, the tailstock was moved away and the mandrel was taken out of the work. This procedure made it possible to bore the bearing to the required size without any trouble. The idea is illustrated in the accompanying sketch.—*R. Hoyle, "Practical Engineering", Vol. 5, No. 127, 25th June, 1942, p. 591.*

Pumping Arrangements.

The object of this paper is to give an outline of the pumping arrangements provided in the average ship, in order that the purpose of some of the numerous pipes, valves, cocks and other fittings connected with the pumping system may be appreciated. Separate sections of the paper deal with the general arrangement of pumping installations, water ballast systems, oil fuel systems, oil burning arrangements, feed-water systems, pumps, fire-extinguishing apparatus in the machinery spaces, fire prevention and steam pipes. The paper contains numerous diagrams and sketches showing the arrangement of the pipe systems and fittings described in the text.—*Paper by J. R. Beveridge, B.Sc., "Transactions of the Institute of Marine Engineers", Vol. LIV, No. 5, June, 1942, pp. 55-63.*

U.S. Geared Diesel Vessel.

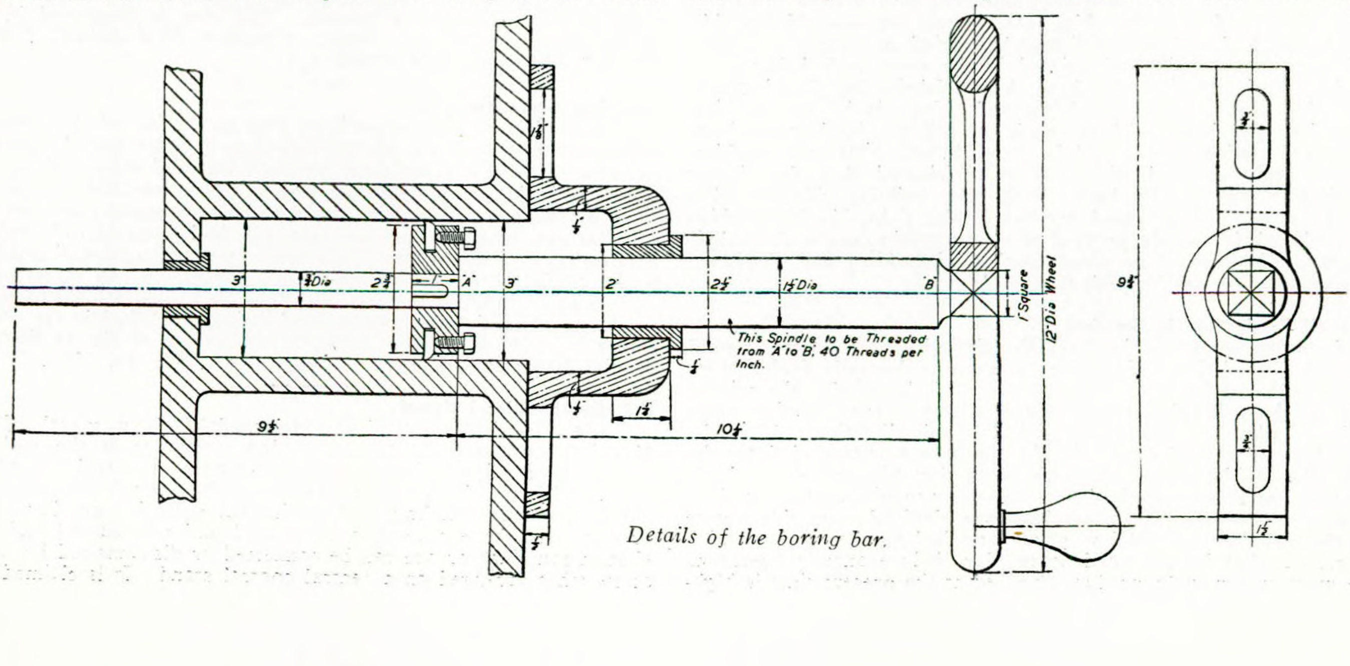
The American motorship "Mormacdale" is a vessel of the Maritime Commission's C-1 class, but differs from the majority of her sister ships in having only two 6-cylr. two-stroke Nordberg engines driving the single propeller shaft through Westinghouse electro-magnetic couplings and mechanical reduction gearing. Both or either of the engines can be started and manœuvred and both electric couplings or one can be connected or disconnected by means of switches arranged on a central control stand. It is claimed that the transmission loss through the magnetic couplings and reduction gear amounts to only 3·5 per cent., whilst the overall efficiency of each coupling, including excitation, is 98 per cent. The couplings are of the air-gap type, and consist of two rotating members, the inner one being of the squirrel-cage induction type and the outer one of the salient-pole rotating-field type, with the poles mounted on the inside of their supporting rim. The rotating members are bolted to flanges on the engine crankshaft and gear pinion shaft respectively. The inner one has a double-deck damper winding made up of heavy copper bars and end rings which is designed to minimize slip losses during normal operation, and a separate bare damper winding, effective mostly during a crash-stop operating condition. No information is available concerning the amount of current absorbed by the couplings from the ship's auxiliary load. The method by which the main engines are controlled is as follows: Both engines and couplings are operated from a central starting platform at the forward end of the engine room. The engines may be worked with both coupled to the propeller shaft, running ahead or astern, or with one engine only coupled to the shaft running ahead or astern, or with both engines running, but in opposite directions, making a quick reversal of the propeller shaft possible. There is also an emergency stop and reverse. Each engine is controlled by a single control lever which is provided with an automatic release stop to prevent it from being placed in the "fuel" position without first pausing in the "start" position. A mechanical clutch device is fitted for connecting both engine control levers together to enable both engines to be manœuvred simultaneously by either of the control levers. When both engines are operated by the single lever, the latch of the other lever is made inoperative by a trigger which locks it out of engagement with its quadrant. The clutch is operated by a clutch control lever which moves it in or out of engagement, and is connected with a clutch control switch, closed only when the clutch lever is in position, *i.e.*, when both engine control levers are connected together. This means that the two electric couplings can be energised simultaneously only if both engines are set to run in the same direction and at the same speed. Unless these conditions prevail it is mechanically impossible to engage the clutch and close the clutch control switch. Provision is likewise made for alternative arrangements of the levers—for one engine only coupled to the propeller shaft, running ahead or astern, and for both engines running in opposite directions for quick reversal of the propeller shaft. There is, therefore, considerable flexibility in the operation of the propelling machinery. The design may be open to criticism as being too complicated for a cargo vessel, but it has the advantage of giving optimum propeller condition, which is not always attainable with direct-coupled Diesel engines. The "Mormacdale" recently completed successful sea trials for the Moore, McCormack Lines, Inc.—*"Lloyd's List and Shipping Gazette", No. 39,795, 3rd June, 1942, p. 8.*

Boring Bar for Cylinders.

The accompanying drawing shows a boring bar which has, it is stated, proved extremely useful and effective for boring out the cylinders and valve chambers of a ship's steering engine. The employment of this device made it possible to carry out the whole of the work in place, thereby saving a considerable amount of time and avoiding the risk of breaking any part of an old engine. The bar is made from a piece of steel, 22in. long, one end being turned down to $\frac{3}{4}$in. diameter and the other to $1\frac{1}{2}$in. dia. with a 1-in. square cut on it to take a handwheel. The $1\frac{1}{2}$-in. portion of the bar is screwed 40 threads/in. and runs in a brass bush which is firmly secured in a bridge plate. The latter may be of cast iron or wrought iron and is faced up on both feet as well as on the counterface carrying the screwed brass bush at a single setting, after which it is turned and faced up on the reverse side in way of bore for alignment on the collar of the screwed bush. Slots $\frac{3}{4}$in.$\times 1\frac{7}{8}$in. are cut in the bridge feet to allow for adjustment when clamping down on the cylinder end. The end bush in the cylinder to be bored is removed and replaced by a new bush, suitable for the bore, to take the $\frac{3}{4}$-in. dia. end of the bar. This ensures a correct alignment when the latter is in position. The boring head is of cast iron, turned to a diameter of $2\frac{1}{2}$in. to give clearance for cuttings, and keyed on to the bar at the shoulder. The two cutting tools, of round steel, are fitted at opposite sides of the boring head, being held in their slots by screwed pinch bolts. The tools are set to follow each other as closely as possible, and with a sharp tool on one side and a broad following-up tool on the other, a smooth, clean finish can be obtained. Four wooden wedges are required for lining up the boring bar in the cylinder. The bridge is then tightened down and the bar set for cutting. Cylinders up to 12in. diameter and 14in. stroke can be bored out by this means, using bars and heads of suitable size. A 3-in. dia. bar is suitable for cylinders from 8in. to 12in. in diameter, a 2-in. bar, from 4in. to 8in. dia., etc.—*"Practical Engineering", Vol. 5, No. 130, 16th July, 1942, p. 671.*

Vibration in Pipe Lines.

A report was recently issued by a sub-committee appointed in 1940 by the British Electrical and Allied Industries Research Association to enquire whether there was sufficient information obtainable to enable a decision to be made in regard to the undertaking of special research work by the Association into the effects of vibration in pipe lines in power station installations. Although the findings of this sub-committee are only of an introductory character, they might be of interest to marine engineers. Broadly speaking, two types of vibration have been noted: (*1*) Low-frequency vibration of large amplitude, and (*2*) vibration of audible frequency and relatively small amplitude. The first type can be cured by modifying the method of supporting or bracing the pipe line, and it is not considered that these cases present a problem for research work. The second type does not respond to such external treatment and was actually the origin of the request made to the Association to carry out a research. The possibility of supersonic vibration does not appear to have been considered, and attention is usually drawn to high-frequency vibration by the noise in the first place, this being subsequently confirmed by the sense of touch. The noise is variously described as a penetrating roar or as a hum of varying pitch. Only in one or two cases has an attempt been made to take instrumental measurements to determine the frequency, and in these cases wide variations of frequency were found or estimated, and they included subsonic frequencies. The periodicities quoted vary from 6·9 to



Details of the boring bar.

683 cycles/sec., the lower figure being some seven octaves below, and the higher one in the second octave above middle C. The damage reported from this type of vibration does not include failure of the pipe itself, but appears to be confined to the damage of valves; in at least one case to the damage of links and pins, and in another case to the damage of a by-pass fitting. Parallel slide valves appear to be particularly susceptible to damaged seats caused by chattering, but it should be remembered that other types of valves are far more common in power station installations. Cases have also been reported of vibration by valve gates of the wedge type. Of the ten cases cited in detail, nine relate to damage to parallel slide valves and their fittings, whilst the tenth case concerns a globe valve with hammered valve guides. In most of the cases investigated, the pipes concerned were connected to a receiver or receivers, the steam pressures varying from 225 to 600lb./in.^{2}, but rising to 1,250lb./in.^{2} in the case of the globe valve. In nine of these ten cases the pipe bends were corrugated and in one case the straight piping was in part corrugated. Reports both from supply undertakings and from pipe manufacturers make it clear that the vibration is in some way associated with the use of corrugation in the piping or bends, and it also appears to be related in some manner to the conditions of steam flow, though the manufacturers consider that in certain instances it may arise from, or be amplified by, some effects on the flow produced by the valves, more especially by those of the parallel type. This view, however, is not supported by any evidence before the sub-committee. Where the steam velocity was ascertained it seems to have ranged between 31·5 and 159ft./sec., and in one case there was apparently a critical velocity, the vibration starting at 46·2ft./sec. and diminishing above 70·9ft./sec. It is suggested that this may imply passage through a resonant condition. The flexural conditions in the pipe line may contribute in some way to the trouble, as, although no direct evidence of this is available, most of the serious cases reported occurred where corrugated bends had been provided on account of the flexural conditions, as between a turbine and a receiver. The partial closure of parallel slide valves has proved helpful in several cases, but where this has been successful and the partially closed valve has been then replaced by the equivalent crescent-shaped orifice, a similar improvement has not resulted. In one case the complete replacement of the whole valve by a plain sleeve produced no improvement. These apparently capricious results are reminiscent of the early stages of many such enquiries, of which the singing propeller is a recent marine instance. They suggest the existence of some cause as yet undiscovered, and it would appear that special research will be necessary before the nature of the phenomenon can be properly understood or any rational method of forestalling the trouble on new plant can be made possible. It is a question whether this work, if undertaken, should be analytical or with full-scale models or in full-scale tests. The sub-committee generally favour the method of scale model experiments, and it is suggested that the investigation might usefully be extended to ascertain the comparative flexibility and comparative pressure losses as between corrugated pipes and plain pipes. —*"The Syren", Vol. CLXXXIII, No. 2,388, 3rd June, 1942, p. 255.*

An Electric Remote-control System.

The propelling machinery of the new 83-ft. cutters of the U.S. Coast Guard is fitted with electric remote-control gear which permits the engines to be manœuvred from either of two steering positions. In its simplest form, this control gear—known as the Panish Remote-Control System—consists of a control station instrument in the wheelhouse, somewhat resembling an E.R. telegraph, connected to an electric motor driving the reversing-lever spindle of the engine by means of a worm and wheel, and mounted on the side of the gearbox. The control instrument has a hand lever operated through "ahead", "neutral" and "astern" positions, and a red warning light that shows momentarily as the gear engages. Should the gear fail to engage, the light "blinks", while if the battery current is too weak to operate the motor the lamp remains alight until switched off by the helmsman. Although the electric motor is quite small, it exerts a torque of 500ft./lb. for about one second on a consumption of 960 watts, which can be provided by a starter battery. The current is automatically cut off on completion of the necessary movement, a device being fitted to stop the clutch from slipping back out of engagement. The throttle control in this system is by push-and-pull metallic cable interlocked with the gear control, so that the throttle only opens fully after the gear is engaged. In an emergency the control system is capable of effecting a change-over of the engine gears from "full ahead" to "full astern" within one second, although in normal manœuvring it can control box determines which of the control instruments in the be operated more slowly for the sake of the machinery. A master two steering positions shall be in operation at any given time. All the electric circuits are complete in themselves, and no connection throughout the entire system is earthed to the hull or machinery, thus precluding interference with the W/T transmitting gear. The master control box can only be operated if the control instruments are "neutral". It not only switches over the electric circuits for the reverse gear operation, but also operates the mechanical throttle connections. The installation of the Panish Control does not preclude the direct operation of the reversing lever by hand when all the control instruments are switched off.—*"The Motor Boat", Vol. LXXV, No. 1,896, June, 1942, p. 156.*

Diesel Engines and Black-out Conditions.

According to a statement in *Pacific Marine Review*, a British twin-screw motorship with four-stroke air-injection machinery recently arrived at a Pacific Coast port after a troublesome voyage involving many stops at sea owing to the valves sticking. The running of the engine-driven air-injection compressors was also unsatisfactory due to the unusual amount of wear which took place. The ship in question was built 14 years ago, and up to the outbreak of war the machinery had given no trouble, but the difficulties referred to above came as a climax to a steady deterioration in performance which had been experienced since that time. An investigation was made while the vessel was in port. The E.R. skylight was permanently closed, and all entrances were either closed and sealed or fitted with heavy double curtains of canvas. There were two E.R. ventilators, but stale air could not be discharged. The air intakes for the compressors and for the air supply to the main cylinders were in the upper part of the engine room. When the three-cylinder three-stage air compressors were dismantled, heavy wet deposits were found in the L.P. and I.P. stages and a brown dry deposit in the H.P. stage. The I.P. stage piston rings were stuck, and a heavy black oil deposit was found in the air pipes. A similar deposit was found in the main-engine air intakes. It was clear that the trouble was due to foul air, probably in insufficient volume, being drawn into the compressors and the main cylinders. When fresh-air ducts were fitted to the intakes, a marked improvement in running was noted. No doubt this was an extreme case, but it is possible that under the black-out conditions governing the operation of ships practically throughout entire voyages, many Diesel engines, especially those of the old air-injection four-stroke type, may not be running very efficiently.—*"The Motor Ship", Vol. XXIII, No. 269, June, 1942, p. 71.*

Sea Transport of Refrigerated Produce in War-time.

A paper bearing the above title was read at a meeting of the British Association of Refrigeration on the 27th May by J. R. Beveridge, B.Sc. The author pointed out that in the past the carriage of refrigerated cargoes was in the hands of a relatively small number of shipping companies, who had developed special types of vessels for the particular trade routes concerned. Although the designs finally evolved were eminently suitable for these specific purposes, the ships are too elaborate and expensive when judged by war-time standards, and the author advocated the employment of a somewhat smaller, slower and simpler type of vessel suitable for all-round purposes. He suggested that a ship of about 8,000 gross tons with a refrigerated-cargo capacity of some 400,000 cu. ft. and a service speed of 15 knots would fulfil these requirements. Such a speed would involve propelling machinery of about 7,000 i.h.p., and although in times of peace, oil engines or D.R. geared turbines would be in keeping with up-to-date practice, under present-day conditions twin-screw reciprocating steam engines supplied with steam by two large oil-fired watertube boilers, could probably be produced more readily than the more complicated types of machinery. The refrigerating plant would consist of two units each having a capacity of 70 tons per day, the compressors being driven by reciprocating steam engines. The refrigerant might be either CO_2 or NH_3, preferably the former. The holds would be cooled by brine circulated through air-blown batteries located in each of the refrigerated compartments, this system being more economical in material than the orthodox arrangement of grids round the holds and under the decks. The author claimed that although primarily suitable for the carriage of fruit, cheese and eggs, the arrangement he proposed should be quite convenient for the more common war-time cargoes of frozen meat and butter. In normal times, the insulation of the refrigerated spaces would consist of granulated or slab cork, but present circumstances would probably necessitate the use of silicate cotton, either plain or treated; in the former condition this material is liable to absorb moisture, but it has the great advantage of being non-inflammable, a feature which is of special value at the present time. The insulation should be covered with two layers of tongued-and-grooved wood lining, but in existing circumstances it might only be possible to fit a single layer. To economise insulating material the frames and bulkhead stiffeners would have to be made as shallow as possible and all unnecessary projections into the holds eliminated. The author gave particulars of the thickness of insulation required on the various surfaces and indicated the arrangements which should, in his opinion, provide maximum efficiency at the lowest cost. The paper is very timely, on account of its enumeration of the difficulties which now beset naval architects, and its suggestions for overcoming them, but one is inclined to think that the compromises forced on the designers of ships of the type envisaged by the author would reduce the post-war value of the vessel to a greater extent than in the case of the simpler cargo steamer, where deficiencies in the specification can be more readily rectified.—*"Fairplay", Vol. CLVIII, No. 3,082, 4th June, 1942, p. 658.*

Light Alloys.

The utilisation of the huge output of aluminium and magnesium which will have been attained by the end of the war is likely to be one of the minor problems of the peace. Apart from the desirability of maintaining continuity of employment both of labour and capital in the form of plant during the transition period, there is a case for wide use of these metals in many fields. There is ample scope for the use of aluminium on board ship as a substitute for heavier metals, including steel, for a variety of internal fittings and even for superstructures, where weight is so important. Cost considerations may not weigh so heavily, for with initial capital costs already met and comparatively cheap raw material, the price per ton should be less than before the war. Magnesium, which is even lighter and equally strong in proportion to its weight, is less of a structural type of material, and corrodes easily, but may quite well be used in suitably protected positions.—*"Shipbuilding and Shipping Record", Vol. LIX, No. 23, 4th June, 1942, p. 583.*

Launch of Swedish Destroyer.

The destroyer "Magne", built by the A.B. Götaverken for the Swedish Navy, was recently launched at Gothenburg. She is the third of a class of coastal destroyers of 698 tons displacement, 257ft. in length and 26ft. 6in. in breadth, with a draught of 7ft. 6in. The designed speed of the ship is 30 knots, and the propelling machinery consists of two sets of De Laval geared turbines supplied with steam by two oil-fired watertube boilers. In addition to a turbo-generator for the provision of electric current when steam is available, there is a 60-kW. dynamo driven by a six-cylinder Diesel engine for use in port. The armament includes three 4·1-in. guns, A.A. guns, three 21-in. torpedo tubes, and depth-charge and mine-laying equipment. The "Magne" was launched a little more than seven months after her keel was laid.—*"The Syren", Vol. CLXXXIII, No. 2,388, 3rd June, 1942, p. 259.*

An Electrode Holder.

Although welding is not a process which calls for a high degree of physical strength, it is one which may readily induce fatigue in the operator, due to the facts that the electrode has to be maintained in a certain definite position for considerable periods, and that the operator may be in a cramped position while working. Because of this it is necessary in ship work that the electrode holder, which is simply a clamping device for holding the electrode and is provided with a handle for the operator, the welding current being conveyed by the holder to the electrode, should be light and well balanced. It is also desirable that the design should enable the electrode to be securely held in position, and facilitate a quick and easy change of electrodes. An electrode holder manufactured by a leading firm of welding equipment makers in this country is claimed to possess all these properties, and, in addition, to be of such a size that the stub end of the electrode is kept to a minimum. In view of the proportion which the cost of electrodes bears to the total cost of welding, this is a highly important point. In this particular holder the electrode is gripped in the jaws by a strong spring clamp, so that the operator may concentrate on the welding without finding it necessary to grip a lever to keep the electrode in place. The jaws are grooved so that the electrode may be held at whatever angle is required for vertical, overhead or horizontal welding. Special holders are available for use with either light-gauge work, or for large electrodes which involve the employment of a heavy current. In the latter case the jaws are faced with a special metal of high conductivity which provides good resistance to wear at high temperatures.—*"Fairplay", Vol. CLVIII, No. 3,082, 4th June, 1942, pp. 659-660.*

Two-stroke Supercharged Engines.

Important developments are taking place in the application of supercharging to oil engines of the two-stroke type, in order to produce cheaper and lighter engines which take up less space than existing designs. The thermal efficiency of these engines is no higher than that of a modern Diesel engine of the normal type, but the fuel consumption (0·35lb./b.h.p.-hr.) is practically equal to that of the most advanced designs of standard engine. The basic principle involved is the employment of an exhaust-gas turbine in which the energy of the gas discharged from the Diesel engine is utilised. The exhaust-gas turbine is coupled to the crankshaft through gearing (otherwise it would not be possible to start the engine) and the combustion air is supplied at a pressure of about 35lb./in.^{2}. The corresponding m.e.p. is in the region of 170lb./in.^{2}, which is claimed to represent a satisfactory commercial compromise for the most efficient design. This, however, makes it possible to raise the supercharging pressure to 5 or 6 atmospheres, when the power developed by the engine is equivalent to that which is absorbed by the compressor. When this "critical" point is reached the turbine can be disconnected. Even higher supercharging pressures might be employed, but these would involve precompression. The system is virtually a further development of the gas turbine in conjunction with the Diesel engine in order to secure the maximum advantages of both under present limitations. A so-called combustion turbine operated by gas from a combustion chamber in which oil is burned separately cannot attain a thermal efficiency of more than about 20 per cent., which is approximately that of a modern high-pressure steam turbine and just over half the thermal efficiency of a Diesel engine. The application of the exhaust-gas turbine to a supercharged two-stroke oil engine, however, enables a thermal efficiency of about 40 per cent. to be obtained. The well-known Swiss engineering firm of Sulzer, Bros., have developed a new supercharged opposed-piston type of two-stroke engine which is intended to take full advantage of the new principle, and a recent issue of the *Sulzer Technical Review* contains some interesting proposals for the utilisation of machinery of this class. A marine application is shown in Fig. 21, which illustrates the arrangement of a Diesel-electric installation of 37,500 b.h.p. for a large twin-screw motorship of dimensions similar to those of the Dutch motor liner "Oranje". The installation comprises 10 electric generator sets, of which nine are used to supply the current taken by the two propulsion motors at full power, whilst one is required for supplying electricity for auxiliary purposes. The

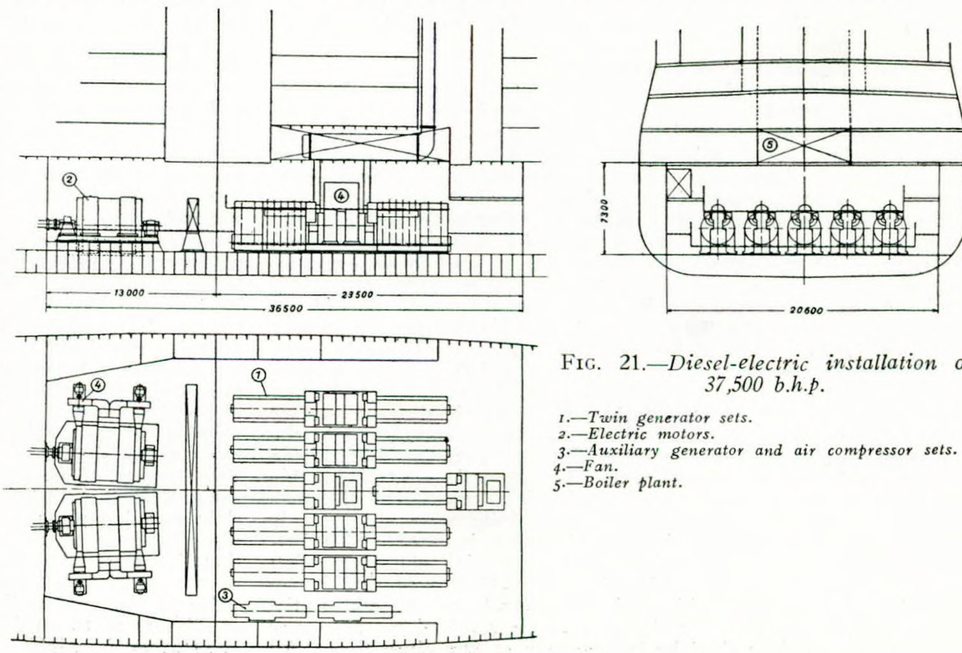
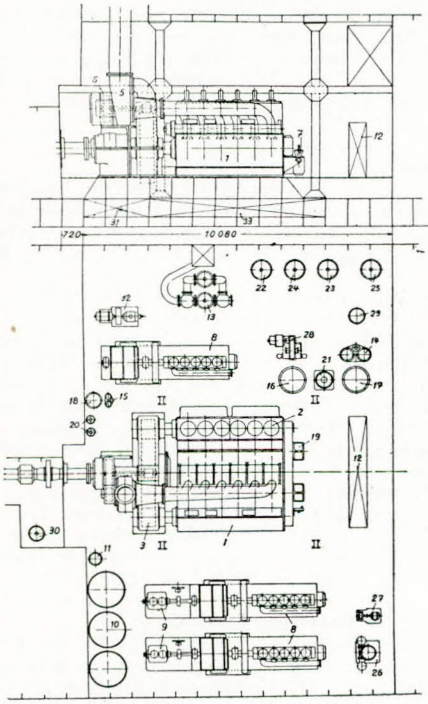


FIG. 21.—*Diesel-electric installation of 37,500 b.h.p.*

1.—Twin generator sets.
2.—Electric motors.
3.—Auxiliary generator and air compressor sets.
4.—Fan.
5.—Boiler plant.

generators are driven by supercharged two-stroke two-shaft opposed-piston Diesel engines, each developing 4,600 b.h.p. in six cylinders of 320mm. bore and 2×400mm. stroke. The scavenging and charging air is provided by reciprocating compressors driven direct from the crankshafts. At full power the supercharging pressure is about 35lb./in.^{2} and the m.e.p. 170lb./in.^{2}. Two small auxiliary generator and compressor sets are also fitted, each driven by a 200-b.h.p. Diesel engine. Each of the main engines is equipped with two exhaust-gas turbines, the output of which is transmitted through the synchronizing gear to the driving shaft of the electric generator. The two propulsion motors each develop 18,750 b.h.p. when driving the propellers at 130 r.p.m. The adoption of supercharged two-stroke opposed-piston engines instead of non-supercharged big Diesel engines would, in the present instance, enable a reduction of 15ft. to be made in the height of the engine room, whilst the actual machinery-space length would be only 112ft. as against 130ft. in the "Oranje". The cost of production should be lower than with normal Diesel machinery, and the weight would be reduced. In the case of the Diesel-electric installation shown, reversibility is obtained in the usual manner, but direct reversal could also be secured by separating the supercharging sets from the Diesel engines and using auxiliary electric motors to provide the additional power required when starting and at low loads. Another possibility consists in the employment of reciprocating compressors to supply the scavenging and charging air, and to connect the exhaust-gas turbines to the engines through clutch couplings. When running astern, the exhaust-gas turbines would be disengaged and the exhaust pipes connected to the atmosphere through a throttle orifice, the resulting reduction in output being of little importance to astern running. Fig. 22 shows the arrangement of a single-screw installation of 3,900 s.h.p., with a direct-reversing horizontal supercharged two-stroke two-shaft opposed-piston Diesel engine with six cylinders of 320mm. bore and 2×400mm. stroke. At 450 r.p.m., corresponding to a piston speed of 1,200ft./min., the supercharging pressure is 30lb./in.^{2} and the m.e.p. 142lb./in.^{2}. The large wheel of the synchronizing gear also serves as a reducing gear, driving the propeller shaft coupled to it at 112 r.p.m. Scavenging and charging air for the engine cylinders is supplied by vertical reciprocating compressors, driven from the crankshaft. The exhaust-gas turbine drives the large wheel through a hydraulic coupling and a countershaft, the hydraulic coupling being disengaged by emptying it for going astern. The auxiliary machinery includes three 720-kW. generators driven by standard-type Diesel engines. The adoption of a supercharged two-stroke engine for this installation and the lay-out chosen in this case, makes it possible to reduce the length of the engine room by about 40 per cent. in comparison with installations of normal design. Drawings have also been prepared for 13½-knot and 16-knot 9,000-ton cargo ships requiring machinery of 3,800 b.h.p. and 6,500 b.h.p. respectively. Owing to their low height, the generators with oil engines built on the principle described may be installed in a compartment above the propulsion-motor room right aft, thus making almost the whole length of the ship from the fore-peak to the motor room available for the carriage of cargo. If all the claims made for the new Sulzer engines can be substantiated, without any supervening disadvantages, it may be assumed that much progress will be made with these engines in the future, at any rate, for certain classes of ship, and especially where high powers are in question. It would appear that it is the intention to build only high-speed engines with fairly high piston speeds, and the mean pressures are naturally very high. These factors have to be taken into account in their general influence upon maintenance and upkeep, but it is obvious that this type of engine will receive close consideration.—*"The Motor Ship", Vol. XXXIII, No. 270, July, 1942, pp. 104 and 118-126.*



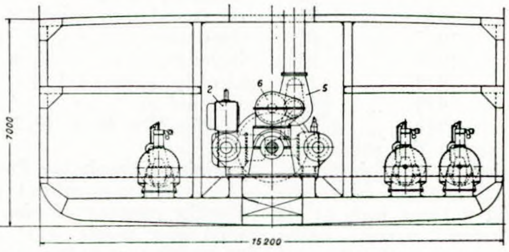


FIG. 22.—*Marine installation of 3,900 s.h.p.*

1.—Main engine. 2.—Scavenging pumps. 3.—Reduction gear. 4.—Thrust bearing. 5.—Exhaust-gas turbine. 6.—Hydraulic coupling. 7.—Manœuvring platform. 8.—Auxiliary Diesel engines. 9.—Air compressors coupled to auxiliary Diesel engines. 10.—Starting-air bottles for main engine. 11.—Starting-air bottles for auxiliary engines. 12.—Switchboard. 13.—Sea-water strainer. 14.—Oil filter for main engine. 15.—Oil filter for gears. 16.—Fresh-water cooler. 17.—Oil cooler. 18.—Oil cooler for gears. 19.—Oil pumps on main engine. 20.—Lubricating-oil pumps for gears. 21.—Spare oil pump for main engine. 22.—Sea-water pump. 23.—Fresh-water pump. 24.—Spare pump for fresh or sea water. 25.—Ballast pump. 26.—Fuel transfer pump. 27.—Fuel daily-service pump. 28.—Reciprocating F. and B. pump. 29.—G.S. pump. 30.—Emergency fire pump. 31.—Lubricating-oil tank for gears. 32.—Automatic refrigerating plant. 33.—Oil tank for main engine.

American-built Diesel-electric Tugs for Britain.

The first of a number of tugs with Diesel-electric propelling machinery, under construction for the British Government in the United States, was recently completed. These tugs are equipped with a 12-cylinder two-stroke General Motors high-speed V-type Diesel engine of 900/1,200 b.h.p., driving an 814-kW. d.c. generator and a 24-kW. exciter at 720 r.p.m. The engine has cylinders 8½in. in diameter. The current is supplied to a high-speed electric motor which drives the propeller through reduction gearing. It is understood that over 100 ships of various kinds now under construction for this country in the U.S.A. are to be equipped with Diesel-electric propelling machinery.—*"The Motor Ship", Vol. XXIII, No. 269, June, 1942, p. 101.*

Gas Engines for Ocean-going Ships.

In view of the restricted supply of oil and of the publicity which has recently been given to the question of utilising gas engines for ship propulsion, it might be thought that the prospects for this, in some ways apparently attractive development, are favourable. Such a supposition is, however, not borne out by hard facts. Admittedly, the present-day high-compression gas engine specially designed as a dual-fuel unit is a vast improvement on the old low-pressure engine, but there are still serious difficulties in the way of a wider adoption of coal-fired gas-driven machinery for sea-going ships. The main problem is the availability of suitable fuel. No really efficient gas producer has yet been constructed which will operate on all grades of coal, and it is necessary to provide anthracite or specially graded coke in order to obtain satisfactory results. It is true that the low fuel consumption—0·9lb. of coal per b.h.p.-hr.—of the modern gas engine makes it appear to be an attractive proposition for marine propulsion when compared to coal-fired steamers, and, more especially, in conjunction with the dual-fuel design; but there would appear to be no reason to anticipate any marked progress in the development of gas-engined vessels, even on inland waterways, once the world has settled down to peace-time commerce. This is the position as it now stands, although the possibilities of further development of the gas producer must not be entirely ruled out.—*"The Motor Ship", Vol. XXIII, No. 269, June, 1942, p. 71.*

Salvage of Big Tanker.

One of the world's largest tankers, the Atlantic Refining Company's "E. H. Blum", which was wrecked east of the Virginia Capes in February by five explosions, has now been salved, and as soon as her two sections have been welded together and her machinery reconditioned, she will be put into service again. After the explosions occurred the master of the vessel ordered the crew to abandon ship, which was carried out without loss of life or serious injury. Salvage experts who visited the wreck found that the tanker had almost broken into two sections, the forward one being unharmed and the 300-ft. after section, containing the propelling machinery, resting on the bottom in 32ft. of water. They severed the two sections and towed the forward part to port, but expressed the opinion that the stern portion should be abandoned and destroyed as a danger to navigation. The Atlantic Refining Co.'s superintendent engineer, Mr. L. M. Goldsmith, disagreed with the salvors' decision, obtained the co-operation of the U.S. Navy Department, and carried out operations that resulted in the recovery of the stern portion, which was brought into port for repairs and attachment to the fore part. Mr. Goldsmith stated that he was convinced that the salvage job could not have been successful if the ship had not been of all-welded construction.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 35,687, 25th June, 1942, p. 2.*

Government Control of Marine Engineering Patents.

An examination of the records of marine engineering patents reveals the fact that there was a substantial increase in their numbers during the years following the war of 1914-18, but that during the decade preceding the present war a marked decrease in the numbers of such patents reflected the decline of the marine engineering industry in general. The following table, compiled by the writer, shows the annual numbers of British patents granted during the period 1900-1941:—

TABLE OF PATENTS, 1900-1941.

Year.	*Patents.*	*Year.*	*Patents.*	*Year.*	*Patents.*
1900	93	1914	78	1928	105
1901	87	1915	63	1929	109
1902	102	1916	58	1930	103
1903	108	1917	74	1931	90
1904	99	1918	102	1932	64
1905	141	1919	110	1933	51
1906	120	1920	136	1934	47
1907	144	1921	158	1935	41
1908	171	1922	138	1936	35
1909	144	1923	136	1937	35
1910	144	1924	126	1938	35
1911	120	1925	123	1939	34
1912	132	1926	119	1940	22
1913	108	1927	105	1941	91

Approximately two-thirds of these patents concern the propulsion of ships and boats, whilst most of the remainder relate to improvements affecting the steering and manœuvring of vessels. Since the outbreak of this war it is to be expected that a large number of important inventions will have been made "secret" patents under Section 30 of the acts, either because they might be of immediate use to the enemy or because they contain the germs of good ideas that require further development. These "secret" patents are not published, and are therefore omitted from the table. Among the most important marine engineering patents to be published within the past few weeks is one—of German origin—covering a combined fuel-injection valve for I.C. engines. One nozzle body is employed to inject through two or more sets of orifices in different positions, supplies of fuel varying in amount, timing and subdivision. Needle valves control the orifices and are normally held closed by the fuel at a pressure equal to the difference between that at the needle and the supply pressure. Reduction in pressure in a separate lead from a distributor opens the valves. The nozzle body has inlet passages for different part charges of fuel in its contact face, and is a one-piece body which is clamped against the injector body. The invention would appear to be intended for use with the heavier types of fuel, with pilot injection of lighter fuel to assist combustion. Another patent concerns a horizontal multitubular marine boiler. Substantially the entire boiler is made up of smoke tubes and furnace tubes. A space for collecting steam and reserve water is provided by a chamber above the boiler, to which the upper part of the latter is connected. Yet another patent relates to gearing apparatus for marine engines. Two transmission cones, axially spaced and of different radius, are selectively engaged by a double-drive cone. A stub shaft, co-axial with the driven shaft, carries a hub which is free to rotate on it, and this hub is integral with one of the transmission cones. The second cone is detachably screwed to the driven shaft. The driving shaft is parallel to the latter and carries the double-drive cone. Section 2 of the Amended Patent Act of 1942 deals with Government use of patents, and enables the Crown, through its agents, to do what it likes with any patent on practically any terms it likes, leaving the question of remuneration to be settled by arbitration at a later late, if necessary, where the patentee does not like the situation. The use of a patent by the Crown does not imply a contract with the patentee, although many Crown contracts are so framed as to authorise a contractor, for the purpose of carrying out the contract, to employ any patented invention or design, and any drawing, etc., which he may require, under Sections 29 and 58A of the Patents and Designs Act. The contractor cannot charge for any royalties or other expenses unless he has previously obtained the specific agreement of the authority concerned, neither is he liable for any royalty under a licence or other agreement. Information regarding any such licence must be furnished by the contractor to the Crown, and he is likewise required to state what other patents he needs to utilise to carry out his contract. This applies also to sub-contracts.—*S. T. Madeley, "The Marine Engineer", Vol. 65, No. 779, June, 1942, pp. 106-107.*

1,000-b.h.p. Sulzer-type Canadian-built Engines.

Diesel engines of the Sulzer type are now being manufactured in Canada by the Dominion Engineering Works, Ltd., Montreal, who have, for many years past, built oil engines based on the Crossley design. The firm are now concentrating on the construction of nine-cylinder Sulzer two-stroke trunk-piston engines developing 1,000 b.h.p. at 330 r.p.m. These units are being installed in the minesweepers of the "Bangor" class building in Canadian shipyards. It is stated that they are the highest-powered oil engines that have yet been constructed in the Dominion.—*"The Motor Ship", Vol. XXIII, No. 269, June, 1942, p. 101.*

"Sea Otter" Type of Cargo Ship Now Adjudged Satisfactory.

It is reported from Washington that despite the unfavourable results of the sea trials of the "Sea Otter II" (*for description of ship, etc., see Abstracts on p. 159 of* TRANSACTIONS, *January, 1942*), the design has now been adjudged satisfactory. In March it was announced that the U.S. Navy had given up attempts to develop the type—costs having proved to be about four times the estimate for the first ship built—but in the following month President Roosevelt ordered further tests to be carried out so that the sponsors of the design might be given "a full, complete and sympathetic opportunity" to prove its value. Experienced shipowners in America, including the president of the American Bureau of Shipping, had already expressed disapproval of the "Sea Otter" design.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 35,687, 25th June, 1942, p. 2.*

Training Schools for Firemen.

A training school for firemen was recently opened in London for the purpose of providing a course of elementary instruction for men who would in the ordinary way have started as trimmers in steamships carrying a large stokehold complement. The school is managed and staffed by the Shipping Federation, with the full support of the Ministry of War Transport and the National Union of Seamen. The course of training lasts a fortnight and about 24 pupils can attend a course. They are mostly volunteers with no previous sea experience who wish to serve afloat in some capacity. These trainees attend lectures on boilers and engines, the principles of combustion, correct methods of firing with different kinds of coal and elimination of smoke. Practical instruction in handling a shovel and stoking a boiler is given in a room modelled as a stokehold, complete with boiler-front furnaces, gauges, etc. On completion of their fortnight's training the men usually spend a preliminary period of service in a ship in home waters before being appointed to a vessel going overseas. A similar training school for firemen was opened in Cardiff some time ago.—*"Shipbuilding and Shipping Record", Vol. LIX, No. 26, 25th June, 1942, p. 675.*

All-welded American Tanker for Coastwise Service.

The twin-screw tanker "Flying A" recently built by the Charleston Shipbuilding and Dry Dock Company for the coastwise service of the Tidewater Associated Oil Company, is the first vessel of all-welded construction to be owned by that firm. The ship is longitudinally framed in the way of all tanks, and transversely framed fore and aft of the six cargo oil tanks. The capacity of these is 18,500 barrels (or about 2,500 tons) and there is also a dry cargo hold forward of No. 1 tank. The machinery space is aft, and fuel oil to the amount of 70 tons is carried in wing bunkers. The suction pipes from the cargo oil tanks are led to four independent but interconnected cargo pumps in a pump room forward of the engine room. This makes it possible to handle different types or grades of petroleum products by each of the pumps. Two of the latter have a capacity of 1,000 g.p.m. (U.S.) and are driven by 75-h.p. electric motors, whilst the other two have a capacity of 800 g.p.m. (U.S.) and are driven by 60-h.p. motors. The main propelling machinery consists of two 6-cylr. four-stroke direct-reversing De La Vergne Diesel engines developing 680 b.h.p. each, whilst electric current is provided by two 150-kW. 240-volt d.c. generators directly driven by two 225-b.h.p. De La Vergne Diesel engines.—*"Shipbuilding and Shipping Record", Vol. LIX, No. 26, 25th June, 1942, p. 663.*