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Metallizing in Relation to Marine Engineering

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The paper describes the metallizing process—dealing briefly with the equipment used to spray metal and considering in some detail the characteristics of the coatings produced. Various methods by which bonding to the base material may be achieved are discussed, and techniques for finishing sprayed metal coatings are considered. The many applications of the process to marine engineering are conveniently divided into two main groups: (a) the reclamation of worn parts, and (b) protective coatings to resist corrosion. The paper is illustrated by explanatory diagrams and a number of photographs of work being carried out.

THE PROCESS

Metallizing can be defined as a process whereby heated metal in a finely divided state is projected onto a receiving surface by means of an air blast. Fig. 1 shows metal spraying being carried out for the protection of steelwork, exemplifying its original purpose although the particular application—zinc spraying a steel

FIG. 1.—*Sand blasting and zinc spraying a steel hull*

hull—is a comparatively recent innovation in this country. In order to obtain a balanced conception of the usefulness of the process, Fig. 2 is included to illustrate the reclamation of worn machinery parts—in this case spraying stainless steel on an auxiliary turbo-pump shaft. Both classes of work are of interest to marine engineers, but a brief study of the process itself is essential for the intelligent application of either of them.

During its development, metallizing has passed through stages

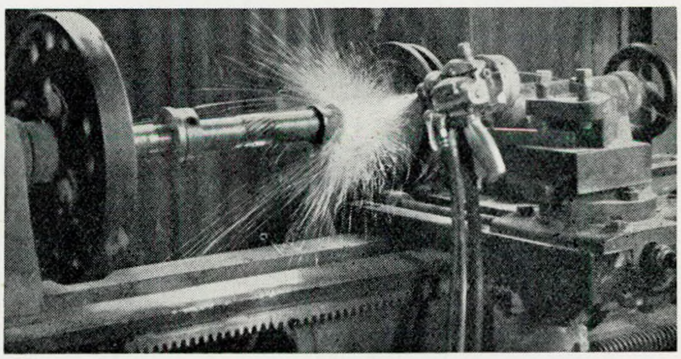

FIG. 2.—*Auxiliary turbo-pump shaft being metallized with stainless steel*

in which first molten metal, then powdered metal and finally wire has been the state in which the material has been fed into the hand-tool, known as the metal-spraying gun. The convenience of storage and handling of metal in wire form need scarcely be stressed, although emphasis should be placed on the fact that in the case of wire, the necessity to melt it in order to atomize it implies that every particle must have been adequately heated, whereas with molten metal or powder neither may be deposited with the same guarantee of heat control. Thus it is not surprising to find that the wire-type of metallizing gun is the one in most general use today. The range of wire metal-spraying is limited only by what materials may be obtained in wire form, so that all the common metals and alloys may be sprayed, with the exception of pure chromium.

* The Metallizing Equipment Co., London.

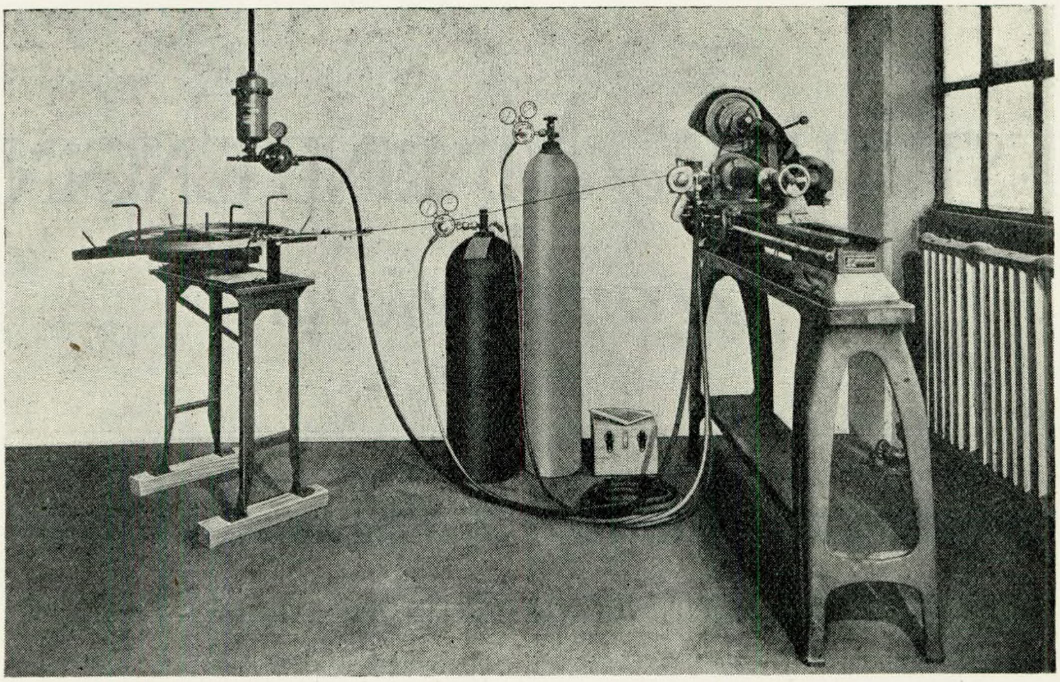

Fig. 3.—*Arrangement of metallizing gun in lathe showing controls for air, gas, oxygen and wire*

Fig. 3 shows the general arrangement of a typical modern metallizing installation with the gun fixed to the toolpost of a lathe. A governor-controlled high-speed air-turbine through double worm-reduction gearing to a pair of feed-rollers pulls the wire into the gun and pushes it through the central orifice of a close-fitting nozzle. Fig. 4 is a diagrammatic representation of the melting and deposition of the wire. A mixture of gas and oxygen

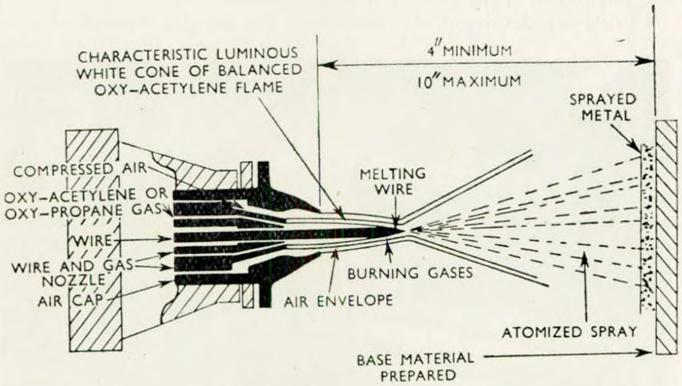

Fig. 4.—*Melting, atomization and deposition of metal showing section through combustion head of spray gun*

is led to the nozzle tip by means of small passages, usually six in number, so as to play small jets of flame on to the wire. Thereafter, an air-stream breaks up the melting wire into small particles, at the same time directing the jet of metal on to the work. The mean temperature of the stream, consisting as it does of a small volume of hot metal and a large volume of cool air, is quite low—so low indeed that it may be directed on to the hand without any considerable discomfort.

An individual particle, once separated from the wire, assumes a roughly spherical shape and is subject to cooling and oxidizing conditions during its flight, which may occupy about one thousandth of a second. On impact, and according to varying circumstances, the kinetic energy of the particle must largely change to heat, and thereafter, in most cases it will be in intimate contact with a much larger and cooler body, so that rapid "quenching" results. Coincident with impact, the spherical shape of the somewhat oxidized and externally cooled globule will change to a spheroid, or may even become saucer-shaped. On flattening, the major perimeter will be the part most highly stressed and either cracks or torn, distorted edges will result. Maximum oxidization occurs during the period immediately following impact and continues until covering by subsequent particles has eliminated contact with the air.

From this simple study quite a lot of useful information can be derived as to the nature of sprayed metal. Perhaps the most interesting item is the manner in which the particles are joined together. Mechanical interlocking of the torn edges of particles accounts for much of the tenacity with which they hold together, but this is greatly increased by their tendency to flow on impact so as to key into one another. There is also undoubtedly some form of oxide cementation between particles, and this is probably the

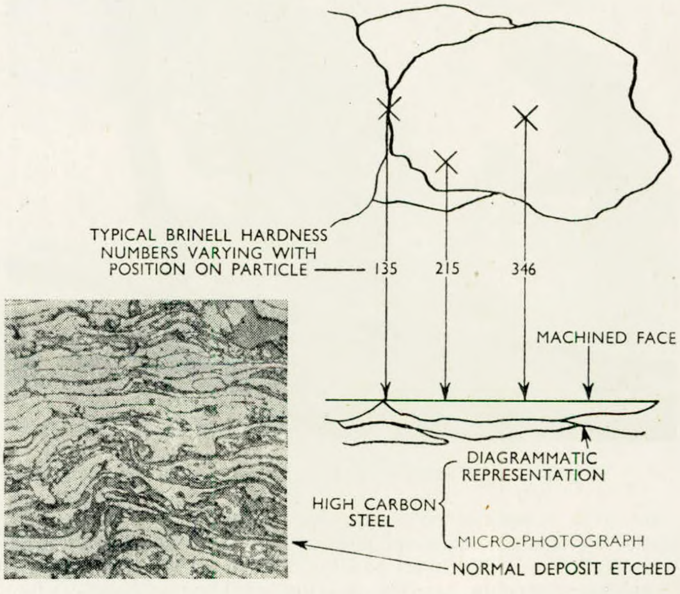

Fig. 5.—*Variations in apparent hardness due to structure of sprayed metal*

major factor in providing tensile strength normal to the surface being sprayed, whereas in a plane parallel to the surface mechanical interlocking provides tensile strength which may be even ten times as great as that normal to the surface. A certain amount of rather haphazard welding does occur between particles here and there in a coating, but is generally of little importance in considering the strength.

Fig. 5 represents diagrammatically several typical particles of sprayed steel, and indicates how misleading an ordinary hardness test can be as shown by readings taken in the centre of a particle, nearer the edge, and again at the junction of two particles. The normal difficulties of making due allowance for the coating thickness and the nature of the base material are insignificant compared with the errors arising from the positioning of the test on the particle.

If machining properties are to be considered in relation to hardness, then it is obvious that the properties of the oxides separating the particles must not be overlooked and it must be decided whether the cut will be parallel to the laminations or across them; the "apparent" oxide content being much less in the former than in the latter case, since, although each particle covers a relatively large area, it has very little thickness. Fig. 5 includes a micro-photograph of sprayed steel which is obviously porous, though not so much by reason of minute voids as by the oxide layers.

Table 1 tabulates hardness for a range of common metals in the sprayed condition, but is mainly of academic interest, because other factors, such as the porosity and oxide content, have a greater influence over wear-resistance and machining properties. Shepard* has obtained values for the relative specific gravities of various metals and alloys when sprayed as compared with the wires used, expressed as a percentage, and these have been included in Table 1.

Table 1. Hardness values and decreased specific gravities after spraying

Sprayed metal	Hardness, equivalent Brinell No.	Ratio of coating specific gravity to that of wire used, per cent
High carbon chromium steel	296	88·7
80 per cent carbon steel	346	82·5
10 per cent carbon steel	183	86·7
Iron	147	88·4
18/8 Stainless steel	147	88·9
Naval brass	76	89·2

The coating will absorb a great deal of liquid under pressure, and even a substantial amount by capillary attraction. Sprayed metal, when used to form a journal-bearing surface, provides a natural oil reservoir, thus eliminating dry-starting conditions with a consequent lessening of wear. It is interesting to note that in the case of crankshafts, records indicate that the performance of sprayed metal compares favourably with the hardest shafts, and that for this purpose there is very little to chose between metallized coatings of soft low-carbon steel or the hardest of high-carbon steels. One cannot avoid concluding that it is the porous nature of sprayed metal that accounts for its excellent properties as a journal-bearing surface. The typical stress-strain curve* shown in Fig. 6 indicates some similarity to a cast material.

Shrinkage of sprayed metal during cooling provides the chief source of stress in a metallized coating, and it varies rather surprisingly as indicated in Table 2. It is obvious that contraction

* A. P. Shepard, Metco Laboratories, Long Island City, New York.

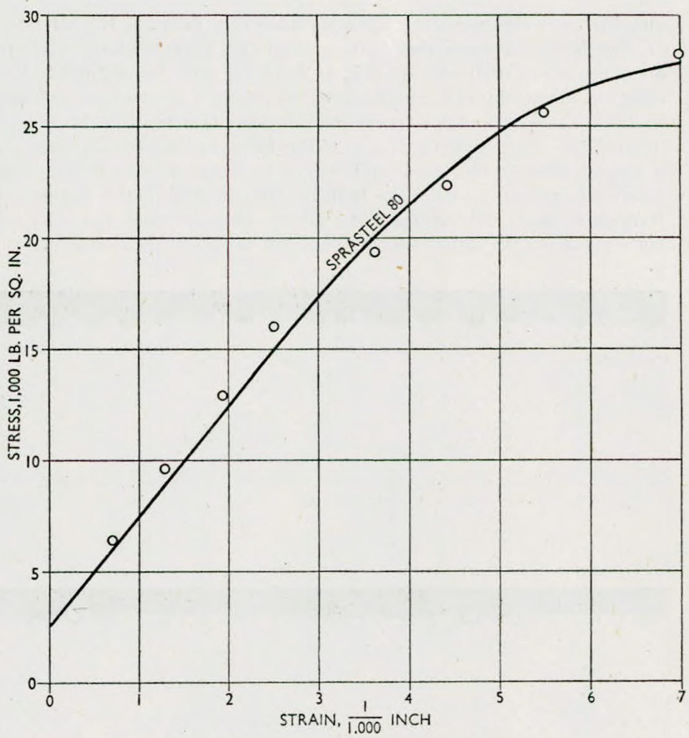

FIG. 6.—*Typical stress-strain curve for steel.*

Table 2. Internal stresses in sprayed metal coatings arranged in order of their relative ability to resist them

Metal	Shrinkage, per cent	Elongation, per cent at ultimate strength	Ultimate tensile strength, lb. per sq. in.	Remarks
High carbon high chromium stainless steel, No. 2	0·18	0·50	40,000	Internal stresses low; coating strong—the most reliable metals for building-up heavy duty parts
80 per cent carbon steel	0·14	0·42	27,500	
10 per cent carbon steel	0·80	0·30	30,000	High stresses—care must be taken to ensure a good bond
Iron	0·90	0·25	28,000	
18/8 Stainless steel, No. 1	1·20	0·27	30,000	Strong bond essential and slight pre-heating in cold weather to prevent risk of cracking
Naval brass	1·00	0·51	13,000	

serves to tighten the bond when a periphery is being metallized while the converse is true of internal work on bores, but in general shrinkage should be held to the minimum, as it pre-stresses and weakens a coating, and may in some cases result in cracking. The permissible amount of shrinkage will depend on several factors, foremost among them being the amount of metal being deposited and the standard of preparation achieved on the receiving surface.

Surface preparation is by far the most important part of metallizing technique since upon its adequacy depends the strength of the bond between the coating and the parent metal. There are numerous methods by which bonding can be achieved, but most of them involve roughening the surface in such a manner that the sprayed metal is mechanically keyed in position by means of suitably shaped depressions in the base material. To produce a strong mechanical bond such surfaces must be rough and free from oil, moisture, etc. As will be seen in Fig. 7 the degree of roughness must be sufficient to allow average-sized particles of sprayed metal to enter the depressions without "bridging" them,

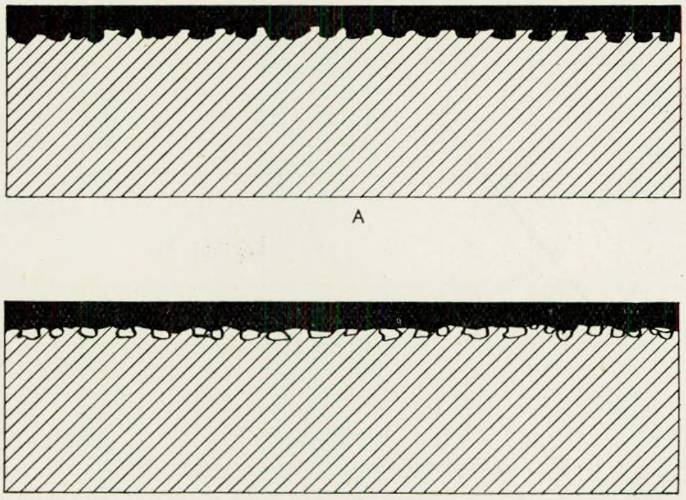

FIG. 7.—*(A) Character of bond attributable to good blasting preparation, and (B) bridging caused by too fine blasting*

and the shapes must include a high percentage of under-cut depressions in which the deposit can anchor.

A second function of mechanical preparation must not be overlooked. It consists of breaking up the surface so as to expose not only a much increased area of contact, but also to tilt the particles of sprayed metal at widely different angles. It has already been noted that the laminar structure yields much greater strength parallel to the laminations than at right-angles to them, and it follows that an irregular surface will distribute this strength more uniformly throughout the coating. While not significant in the case of protective coatings, this factor assumes considerable importance on machine element work and often dictates which method of preparation shall be employed on a particular item. The roughness should, therefore, be of such an order as to "anchor" the coating against contraction stresses, but patterned so as not to produce a change of plane along any given line. A splined shaft is an example of exaggerated roughness without anchorage in some directions and definite weakness along axial lines of maximum stress. where change of shape alters the plane of lamination.

Since various classes of work demand different methods of preparation it is well to understand the several techniques employed and compare their advantages and limitations.

Blasting with Sand or Angular Steel Grit

Grade 24 abrasive used at about 70lb. per sq. in. pressure produces on mild steel and other not too hard surfaces irregular depressions which will key sprayed metal. It is by far the cheapest method of surface preparation, but the bond obtained does not permit heavy deposits, being inadequate to resist severe contraction stresses. Fig. 7(A) represents an enlarged section through a well-blasted surface. The human element enters into sandblasting to such a degree that it cannot be considered reliable, the more so because visual inspection does not easily reveal slightly defective workmanship. It is usual, when employing the blasting process, to rely on rigid control of air pressure and quality of abrasive used and limit inspection to insistence on complete and uniform treatment of all surfaces. Hard cast-iron and heat-treated steels are sometimes blasted with alumina and other extremely hard abrasives, but a similar limitation as to coating thickness still applies.

Rough Turning

This generally produces a bond superior to blasting, although, relying on the small barbs torn-up on the surface it is dependent on the strength of the parent metal, so that in the case of cast iron, brass and similar materials, it is not very useful. A sharp-pointed V-tool ground to about 40 deg. and having little rake or clearance is normally employed to cut from 16 to 24 threads per inch according to the size of workpiece and thickness of coating. Some little skill is required to produce consistent results. Engineers may well look askance at a process involving tearing jagged cuts by way of preparation, but the incidence of failure by fatigue of such work appears to be extremely low, in fact, no instance of such failure has come to the author's notice during the fourteen years he has known the technique to be employed. This may, however, be due largely to the wide margin of safety employed by engine designers, and methods other than rough turning are used by most responsible engineers engaged in the metallizing industry.

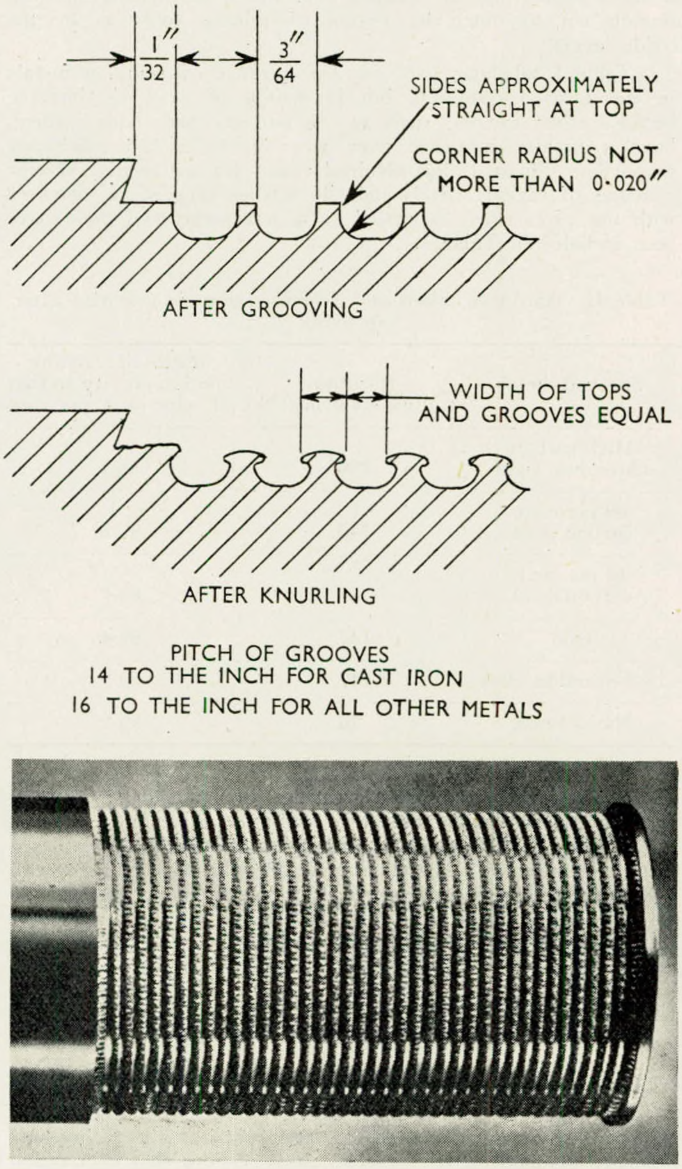

FIG. 8.—*Preparation of shafting by grooving and knurling*

The Shaft Preparation Tool Method

This involves roughening the surface with a special type of knurling tool, using a laminated cutter in which five thin steel blades, each with teeth set at different angles, are rigidly held together. When passed over the surface of a piece revolving in a lathe, a satisfactory kind of roughening is achieved, which has the advantage that uniform results can be repeatedly obtained. Used alone it is only satisfactory to receive coatings for press fits and other similar work in which the bond is not heavily stressed in tension.

The "Metco" Method of Shaft Preparation

This method which was invented in the U.S.A. about ten years ago, remains the best method of machine preparation so far devised.

Fig. 8 shows diagrammatically how a groove or thread is cut with a round-nosed tool and thereafter the ridges are spread over by using the shaft preparation tool. Although this method can only be employed on machineable materials, it does provide a means of producing uniform and reliable bonds over a wide range of machine element work. The technique is simple, and although two machine operations are involved (compared with one in the case of rough threading), it can be effectively performed by anyone who can use a lathe, whereas, except on mild steel, rough threading to the requisite standard can prove much more difficult than one might imagine.

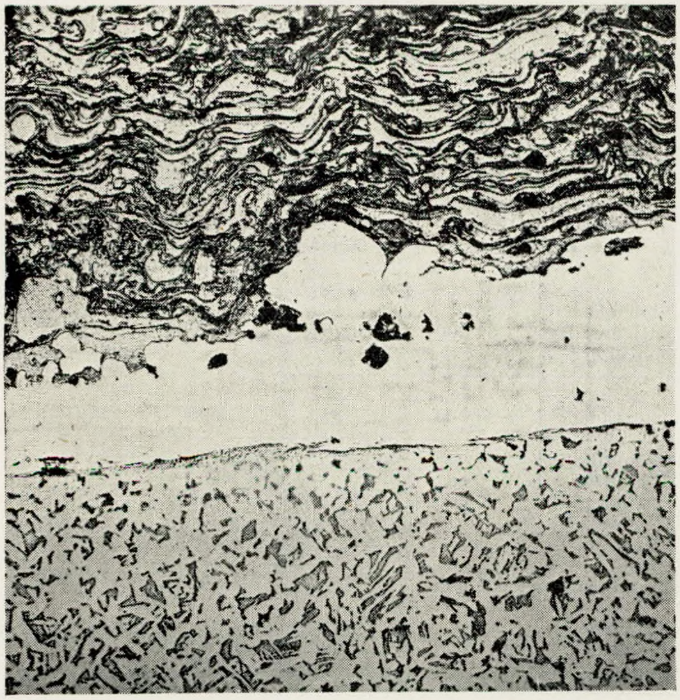

FIG. 9.—*Fuse-bond layer between sprayed steel and low carbon steel base*

Fuse-bonding

Fig. 9 is a patented* method of mechanical bonding in which instead of relying only on deformation of the parent metal, as in all previous methods, there is fused to the surface a layer of rough and cratered material on to which the coating metal is subsequently sprayed. Since low voltage, high amperage current is required to heat a bunch of electrodes, a transformer, somewhat similar to that used for resistance welding, is employed. The chief advantages are that a good bond can be produced on even the hardest steel parts, and items which cannot be machined by reason of their peculiar shape or excessive size, may be prepared for metallizing.

Sprabonding

This is the subject of patents and patent applications belonging to the Metallizing Engineering Co., Inc., of New York and has only recently been used here. It appears to be an exceptionally good method of bonding coatings to almost all metals, with the exception of copper and cuprous alloys. It consists of spraying a thin layer (about 1½ to 2/1,000 inch in thickness) of a special material on to the base metal, and thereafter applying whatever metal may be required, according to normal metallizing practice. The adhesion between the "Sprabond" and the parent metal is molecular and of the same character as that obtaining between say brazing material and steel, or between some metals and the oxides which so tenaciously adhere to them. Fig. 10 shows a photomicrograph magnified to 1,250 diameters, i.e. it is enlarged

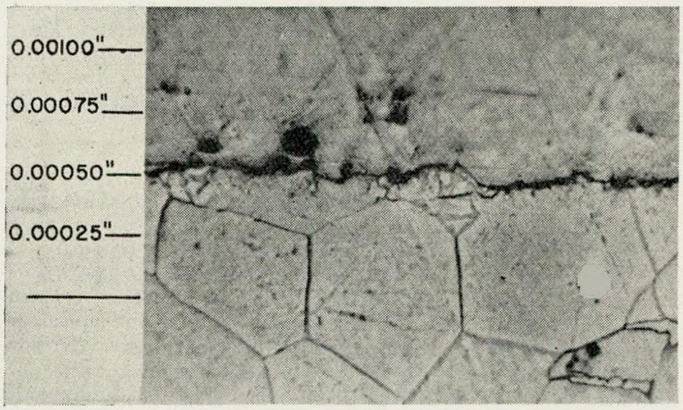

FIG. 10.—*Interface between layer of "Sprabond" and low carbon steel base magnified to 1,250 diameters*

1,500,000 times, so as to show the interface between a steel base and the sprayed layer of Sprabond. It is remarkable in that it indicates molecular adhesion and intimacy of contact equal to that between the crystals of solid steel. According to Ingham† alloying to an extent of 0·00003-inch thickness sometimes occurs between the sprabond and the base, but no real penetration sufficient to disturb the physical properties of a steel base has been detected. The author's investigations have so far only confirmed that in addition to the adhesion between the Sprabond and base being more than adequate for any known application of the metallizing process, the bond between this special preparatory layer and the superimposed coating is of such a high order that when tested to destruction in tension or sheer, the failure has taken place in the metallizing and not at the bond.

It is, however, necessary to exercise scrupulous cleanliness on surfaces to be Sprabonded, the metal always to be exposed either by grinding, turning or cleaning with emery cloth. Degreasing is not satisfactory, nor is it possible to leave a cleaned part exposed to atmospheric corrosion before Sprabonding. Such care is, however, well repaid by the knowledge that a bond stronger than the sprayed metal itself has been obtained without risk of damage to the base metal.

Spray-welding

This forms a link between metallizing and welding. The material, known as "Metco Sprayweld H" is an extruded plastic in which are embedded certain metals which could not otherwise be made into a wire. Its applications to marine engineering are few but it is mentioned here because it has been successfully employed for the reclamation of Diesel engine gudgeon pins. The material is sprayed on to a surface which has been prepared either by blasting or machining, and is then heated either by oxy-acetylene flame, high-frequency current, or other means, so as to raise the surface temperature to between 1,000 and 1,100 deg. C. in order that the deposit may flow and fuse to the base. The resultant coating is extremely hard, being in the region of 550 to 600 Brinell, which is considerably harder than any coating in the "as sprayed" condition. Sprayweld deposits, however, do not have the property of oil absorption so that they

* British Patents Nos. 575128, 575129 and 575130.

† Chief Engineer, Metallizing Engineering Co., Inc., New York.

are generally employed for such purposes as tipping agricultural machinery parts and coating earth-moving machinery blades. Its hardness, absence of porosity and excellent corrosion resistant properties make Spraywelding very suitable for certain purposes which demand resistance to both wear and corrosion.

Bonding by Heat Treatment after Spraying

Use is made of the well-known property of aluminium by which it readily alloys with iron and steel at about 800 deg. C. to protect ferrous metals subject to heat oxidation, by spraying pure aluminium on to a previously blasted surface and thereafter heat treating to produce the heat-resisting iron-aluminium alloy over the surface. Furnace parts are regularly so treated, and the coating becomes integral with the base material. There are numerous other examples of bonds achieved by heat-treatment, but they are not important to an understanding of the more generally employed mechanical bonding methods which cover the bulk of metallizing work.

Hand Preparation

For metallizing this is generally to be avoided, although there are instances in which it can be very useful. One such occasion was during the late war when a destroyer (H.M.S. *Verity*) was found, on trials, to have distorted the port main turbine casing either side of the carbon packing gland, to a depth of about 0·008 inch on each flange. The vessel was required for immediate service, and the author, armed only with a metal spraying gun and some mild steel wire set out to get her to sea with the minimum delay. It was an all night job to jack up the top-half casing, prepare the low areas on the flanges of both top and bottom halves, and metallize them—the preparation being carried out by making undercut chisel marks in three different directions at about 60 deg. to each other. Admittedly, the deposited mild steel had only to perform "jointing" or "packing" duties, after filing and scraping by the dockyard staff, but it illustrates that hand preparation can be useful. On another wartime occasion severe pitting, as much as ⅝-inch deep in places, was found aft of the stern glands and forward of the A-bracket bearings on each of H.M.S. *Stevenstone*'s propeller shafts. Time did not permit withdrawal of the shafts, and the author had to choose between grit-blasting and hand preparation. The latter was selected (except that pneumatic chisels were employed) because the mass of metal required in some areas made it extremely doubtful whether blasting would prove satisfactory. This work was carried out as a temporary emergency repair, but long afterwards the Admiralty confirmed that it was still behaving satisfactorily. Some may wonder how machine finishing of the sprayed metal was carried out on these propeller shafts in situ in dry-dock. The author claims no part in devising the method, which was suggested by the shipyard foreman, whereby these shafts were ground very true to a good finish by the simple expedient of cutting a wood block concave to the radius of the shaft and mounting a pneumatic grinder on it with a piece of rubber insertion to allow for pulling-up to apply a cut. Fig. 11 showing the arrangement used is included not so much as illustrating a method of finishing sprayed metal, but as a tribute to that ingenuity which is found among marine engineers and shipyard staffs.

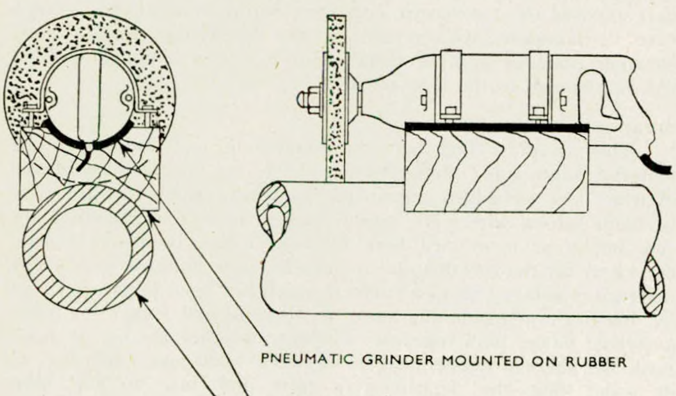

FIG. 11.—*Improvised grinding arrangements for propeller shaft metallized in situ on H.M.S.* Stevenstone

Pre-heating

This is not often resorted to in connexion with preparing parts for metallizing, although a mild preheat is sometimes employed when metallizing internal surfaces such as bores and housings to counteract the effect of coating shrinkage. It must not in any case be carried to such an extent as to oxidize the prepared surface, and can only be used in conjunction with one of the mechanical methods of preparation already described. However, in extremely cold weather, with the workpiece at or below freezing point, it is considered advisable to "take the chill off the job" before preparing, since the surface if very cold rapidly collects moisture, and the mild preheating eliminates unnecessary stressing of the coating and so reduces the risk of low-temperature cracking. Average room temperature of about 60 deg. F. is quite sufficient to obviate this, and the necessity to take any such action will vary with the particular metal being sprayed. As an example, high carbon steel, which has comparatively high tensile strength, but low "shrinkage value" will not require such precaution in this respect as brass, of which the reverse is true.

Table 3 shows the effects of various types of prepration on the endurance and resistance to both axial and rotary shear stress.

Table 3. Effects of preparation on mechanical properties (13 per cent chromium steel on 3½ per cent nickel steel base)*

Type of preparation	Estimated endurance limit, 2×10^7 cycles	Stress concentration factor	Axial shear, lb. per sq. in., 2-inch cylindrical band 0·2 inch wide	Rotary shear, lb. per sq. in., 1-inch diameter $\times 2 \times \frac{5}{16}$ inch $\times$ 0·2 helix
Shot blasted with angular steel grit	54,000†	0·76†	1,200	3,150
Rough threaded	30,000	1·37	7,990	14,700
Grooved and knurled (complete "Metco" method)	27,000	1·52	6,000	25,400
Fuse bonded	35,000	1·17	9,000	24,100
Plain polished specimen	41,000	1·00	This specimen not sprayed	

FINISHING SPRAYED METAL

Table 4 indicates recommended feeds, speeds, etc., for finishing metallizing work by turning and grinding. Because of its peculiar structure, sprayed metal presents certain finishing problems to an uninstructed operator who has hitherto worked only on "solid" metals.

Turning

When a shaft has been metallized on to a machine-prepared surface, it may be found that at each extremity the coating is somewhat harder—in fact, a pronounced hard ring often occurs (Fig. 12). This is due to the flattened particles of sprayed metal being mounted more or less "on edge" in these areas, since they tend to follow the contour of the shoulder at each end of the

* According to U.S. Bureau of Ships.
† Blasting with sand or steel grit stretches the surface and so pre-stresses it in a negative sense to those stresses which tend to cause fatigue in service.

Table 4. Feeds and speeds for finishing sprayed metal

Metal	Turning with carbide tipped tool				Dry grinding				Wet grinding		
	Surface speed, ft. per min.		Feed, inch per revolution		Tool post grinder, 5/6,000 surface ft. per min.				Wheels		
	Roughing	Finishing	Roughing	Finishing	Metco wheel	Work speed, surface ft. per min.	Roughing feed per revolution, inch	Finish feed per revolution, inch	Carborundum 6,100 surface ft. per min.	Norton 6,500 surface ft. per min.	All metals
High carbon steel	35	35	0·004	0·003	44	30	$\frac{1}{32}$	$\frac{1}{8}$	C36-K4-VE	37C46-K5V	Work speed, 80/90 surface ft. per min.
Low carbon steel	90	90	0·006	0·003	42	30	$\frac{1}{32}$	$\frac{1}{8}$	C36-K4-VE	37C46-K5V	Traverse, 3 ft. per min. (roughing)
Brass, bronze, copper	275	275	0·006	0·002	44	30	$\frac{1}{32}$	$\frac{1}{8}$	C36-K4-VE	37C46-K5V	Traverse, 1 ft. per min. (finishing)
18/8 stainless steel	110	150	0·006	0·003	43	30	$\frac{1}{32}$	$\frac{1}{16}$	A465-J5/6-V30	37C46-K5V	Infeed, none (finishing)
High carbon chromium steel	35	35	0·004	0·003	46	110	0·006	0·015	C36-K4-VE	37C46-K5V	Infeed, 0·001 inch (roughing)
Monel metal	225	275	0·004	0·002	46	30	0·006	0·015	GC-60-J8-VW	37C80-H7V	Coolant 45 to 1
Nickel	225	275	0·004	0·002	44	30	0·006	0·015	GC-60-J8-VW	37C80-H7V	

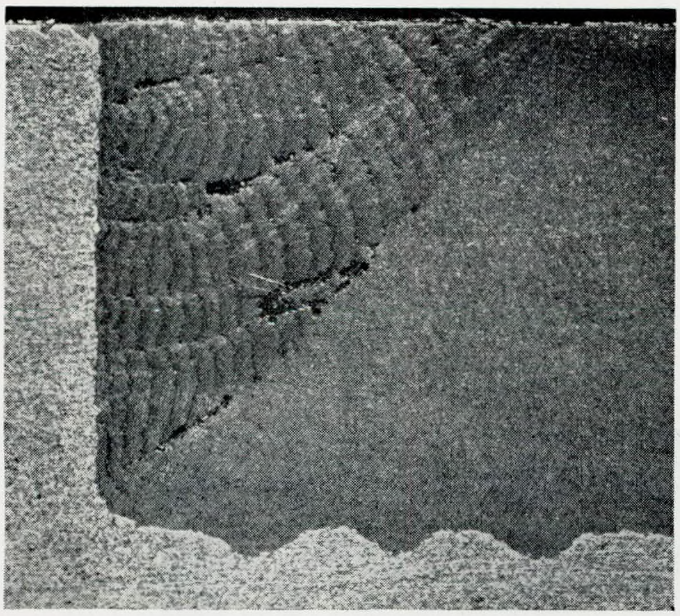

FIG. 12.—*Example of hard ring found at shoulder*

prepared section. Such shoulders also collect particles of dust, carbon, etc. It can be minimized by spraying into the corners before proceeding with the main body of the coating. When it does occur, however, it is better to finish-machine the affected areas with a plunge cut rather than axial feed, using a blunt-nosed tool. With most sprayed metals there is a tendency for unskilled operators to tear out particles, resulting in a rough and pitted surface. Bad tearing may even disturb particles which at the time are beneath the surface and so prevent a good finish being obtained at a smaller diameter. It is generally advisable to set the tool a little above the centre so that front clearance is practically eliminated and the pressure of the tool immediately below the cutting edge will tend to hold each particle in position so that it will cut rather than tear out. Tungsten-carbide tipped tools should be used for all sprayed metals if possible because they require less rake and clearance than steel tools, and for the hardest materials, a grade which would normally be used for chilled cast iron should be employed.

Dry Grinding

This generally implies the use of a tool-post grinder, and the recommendations in the table should be closely followed, otherwise glazing the wheel and burning the coating will result. It is important to select the appropriate type of wheel for the particular coating, since selection based on experience of "solid" metals will yield indifferent results in most instances. All metals, when sprayed, lose some of their heat-conducting property by reason of the oxide surrounding each particle, so that they more readily overheat locally, especially when dry grinding is employed. For ferrous metals the Norton 37C46-15V wheel or an equivalent gives very good results.

Wet Grinding

Wet grinding provides the best possible machine-finish on sprayed metals. Wheels generally are coarser and of lower bond-strength than for normal metals, and if a general purpose wheel is required, then either of the following vitrified wheels should be satisfactory:—Carborundum C36-K4-VE or Norton Chrystolon 37C-46-K5V.

Lapping

Lapping should never be employed on metallized bearing surfaces, since the abrasive can become lodged in the pores of the metal with serious consequences.

Keyways

It is better practice to form a keyway during spraying by the insertion of a dummy key, rather than to attempt to cut one in an otherwise unbroken periphery of sprayed metal. The latter procedure would release the contraction stresses in the coating and possibly damage the bond. Carbon is very suitable for making up into dummy keys, or for plugging oil holes etc., while spraying, and presents little difficulty during machine finishing. When fitting a key the coating should be backed away so that the load is carried on the solid metal only.

Machining Allowance

Allowance is necessary to dispose of the top oxide layer, the natural matt surface of the sprayed coating, and any unevenness resulting from the rough contour of the preparation. As the coating thickness increases, the tendency for initial roughness to follow through decreases, so that the machining allowance becomes less. Generally 0·020 inch measured radially is sufficient when turning and about half that amount for grinding, but it is quite easy to assess what will be required from the character of the work.

Time Lag between Spraying and Machining

When working to very accurate limits it is not only necessary to allow the sprayed coating to cool to room temperature, but also to allow it to settle down. Although contraction is a function of temperature the final adjustments in the material do not keep pace with the rate of temperature drop. While this does not affect the normal run of metallizing work, it has been found from time to time that where the metallized coating is considerable in relation to the wall thickness of the parent metal, further action, after normal cooling, can be sufficient to affect dimensions or even distort an accurately ground surface. A recent case, under the author's supervision, involved the metallizing of a large number of cylinder-liners externally. The first few were checked for tolerance (+0·00025 −0·00025 inch) and were well within limits with no ovality. Three days later they were re-checked and found to be oval +0·0005 −0·001 inch, with room temperature approximately the same. These liners had shrunk further and distorted after grinding, and it was attributed to the fact that they had been ground as soon as they were cooled. When a time lag of two days was interposed between spraying and grinding, this trouble was eliminated. During the two days following metallizing the "dead" note originally given by a piece of sprayed high-carbon steel changes gradually to a bell-like tone which is suggestive of some internal process continuing beyond the cooling-out stage. The subject is an intriguing one and has been engaging the author's attention for some time, but it is not anticipated that it will lead to any conclusions affecting technique, other than the already recommended time-lag in connexion with thin shells.

BUILDING UP MACHINERY PARTS

Building up machinery parts by metallizing covers such a wide range that it is convenient to list a few classes of work connected with marine engineering.

Restoration of Worn Components

Restoration to plan size is the most commonly undertaken class of work, and the examples are so numerous as to make the selection of a typical case difficult. The selection of a crankshaft (Fig. 13) is done because there have been more crankshafts reconditioned by metallizing than any other single component within the author's knowledge. The total number in Britain alone is probably in the region of 50,000, and although they have mainly been small ones, quite a number of large Diesel crankshafts have been metallized successfully. They provide an excellent example of restoration to original size with elimination of the necessity for undersize bearings and provision for re-treatment of the original shaft many times. Some years ago the Admiralty produced an excellent specification for the reclamation of crankshafts by metallizing and this has been the basis for much of the similar commercial work also undertaken in this country. It is not unusual to find that a metallized crankshaft bearing will outlast the standard article, and this is not surprising both on account of the oil retaining properties of the sprayed metal and because crankshaft materials are often selected on account of their forgeability and toughness, rather than exclusively for wearing properties.

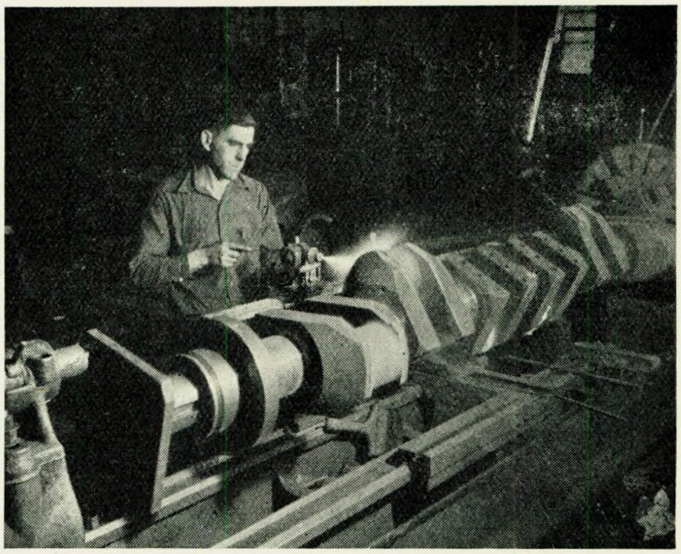

FIG. 13.—*Metallizing journals of Diesel engine crankshaft*

Metallizing Oversize

To extend the life of a mating part metallizing oversize is frequently resorted to. An example is found in building-up piston and pump rods oversize so that the gland may be bored to suit instead of requiring replacement or rebushing. Quite apart from the economic considerations building up oversize is regularly prac-

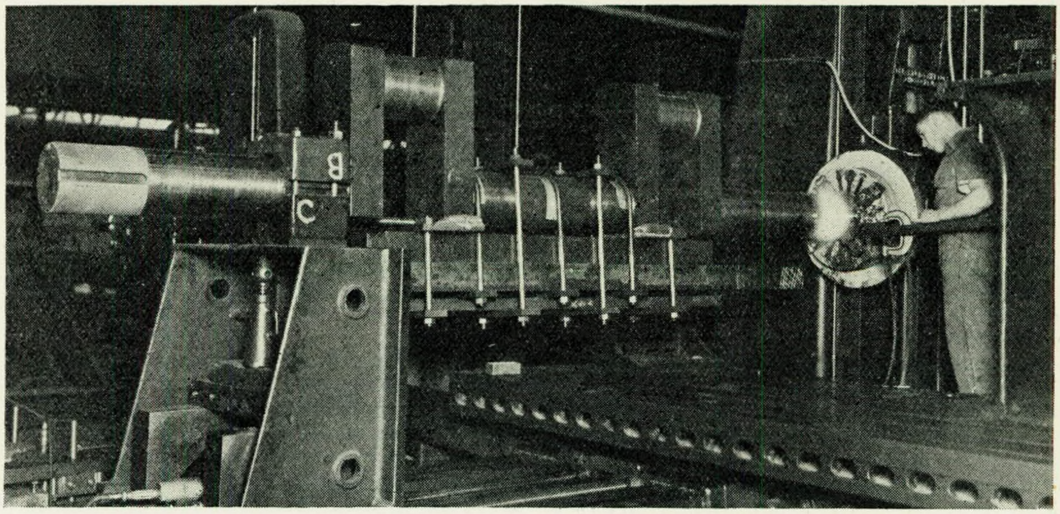

FIG. 14.—*Each end of a press crankshaft being sprayed with steel after damage by failure of keys*

tised for such items as piston valves, while shortages of labour and materials often dictate that it shall be employed in cases where standard sizes would normally be used. Pistons for all classes of engines are regularly metallized oversize. Fig. 14 shows a rather different type of crankshaft reclamation work in which damage to areas other than journal bearings is being rectified by metallizing.

This figure shows a crankshaft set up in a horizontal boring machine at the works of Messrs. Vauxhall Motors, Ltd., Luton, being metallized with 77lb. of high carbon steel at the ends where the double keys had sheared and torn the surface. The driving gears were bored true but oversize and the shaft built-up to suit. Owing to the very great swing involved, no lathe large enough was available and the complete work of machine preparation, spraying and finish machining was undertaken in the boring machine. For spraying, the shaft with temporary balance weight was chucked at one end while the other end was carried in an improvised pedestal bearing as shown. For preparation and finishing the job was packed up to the requisite height on to the carrier and the tool held in the chuck. The interesting aspect of this job is that it was undertaken twelve years ago as an emergency repair, with little confidence that it would do more than save an immediate hold-up on production. In fact, it is still operating satisfactorily and illustrates the point that the vast majority of those engineers who have accepted metallizing originally only tolerated it as a temporary expedient and have since been forced by experience to embrace it as sound reclamation practice. Perhaps more important, however, is the fact that in such work as this, the distortion by welding, which was the only practical alternative, would have risked damage beyond repair. In any case it would probably have necessitated machining all bearings true, and no local facilities for re-machining the crankpins existed. Considerations such as this form an excellent introduction to a cold process.

Material and labour shortage may often dictate this method of "oversize" reclamation. It is also sometimes employed in instances in which no reduction of "core-strength" of the member to be built-up could be permitted. Removal of metal to allow the minimum permissible thickness coating can in this way be eliminated, but even so, it is good practice to ignore any possible added strength due to the deposited metal. In all metallizing reclamation the engineer responsible should decide whether the component is strong enough for service without making any allowance for the strength of the coating.

Metallized Inserts

These are chiefly employed to permit a more valuable metal to be used only on that part of a component in which its particular properties are required. Both manufacturers and repairers take advantage of metal spraying for this purpose. Fig. 15 shows an excellent production application in the practice of Messrs. G. and J. Weir and Co., Ltd., who line heavy duty pump barrels with a thick nickel coating. This combines corrosion resistance with excellent wearing properties, whereas it would, of course, be economically impossible to produce the pump barrel completely in nickel, and normal plated deposits would be inadequate to allow for subsequent re-machining when worn. Inserts are frequently metallized so as to form sleeves on shafting, and especially mild steel pump-spindles which are given a stainless steel or monel-metal coating on areas subject to corrosion. Circumstances in repair work can sometimes make metallizing the only possible method of repair, because a sleeve could not be fitted, e.g. a section of a shaft between two collars.

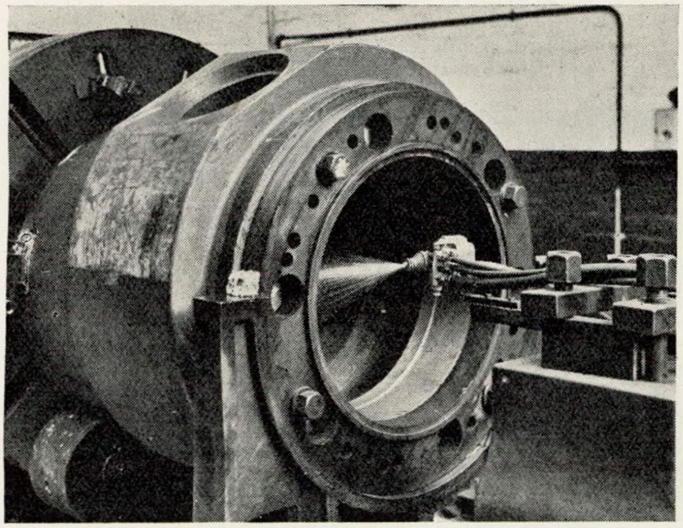

FIG. 15.—*Pump barrel being lined with sprayed nickel*

Remedying Machining Errors

An argument frequently put forward against the wider use of metallizing for this purpose is that once the machine shop people know of its existence, they may become careless in the certain knowledge that mistakes can be rectified. Although this implies confidence in the process, it does so in a negative manner, which might react unfavourably to the wider use of the metallizer. The author has investigated the suggestion in three machine-shops and statistics in each case have revealed that the incidence of careless errors has tended to decrease after a spray-gun has been installed for reclamation. It is believed that this is largely due to the fact that metal spraying a machining defect gives much greater publicity to the error than does the making of a new part. At any rate, some hundreds of machine-shops, in Great Britain alone, include a metallizing-gun in their equipment, using it as a "putting-on tool" with the same confidence that they show in employing an orthodox lathe tool. The classes of work include not only shafting, but bores and internal ball-race housings and flat surfaces. It is not usual to build-up screw threads by metal spraying, since in general the shear stress on the bond is too great and in any case sprayed metal is not very suitable for this class of loading owing to its structure. Much the same may be said of the actual working faces of ball and roller races, in which the respective point and line contacts impose too great a stress trying to force the particles of sprayed metal apart. It is true that some ball and roller races have been successfully built-up by metallizing, but only in cases of very light loading, with the exception of work recently carried out by the Sprayweld process.

The suitability of Spraywelding to carry heavy localized loading is due both to its hardness and to the fact that the heat treatment results in the sprayed particles flowing together so that the coating can no longer be regarded as a regular sprayed-metal deposit. For press fits and shrunk-on collars, sprayed metal, particularly if loaded with oil or colloidal-graphite, exhibits considerable resistance to "fretting-corrosion", that is to say the type of corrosion which is believed to result from the slight relative movement of two parts, one of which is subject to severe alternating stresses only partially passed on to the second member by virtue of the tightness of the fit. A gear wheel shrunk on to a crankshaft is an example. Sprayed-metal itself, when forming a sleeve on a shaft—a crankshaft again being an excellent example—might well be expected to exhibit this phenomenon, but it has only been found on one occasion by the author, and the part was a thick coating on the non-lubricated end of a large industrial crankshaft, which was being examined after many years service (it has been prepared by blasting before any of the later surface-preparation techniques had been devised), and was comparable with what might be expected of a shrunk-on sleeve.

It is believed that by any of the other methods of mechanical bonding outlined in this paper, the keying effect is sufficient to prevent relative movement, even the microscopically small movement that can give rise to this form of corrosion, so that such vibrations and stresses as occur in the parent member are passed on to the coating. This matter is not merely of academic interest, since fretting or rubbing-corrosion can be a factor in giving rise to such stress concentrations as may ultimately cause failure by fatigue. While there remains room for much more useful work to be done on this aspect of coating parts subject to alternating stresses, it is encouraging to note that all the evidence of metallizing work during the past fourteen years appears to indicate that the process combats fatigue rather than encouraging it. Referring to Table 3 comparing bond strengths it is worthy of note that blasting stretches a surface in such a manner as to render it less liable to fatigue than a similar polished surface, and this even though a sharp abrasive be employed.

Oil Absorbent Bushes

These may be formed either by lining conventional bushes internally by spraying or may be manufactured entirely by metallizing. Babbitt-metal is generally employed as the actual bearing metal and the method of manufacture of complete bushes by metal spraying is as follows. A very slightly tapered and undersized mandrel is cleaned and "dulled", but not roughened, by blasting. Babbitt metal is then sprayed over the mandrel to the requisite thickness, usually 12 to 15/1,000 inch but with the thickness compensated for the mandrel-taper so as to finish parallel. Thereafter, the spraying is continued to give a wall thickness of from ⅛ to ¼ inch with whatever metal may be required for the bearing-shell, steel, bronze, aluminium and even magnesium having been employed for this purpose successfully. Thereafter, the outer surface is turned to finished dimensions and the bushes parted-off, it only remaining necessary to reamer the bores parallel (located by the perimeter) to complete the machining. Before putting such bushes into service they are impregnated with oil containing colloidal graphite by dipping, or, if maximum absorption is required, by subjecting to a vacuum followed by oil under pressure. Bushes of this kind are economical to manufacture and are particularly suitable for inclusion at points where lubrication may be neglected by reason of inaccessibility.

Casting Faults

These are not always detected before it is too late to replace or uneconomic by reason of considerable machining work having been carried out. The informed engineer will in such cases wish to consider whether the defect can be remedied by metal spraying, but will have well in mind that metallizing does not substantially strengthen a casting. Having decided that the part has the requisite strength he will know that metallizing can be employed for the following purposes :—

(*a*) *Building-up where undersize.* Provided that the bond between the coating and the casting is not subject to considerable shear-stress, nor the resulting surface liable to impact or excessive localized loading the process is as previously described.

(*b*) *Sealing porosity in castings.* This may at first sight seem contradictory in relation to the claims made for the oil absorbing properties of sprayed metal, but not so when it is realized that the porosity of the coating is a function of the thickness. The paths through sprayed metal become increasingly devious as the thickness increases. Furthermore, by decreasing the distance of the gun from the work, the incidence of welding between particles increases—and slight pre-heating of the casting (insufficient to cause oxidation) can be used to exaggerate this until porosity is eliminated.

(*c*) *Cracks in Castings.* These can often be temporarily, and in some cases permanently prevented from leaking even under considerable pressure. The technique of repairing cracks, except in cuprous alloys, has been greatly improved by the invention of Sprabonding.

(*d*) *Unsightly Blowholes.* These can be sprayed with metal matching the casting, and when occurring on a working surface, can, by careful selection of a material giving an equivalent wear-resistance, be made to render an otherwise useless part quite serviceable.

Metallizing Patterns

Perhaps the chief use of metal spraying in connexion with patterns in ship repair work has been to apply quickly the necessary machining and shrinkage allowances on actual castings which have to serve as emergency patterns. The parts requiring added metal are cleaned, preferably by blasting, but sometimes only by rough filing, and a coating of zinc applied to the necessary thickness. This is particularly convenient on parts which owing to their shape cannot readily be enlarged for use as a pattern by the usual means. Additionally, patterns for repetition work can be made undersize of wood and then metallized, with the advantages of lightness in use, easy alteration by spraying metal to thicken a webb or alter a curve, and elimination of warping.

Emergency Repairs

Ship repair work is so frequently a matter of urgency that many of the classes of work already mentioned fall within this category at some time or other. The work on the port main turbine casing of H.M.S. *Verity,* described earlier is an example, and another instance occurred on the same vessel which illustrates how well metallizing is adapted to eliminate delays in shipping. Fig. 16 shows the top and bottom halves of *Verity*'s port circulating pump, damaged by an underwater explosion at

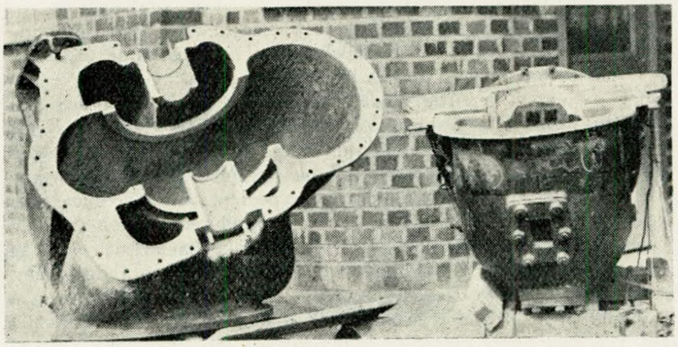

FIG. 16.—*Top and bottom half castings of a circulating pump built up with 140lb. of bronze on flanges, bearing housings, etc.*

the same time as the other major defect. The pump, originally manufactured in France, had no patterns or spare parts available and was so distorted that the author could get his fingers between top and bottom casting flanges. The bearing housings were pushed upward 5/16 inch and the impeller-boss axial clearance increased by ⅝ inch. Time was the essence of the repair, and metallizing solved the problem. 140lb. weight of bronze was deposited over the "low" surfaces, and the two castings remachined to original dimensions with completely satisfactory results.

The chief factors favouring metallizing for emergency repairs are:

(1) Speed with which the work can be carried out—as much as 20lb. of steel or much larger quantities of lower melting point metals can be deposited in an hour, so that it is quicker than welding to apply, and much less machining allowance is necessary by spraying.

(2) Risk of heat-damage is eliminated so that parts can often be metallized in situ, e.g. a turbine bearing can be metallized with the rotor in position without fear of distortion, and the

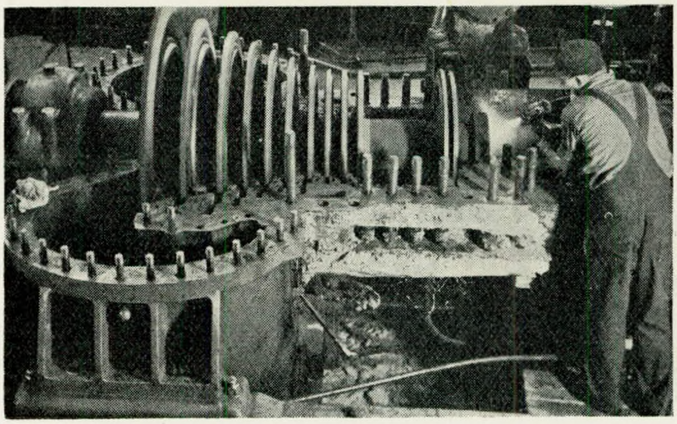

FIG. 17.—*Turbine shaft being repaired in situ*

same applies to sealing a crack in a Diesel engine cylinder block water jacket. Fig. 17 showing the metallizing of a turbine shaft

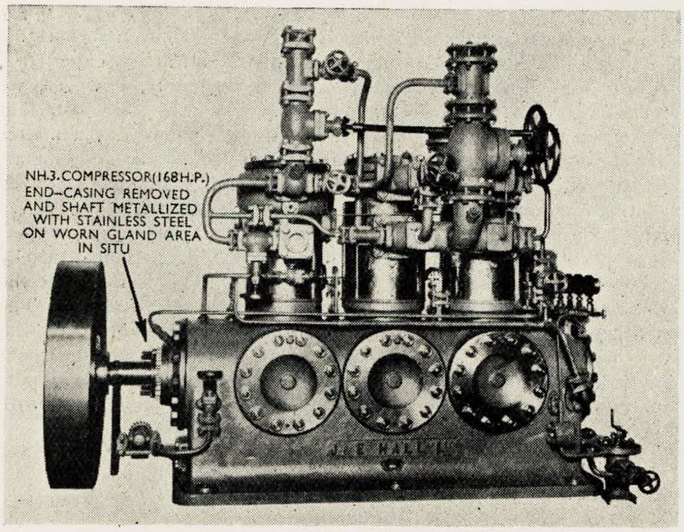

FIG. 18.—*Ammonia compressor repaired without dismantling*

in situ, is typical. Fig. 18 formed the subject of an in situ repair on an ammonia compressor and although similar to marine engineering applications this work was carried out in a London brewery under the guidance of the chief engineer. The gland cover was removed so as to expose the shaft which was metallized with stainless steel and reground with a portable tool post grinder successfully without removing the shaft from the compressor.

(3) The most appropriate metal can be selected without reference to its fusibility to the parent metal, so that a limited variety of metal wires will cover all likely classes of repair work.

(4) It permits using worn and oversize mating members with consequent advantage.

(5) Metallizing is often the only possible means of salvaging a worn part, and yet it involves no special plant with the exception of the hand-gun provided an adequate supply of compressed air is available on site.

General Marine Applications of Building-up Work

The ideal example of metallizing, and one which is not only well proved, but particularly easy to accomplish, is building-up an unbroken periphery, such as a journal bearing. Whereas it takes approximately three days for an operator to be intensively trained in all classes of building-up work (provided he is able to use a lathe), in a single day a man of average intelligence will be quite capable of learing how to build-up worn journal bearings faultlessly. The manufacturers of metallizing equipment train operators, although with such a book as the "Metco Metallizing Manual" in his hands, a foreman can quite easily train a machinest in preparation, spraying and finishing, beginning with the straightforward reclamation of bearings.

Propeller shafts are perhaps the simplest class of work on which to begin, and are well worth doing, not only on account of the longer service obtainable from metallized journals, but because such shafts do not readily lend themselves to welding on account of distortion. Steel or bronze shafts, large or small, at the A-bracket bearing, stern gland, or any plummer block bearings, are all equally suitable. Fig. 19 shows two guns simultaneously spraying a propeller shaft journal.

The period just prior to D-day found metallizers busy around the southern coast of England making good the ravages of corrosion on the tailshafts of landing craft. With salt water as the electrolyte and steel shafts against bronze bearings, many of these craft had stood in creeks and rivers long enough to "rust-up solid", and but for the metal spraying process might have presented a major problem. Fortunately, it was found possible to salvage these shafts well inside the time limit.

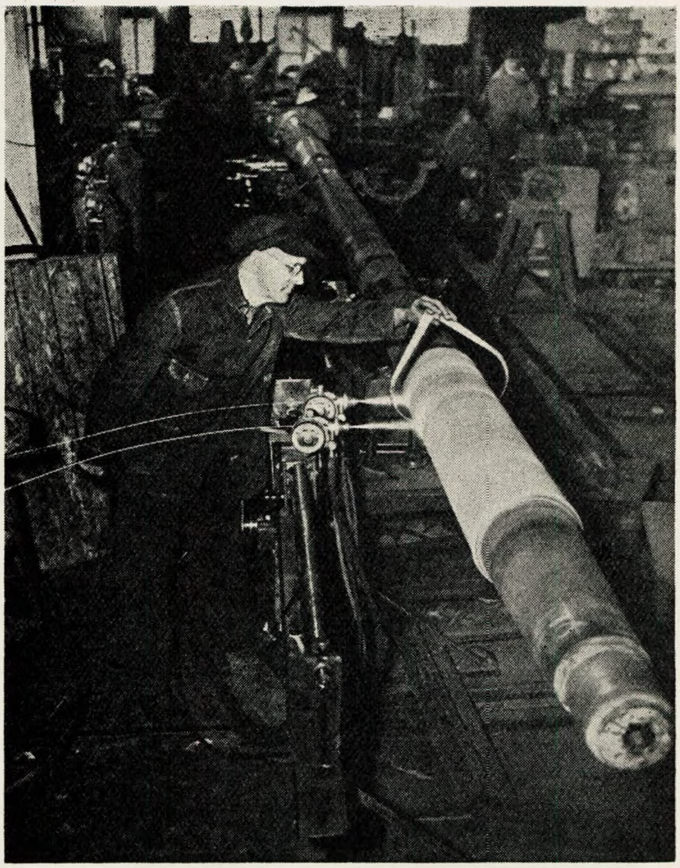

FIG. 19.—*Propeller shaft journal being metallized in a lathe*

The turbo-pump shaft, illustrated in Fig. 2, is typical of repairs to auxiliary machinery, which of course, include also all types of pump and piston rods. Where corrosive conditions are encountered, stainless steel and pure nickel are the general choice, and as a rule stainless steel is favoured for a rotary part and nickel when reciprocating motion is involved. Stainless steel is not recommended where it would be in contact with leather packing; it is, however, one of the metals chiefly employed on shipwork, so that a word as to its properties in relation to the solid metal may be worthy of inclusion here. In order to retain its quality of resistance to corrosion, stainless steel must have a high finish, such as is imparted by grinding. The characteristic matt finish in the sprayed condition is, therefore, not the most suitable type of surface to withstand corrosion and must be corrected by turning or grinding. It is worthy of note that the time taken to heat, atomize, deposit and cool the metal below the critical temperature during spraying is insufficient to permit migration of carbon to the grain boundaries, so that, unlike welding, there is no risk of "weld-decay" when spraying any of the wide range of austenitic steels. A material developed from the well known 18/8 stainless steels is often employed where corrosion resistance is all important. High-chromium steel known as "Metcoloy 2" is by far the widest used metal for building-up worn parts which, in addition to requiring reasonable resistance to corrosion must be particularly hard wearing. Pump-rods, hydraulic rams, deck and dock machinery parts are regularly metallized with this material with excellent results.

Pistons have recently received more attention from a metallizing point of view due to shortage of supply. In general it was considered previously that only really large pistons were worthy of treatment, except that the skirts of small pistons were sometimes metallized to take up piston-slap. Ring grooves are not usually metallized, since as new rings are usually called for it is easier and cheaper to make the new rings wider than the original and machine the grooves oversize. The lands between the grooves on the larger pistons are now regularly sprayed, a shoulder being left at each end of the land when carrying out machine-preparation.

Some experiments with the reclamation of aluminium and light-alloy pistons are not without interest. These can be built-up with high-carbon steel with only negligible increase of inertia forces, and have very good wearing properties. Tests suggest less cylinder or liner wear than when the "solid" aluminium or light alloy pistons are employed. Metallizing has also been employed to rectify piston top damage, and within pistons, bands of copper have been sprayed to conduct heat away from undesirable hot-spots.

The more difficult problems connected with building-up by metallizing relate to the treatment of flat surfaces or spraying internally in bores. In general these classes of work require more particular attention to preparation so as to anchor sufficiently well to take care of contraction stresses. Wherever possible spraying of flat surfaces is continued over edges, and if a heavy coating is required it is advisable to Sprabond the surface before applying the coating material. Internal work, of 3½-inch diameter and above can generally be carried out satisfactorily, but where spraying is all from one end of a small bore, then unless extension equipment is used in connexion with the gun, it is not practical to spray the bore to a depth greater than the diameter, or twice the diameter if spraying can be carried out from each end. The reason is that the spray should strike as nearly as possible normal to the surface, but in no case at an angle of less than 45 deg. Where greater depths are required, the front of the metallizer is extended by a tube, and a deflecting nozzle, known as an angular air-cap is employed to deflect the spray sideways on to the walls of the bore being treated.

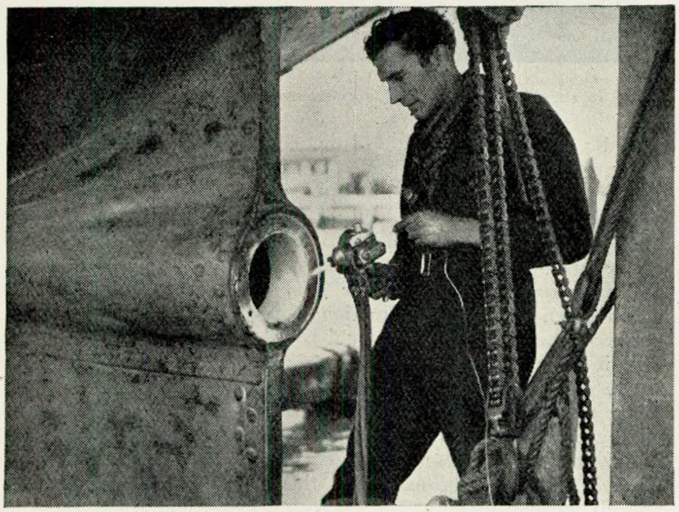

FIG. 20.—*Repair of oversize bore in sternpost*

Fig. 20 illustrates internal work—a recent instance of remedying clearance between the stern-tube and bore of the sternpost on a Gosport-Portsea ferry steamer. The 9-inch diameter hole was Sprabonded and metallized with 15/1,000-inch thickness of zinc, scraped true and the stern-tube pressed back in place in less time than would have been required for fitting "shims" and the result was much more reliable.

PROTECTIVE COATINGS

The Theory of Corrosion

In order to be in a position to select a suitable material to resist particular conditions of corrosion, it is necessary to have at least an elementary conception of the theory of corrosion, and in addition to understand the structure of sprayed metals so that due allowance can be made for its influence upon the problem. So many factors affect the rate of corrosion between metals—and some of these factors are so elusive—that it is good practice to confine actual work to classes for which there are successful precedents or, alternatively, to carry out tests under circumstances which as nearly as possible duplicate the conditions of service. Only by such means will the marine engineer be able to apply corrosion resistant coatings with confidence, and even then if his opinion is based on laboratory tests rather than actual experience, results may not justify expectations. Fortunately, however, we now have a wealth of experience on which to draw, so that reference to the theory of corrosion is made mainly as a matter of interest though it can be useful in the selection of likely metals for a test. Corrosion problems in connexion with metal sprayed coatings commonly involve two metals only, so that it is worth while considering the effect that one metal may have on another. It is possible to arrange metals in order, based on their tendency to set-up galvanic corrosion on each other. (This is not quite the same thing as the electro-chemical series, though similar). The list begins with materials which are the more readily attacked, or what is known as the anodic end of the series, and continues in order of merit until it ends in the more noble or cathodic materials which themselves derive protection from contact with the more corrodable metals higher in the last.

Galvanic Series*

Corroded end (anodic):	Magnesium Aluminium Duralumin Zinc Cadmium
	Iron Chromium iron (active) Chromium-nickel-iron (active)
	Soft solder Tin Lead
	Nickel
	Brasses Bronzes Nickel-Copper Alloys Copper
	Chromium-iron (passive) Chromium-nickel-iron (passive)
	Silver solder
Protected end (cathodic)	Silver Gold Platinum

The metals are grouped and those in each group do not possess any strong tendency to set up galvanic corrosion with each other. Contact between metals far apart in the list tends to corrode the one in the higher group. Circumstances may cause metals to change their position in this list, but usually only within a group, i.e. not between groups. The chromium-irons and chromium-nickel-irons, however, are an exception in that they take one or other of the positions indicated according to oxidizing conditions, acidity, and chloride in solution. The list as arranged, however, is correct for a large number of dilute water solutions including sea-water and both weak acids and alkalis.

Sacrificial action of anodic coatings. All marine engineers are familiar with the protection afforded to steel by the introduction of zinc slabs in intimate contact with the steel, and as near as possible to any corroding influence. The degree of protection varies inversely with the distance from the zinc slab, so that if the steel could be covered all over with a large number of of very small zinc slabs, it might be anticipated that whereas the

* From "The Corrosion Resistance of Metals and Alloys" by McKay and Worthington.

zinc itself would be attacked, complete protection would be afforded the steel. This, in fact, is just what happens when steelwork is zinc sprayed on all exposed surfaces. The commonest material requiring protection by metal spraying is, of course, steel, denoted in the galvanic series by its main element iron. Anodic protection of steel is afforded only by those metals appearing higher on the list, and aluminium, zinc and cadmium are all employed for this purpose, although cadmium to a much lesser extent on account of its high cost. It may at first sight appear absurd to use a metal which will corrode in order to protect another metal. The explanation is that while the initial attack on exposed zinc or aluminium will be rapid, the oxides which form during the attack stifle further action until they themselves are either mechanically removed or dissolved so as to expose more of the protecting metal. Protection may thus be truly described as being afforded by the zinc or aluminium oxide respectively, the balance of metal remaining in the coating acting rather as a resorvoir to supply further oxides to replace losses. It is unfortunate that rust, the oxide of the commonest metal, iron has no such advantages, but it is an easy matter to replace it with a surface which will behave in the manner described.

It has already been noted that sprayed metal is porous, but this provides no great difficulty when using the coatings to give anodic protection because the formation of the zinc or aluminium oxide seals the pores and prevents exposure of the steel base. While aluminium may claim certain advantages, especially in industrial atmospheres, because its oxide is not so readily soluble in rainwater, zinc is the metal recommended for protection of steel against sea-water corrosion both for immersion and for very salt atmospheres. For immersion in hot fresh water—particularly hard water—aluminium is the better coating, although it gives disappointing results with some soft waters. Zinc, however, is not satisfactory in any water at temperatures exceeding 125 deg. F.

Anodic coatings fulfil two useful functions in service, after initial attack has occurred; they protect a surface mechanically (as indeed most coatings do), and in addition sacrifice themselves in such a manner as to continue to give protection. Even if damaged, as by scratching, the oxide tends to bridge any gaps, and if too great to be bridged the very presence of the anodic metal in close proximity and intimate contact, will retard the corrosion rate of the exposed surface.

Cathodic Coatings. Cathodic coatings are sometimes employed for protecting parts from corrosion. Because the average engineer has a working knowledge of how metals behave in the "solid" state, he is apt to expect too much of cathodic metals when sprayed. This is largely due to the porous nature of sprayed metal and unless considerable thicknesses of cathodic metals are employed, coatings fail by reason of attack on the parent metal through the pores of the sprayed coating. Reverting again to the galvanic series, it will be noted that there is an extensive list of metals below iron which are all cathodic to iron—some indeed, such as copper, are pronouncedly so. Consider, therefore, what happens when a thin coating of copper is sprayed on iron or steel. The electrolyte, which may be rainwater, seawater or perhaps something more corrosive, will find paths through the copper by which it can attack the steel. Since the steel is anodic to copper, the copper will tend to be protected by its contact with the steel, and the steel itself may be the more rapidly attacked. The sacrificial action so laudable in zinc or aluminium with respect to steel is the source of weakness when the steel becomes the anode and is itself sacrificed. Cathodic coatings if too thin and porous, or having pinholes, scratches or other means of exposing the anodic base material may accelerate corrosion rather than retard it. Once this basic principle is properly understood, it follows naturally that cathodic coatings such as stainless steel, tin, lead, nickel, bronze, etc. must be rendered impervious to the corroding influence either by the thickness of the coating employed when applied to machine element reclamation work, or by sealing the porosity in thinner coatings—a course frequently resorted to when applying coatings to resist corrosion.

Sprayed tin, which is quite an expensive metal, requires approximately 15/1,000-inch thickness to prevent access by most liquids, and even then must be scratch-brushed with a stiff wire brush to close mechanically the pores as far as possible. With liquids of low viscosity even thicker coatings are necessary. However, even half this amount can be used satisfactorily if the pores are originally sealed by spraying, brushing, or dipping with a suitable sealing medium to withstand the particular conditions of service. A type of bakelite varnish is sometimes employed for this purpose, while on other occasions chlorinated-rubber may prove more suitable. Sprayed lead is often similarly sealed. It is less usual to seal nickel, copper, and their alloys, as these are largely restricted to building-up worn parts where the coating thickness will be sufficient to prevent contact between the base metal and the electrolyte but where excessive pressures are anticipated, as with hydraulic rams, linseed oil mixed with 5 per cent by volume of cobalt liquid drier is found suitable.

Coating thickness. It will be obvious from the foregoing that a great deal depends upon the thickness of coating employed and the total life of anodic coatings is very largely proportional to their thickness. Aluminium and zinc are generally applied in thicknesses varying from 0·004 to 0·012-inch according to the conditions of service and life required. With cathodic coatings the thickness is more critical in that below a certain minimum, which will vary according to circumstances, such coatings are useless by reason of their porosity while above that minimum, except for a reasonable margin of safety and allowance for mechanical loss by abrasion, if any, additional life may not be achieved by increasing the thickness. Before using cathodic metals for coating work, therefore, one is well advised to consult suppliers of equipment for their recommedations until sufficient experience has been gained within one's own particular field. The measurement of thicknesses of non-magnetic coatings on to magnetic bases and, of course, more particularly the commoner coatings of zinc and aluminium, are generally determined by either an electric layer thickness meter or a magnetic meter which respectively interpret electrostatic capacity of a small area of the plate, or similarly, the interference of the magnetic field from a small permanent magnet, so as to give the mean thickness of the part of the coating being tested, in thousandths of an inch. However, most commercial work is carried out very uniformly to the requisite thickness by weighing an amount of wire for a given area until the operator has sufficient practice in applying coatings to know when he has deposited the requisite amount. Uniformity of thickness is achieved much more easily than might be anticipated. The ribbon of metal deposited in a single pass of the spray gun tends to be thicker towards the centre than at the extremities, so that parallel strokes should be applied, each successive ribbon overlapping the previous one by approximately one-third. With modern equipment it is usual to arrange the speed of movement of the operator to coincide with a deposition of 0·002-inch thickness for each pass, and for subsequent layers to be applied by making passes at different angles. Where two coatings of 0·002-inch each are to be applied, the second is applied in a direction at right-angles to the first. If three coatings are used it is convenient to make the angle 60 deg. between each coating. It follows that the greater the number of coats applied, the more nearly will uniformity be achieved. For flat surfaces ¾lb. zinc or 1¼oz. aluminium will produce a coating of 0·005-inch thickness and *pro rata.* On narrow sections and on edges due allowance must be made for losses, but in practice it all becomes much easier than its description may imply. If measurement of thickness is read by a micrometer, then additional allowance must be made for the characteristic matt finish, so that the average thickness is somewhat less than the apparent thickness read by such means.

Finishes Applied Subsequent to Spraying

Painting. The matt surface of sprayed metal renders it very suitable for bonding paint, and unlike galvanizing, no "weathering" is called for since no acids have been employed in producing the coating. The success of the painting will largely depend on the choice of paint, which must be suitable for the matt surface and selected as appropriate to the particular metal of the coating. The former consideration applies to all sprayed metal coatings and in general it is important that the paint must not be so thin that it will be absorbed in the pores of the sprayed metal or so thick that it will bridge across the "valleys" in the matt surface. Quick-drying paints should be avoided, except when a very thin coating is to be employed, e.g. a lacquer finish for appearance. When paint is to be applied to sprayed zinc it is recommended that zinc chromate or iron oxide-zinc chromate paint be used, and these should preferably be in long oil varnish vehicles or those made with bakelite and glycerol-phthalate resins. Bituminous base paints are sometimes used but are not generally regarded as being equally satisfactory. Read lead must not be used with zinc coatings nor must anti-fouling compounds be employed with them since most of these contain metallic copper which would result in rapid corrosion. Paints which are suitable for use on zinc coatings are generally suitable for aluminium, and in addition pigments such as aluminium, iron oxide, red lead, titanium oxide and zinc oxide held in durable vehicles may be used on top of sprayed aluminium.

Coatings used to support a sealing medium. Reference has already been made to sealing metal sprayed coatings, but there is another aspect of this which involves the use of the sprayed metal largely as a vehicle to hold a second material. It has been found, for instance, that protection of tanks to hold certain edible oils is afforded just as much by an extremely thin coating of, say, 2/1,000-inch thickness of aluminium as by a coating many times thicker, but only if, immediately after spraying, the coating is saturated with the particular oil which it is intended to carry in the tank. The sprayed metal holds the oil in its pores by capillary action so that even when the tank is emptied a layer of oil will be interposed between the atmosphere and the mild steel tank, so preventing corrosion. Another somewhat similar example is the use of a very thin coating of zinc or aluminium, followed by brushing, spraying or dipping with a solution of zinc chromate. The zinc-chromate held in the pores inhibits corrosion so long as it remains present.

Steel Hulls

Reverting to Fig. 1 showing the zinc spraying of a ship's hull this work proved unsatisfactory. Because the vessel's bottom had previously shown only negligible corrosion it was not zinc coated. Thus the only wetted zinc was a narrow band in the region of the water line, forming a relatively small anode with metallic and liquid paths to the large cathode formed by the steel bottom. Rapid attack on the ship's sides first destroyed the paint and then consumed the zinc, though the comparatively dry zinc coating on decks and superstructure was scarcely damaged. Thus failure to appreciate the factors governing corrosion made it necessary to re-spray the sides and eventually to metallize the ship's bottom although it had previously not been thought necessary. Some of the details already discussed can now be applied to this important application of the process. The recommended procedure is as follows:—

(i) Where small vessels are concerned considerable advantage may be derived from carrying out the work under cover when possible because otherwise weather conditions can cause delay.

(ii) It is necessary to rig up staging for the work and the author has found it well worth while rigging tubular scaffolding so as to eliminate delays in moving from one part of the hull to another. This is particularly advantageous in that it permits blasting to be carried out in one area and then continued in a second area some distance away while metal spraying can be carried out immediately after each section has been blasted without holding up further blasting work.

(iii) Tarpaulins are arranged around the scaffolding so as to form cubicles to minimize risk from the flying abrasive.

(iv) A sharp angular flint-grit or other sharp sand of between 12 and 20 grade is employed. Steel grit would be quite effective, but there is usually so much loss of abrasive on this class of work that it is much cheaper to employ a suitable sand. Sea sand is smooth and unsuitable.

(v) Each part of the work to be treated is blasted to a rough and silvery finish, and if existing rust is very considerable it may prove economical to carry out preliminary chipping, or in some cases flame cleaning, though the latter is not usually necessary, and in any case only in certain comparatively small localized areas.

(vi) Zinc is used for ship's hulls because it is superior to aluminium for immersion in sea water. It is recommended that a hull be metallized all over since leaving part untreated may call for too much "sacrifice" by the zinc. In any case all the immersed surface must be treated.

(vii) The spraying of each section must be carried out immediately after blasting. It is not satisfactory to leave an area in the blasted condition overnight. The spraying should keep time with the blasting. The speed of blasting is dependent on the volume of compressed air available. Modern metal spraying equipment, which can deposit up to 55lb. of zinc per hour permits metallizing at a rate exceeding the highest blasting rate.

(viii) Where an area must be left for an hour or two zinc should first be applied lightly over the whole surface to be left and the work completed as soon as possible thereafter. Even a thin zinc coat will prevent early damage to blasted surfaces, otherwise the blasting should be carried out a second time.

(ix) The recommended thickness of zinc for steel hulls is 10/1,000 inch and this represents the use of ½lb. zinc wire per sq. ft.

(x) Vessels having steel propeller shafts and cast-iron propellers may have the exposed part of the shaft and the propeller coated with zinc similar to the treatment of the hull, but vessels fitted with bronze propellers and shafts must have such parts coated with monel metal. The thickness of monel metal on the bronze shaft and propeller should be 12 to 15/1,000 inch when finished. If the propeller shafts are drawn for this purpose then the spraying of the shafts can conveniently be carried out in a lathe and they can be finished-machined so as to form a sleeve of monel metal similar to the building-up work described earlier. If this is not possible, then the preparation of the shafts and of the propellers needs much greater care than is the case with the work on the ship's hull, very considerable roughness of the base material being required to make a satisfactory bond for the monel metal. These remarks apply particularly to the edges of

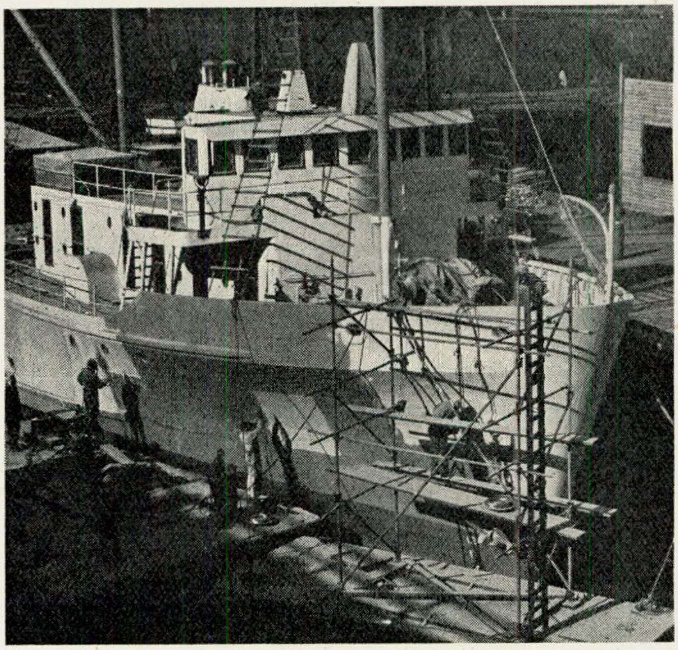

FIG. 21.—*American fishing vessel afloat being zinc sprayed from pontoons*

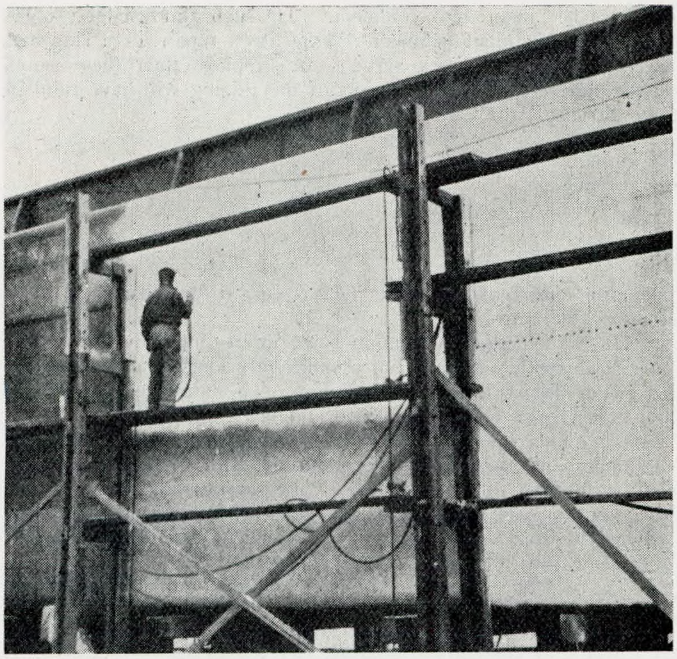

FIG. 22.—*Early example of steel hull being sprayed with zinc*

propeller blades, and it is safer to employ either Sprabonding or Fusebonding on the shaft and propeller unless a very high standard of blasting can be achieved.

(xi) The subsequent treatment of the hull is, of course, as described in the section dealing with painting of zinc coatings, particular reference being made to the remarks concerning the use of anti-fouling compounds. Sprayed zinc itself has some anti-fouling properties in cold waters.

(xii) Generally it should be observed that the life of the zinc coating is very largely proportional to its thickness, so that areas of maximum attack as, for instance, the "wind-and-water" area just above water level, may have a slightly thicker zinc coating, or any other part of the vessel where corrosion is found to be particularly rapid. In the same way it is possible to economize somewhat on areas which experience has proved to be less rapidly attacked.

The zinc spraying of steel hulls has been carried out much more in America and certain European countries—notably Sweden—than in Great Britain, although much has been done here during the post-war period. Fig. 21 shows an American fishing vessel being zinc sprayed for protection. One pre-war example of sprayed zinc on a vessel impressed the author very favourably. A dredger had part of its deck metal sprayed where the action of salt water plus abrasion by ballast falling on the decks during unloading had very much thinned the deck plates until there was definite danger of failure. The vessel discharged ballast nightly polishing part of the deck in so doing. The following day on putting to sea to refill with ballast the deck rapidly rusted, so that the cycle of rusting and polishing was in operation daily. It was considered at the time that zinc might not sufficiently well resist abrasion, but the comparison was not between zinc and steel, but between zinc and rust. The zinc spray was regarded as highly experimental, but it performed better than had been hoped and is still giving good service. A difficulty was encountered recently when one of some barges that were zinc sprayed rapidly threw off the subsequent coating of paint. It was found that the paint had been applied while the sprayed zinc surface was covered with frost, and of course, as might have been expected, this interposed layer completely destroyed all chances of a good bond between the paint and the zinc. But this happens when paint is applied to frosted steel plates also.

Some partial failures of zinc sprayed hulls occurred before the necessity to coat the bronze propellers and shafts with monel metal was fully appreciated. Zinc coating the bronze parts is not a reliable alternative, since mechanical damage to the coating—a thing always likely to occur with a propeller—rapidly results in coating failure, though zinc, sealed with chlorinated rubber has been used with some success. Similar damage to a steel hull, or indeed to a cast-iron propeller, does not have the same dire results. When the various points already made are appreciated by those in charge of metallizing a ship's hull, the process proves not only reliable but of lasting value. Fig. 22 shows a large American coal barge being metallized in 1934 and the most recent reports indicated that it was still giving excellent service.

Protection of Miscellaneous Parts

Steel tanks and holds are regularly metal sprayed. There is, however, no complete answer to such a combination as oil fuel on one trip followed by salt water ballast on the next. Where tanks are employed for one specific purpose, metal spraying usually gives adequate protection. Deck fittings are regularly treated. It is interesting to note that aluminium fittings for yachts, etc. have been given added life by spraying with high-purity aluminium, the oxidized surface so produced imparting some immunity from salt water attack. Furnace parts such as air cones for oil-fired boilers, and fire bars in coal-burning boilers have been protected against heat corrosion by spraying with high purity aluminium. Refrigeration rooms, including coils and fittings, are often zinc sprayed to prevent corrosion. The list, of course, could be extended to include most items subject to corrosion. Fig. 23 shows a batch of cowls and hatchway covers protected by metallizing with zinc. Many complete steel launches have been treated in this

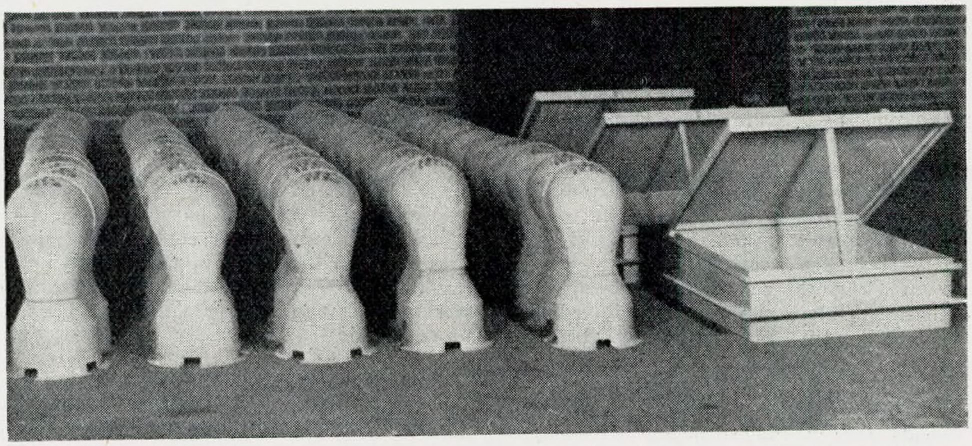

FIG. 23.—*Batch of cowls and hatchway covers protected by metallized zinc coating*

manner, and ship's lifeboats of all-steel construction with their constant exposure to heavily salt laden atmosphere provide another excellent example of the usefulness of the process.

This paper seeks to stress both the limitations and usefulness of metal spraying in ship-work, so that those who would use it may be justifiably confident. If such knowledge sometimes enables a chief engineer to expedite a repair, or a shipyard executive to give better service to shipping, then these notes on the marine engineering aspects of metallizing will have fulfilled their purpose.

Discussion

Mr. F. A. Rivett (Visitor) said that he felt that marine engineering was one of the fields in which metal spraying could be of most outstanding value. The author had dealt at length with the subject of building up by metal spraying for the reclamation of worn parts. On this subject, he was, of course, an authority, and there was no doubt that the many outstanding examples of satisfactory build-up jobs which he had described indicated the big fields for this process. He himself was more interested in metal spraying as a method of surface treatment of steel to prevent rusting, which was, of course, a chronic trouble in marine work.

Using the Schori powder spraying process, they had in recent years done some work which he thought would be of interest to mention. They had found that there was a big demand for the zinc spraying of steel lifeboats, principally because the process could be carried out after the lifeboat had been completely fabricated and because the thick coatings of zinc applied gave long protection against corrosion. Perhaps he might mention in passing the lifeboats of the Orient Line S.S. *Orcades* which were zinc sprayed in this way and were subsequently adrift for many months after the liner was sunk. The lifeboats were finally collected, examined, and put into service again as they showed no corrosion.

More recently his firm had zinc sprayed more than 100 welded craft for the Admiralty. Some of these were 30-feet and some were 40-feet launches. They applied 0·006 inch of zinc above the waterline and 0·012 inch below. Because of the rust-proofing it was possible to build the launches of lighter gauge plate than normally used, with a considerable saving in weight and increase in speed.

Much work which was being done at the present time in the Bristol Channel would, he was sure, be of interest to all marine engineers. The necessity for keeping the deep tanks of cargo ships in a clean condition was well known, and the very short life of paint on the surfaces of these tanks due to alternate exposure to sea-water and cargo was well known also. It had been found that the shot blasting and zinc spraying of the surfaces of these deep tanks followed by the application of zinc chromate paint plus an appropriate finishing coat, kept the tanks in a clean condition for a much longer period. The initial cost of shot blasting and zinc spraying was, of course, higher than painting, but the economy of protecting deep tanks in this way became obvious when the cost of the number of repaintings which otherwise would have been necessary was taken into account.

This work was being done on an increasing scale. In the first place there was some difficulty with dust produced during shot blasting which interfered with work on other parts of the ship. This had been overcome, at least as far as working inside the vessel was concerned. There was still some difficulty about dust produced during shot blasting of the outside of the hull, but this matter was having close consideration and would be remedied.

The author had remarked that it was not satisfactory in general to zinc spray only the plates around the wind and water line of a ship, because, as one then had a large cathode and a small anode, the rate of attack on the zinc was high resulting in only a short period of effective rust prevention. He agreed that, theoretically, this was correct, and it would also apply where the hull was not painted or if the paint coats on the hull were not maintained. However, it appeared from the experience of his firm that, provided a correct painting technique was used after spraying and the paint coats were maintained in a good condition, considerable benefit could be obtained by zinc spraying the plates on the wind and water line of a vessel, no doubt because of the insulating effect of the paint. However, it was better practice to spray the entire hull.

He wished also to mention some interesting work on an oil tanker which they carried out a sufficiently long time ago for the success of the work now to be obvious. The tanker was a German ship taken over for repatriations and being reconditioned in this country. There was heavy pitting of the plates in the bottom of the tanks and these pits were built up with sprayed zinc until they were flush with the surface of the surrounding plates. They also zinc sprayed the surrounding steel work. After two years' service the zinc was intact and in excellent condition. Another interesting job of building up deep pitting was the rudder of the S.S. *Queen Mary*. In 1937, after she had been launched about one year, she was dry docked and it was found that some heavy pitting had occurred over a section of the rudder. The owners were afraid that if this attack continued it would lead to puncturing of the rudder. Shot blasting and zinc spraying was done, filling up the pits and bringing the surface flush with the surrounding steel. He had the opportunity of examining this work when the ship was again in dry dock early in 1947, ten years after it had been done, and he found that although there was some general corrosion, the zinc which had been sprayed into the pits of the rudder was still there and in excellent condition. This was all the more remarkable because the rudder was exposed to the high water speed from the screws.

Mr. F. D. Clark (Associate Member of Council) asked what was the attitude of the classifiication societies to the metallizing process for marine repair work with special reference to corroded main engine crankshafts and tail-end shafts?

Mr. G. T. West (Visitor) said that when discussing particle size it was pointed out that a great deal of the bonding was due to the preparation of the particles. He imagined that the metal should be in a plastic state or in just about that state, when it was imparted to the surface. It was a rather important point to see that when spraying was carried out the metal was in a plastic state. The firm he represented had done a considerable amount of metal spraying and had found it accepted by people with different ideas. In one instance the doors of certain bulkheads had been damaged after the ship was in collision. There was a gap between the door and the base when the door was closed due to slight distortion during welding and this gap was built up by metallizing in order to obtain a watertight joint when the door was closed. One inspector, however, said that with the vibration of the ship it would fall off, but another inspector from Lloyds came up and sanctioned the repair. That was done four years ago as a temporary operation and had been successful. It was an instance of two expert people taking an entirely different view of the possibility of metal spraying.

The author had done much in trying to break down the prejudice which some people entertained against metal spraying. If any failure did occur with metal spraying he would venture to say that in 99·9 per cent of cases it was entirely due to bad workmenship or to bad preparation and not to the metal spraying process itself.

Mr. J. W. Oswald (Visitor) said that his own firm had been concerned for twenty-five years or so in electro-deposition. Electro-deposition and metal spraying were formerly somewhat rival processes, but the claims for each had now reached a certain maturity and it was found that they were not so much rivals as complementary processes. There were some things which could be done best by metal spraying and others by electro-deposition. The author in many cases could carry out the job on the site where other jobs had come to his own firm. He thought that metal spraying could carry out work which electro-deposition could not do and vice versa.

He wished to ask the author what he would do on a job that had been already metal sprayed. Was it possible to re-metal spray on the old spraying or had this to be removed before they could start again? Was it possible to build up interrupted surfaces? He noticed in the paper a reference to spraying a shaft which had a key-way. Was it necessary to spray right through the key-way or could they have that surface left interrupted?

Mr. W. G. Ireland (Associate) said that in the course of the discussion nothing had been said about boilers which were surely a subject to be considered. Were there any technical difficulties against using metal spraying internally in the boilers so as to resist corrosion? He was referring to boilers used on shore, particularly the smaller multi-tubular ones for which the feed water was largely untreated and in which the internal surfaces were accessible only when the boilers were being retubed. The metal spraying process seemed suitable for arresting external wastage in the early stages, but was the system portable and economical enough to justify its use in such cases?

Mr. A. Logan (Vice-Chairman of Council) said that if worn components could be economically restored to their original condition and would give the same degree of reliability, then a very important advance had been made in the engineering world. Most of them had had experiences with metal spraying, some good, and some not so good. From the instructive information given that evening it might now be possible to decide just why their particular job went wrong.

In dealing with the shaping of the particle the author said:

"On impact, and according to varying circumstances, the kinetic energy of the particle must largely change to heat, and thereafter, in most cases it will be in intimate contact with a much larger and cooler body, so that rapid quenching results".

What were the varying circumstances through which the particles passed, and would such particles form the best interlocking shapes irrespective of whether they were sprayed on to, say, cast-iron or a soft wood? It was very interesting to hear just how effectively the particles did interlock, but most engineers would prefer to see the locking on a more positive basis.

Accepting the satisfactory character of the interlocking, did vibration or shocks not break down some of the interlocking edges and cause a slackening up process?

From what the author said in dealing with the bonding of the sprayed metal, it was evident that this was a most important stage of the process, and that the "Fuse-bonding" or "Sprabonding" seemed to be the most suitable methods. Both methods unfortunately had their difficulties which prevented them from being employed in all cases. The spray-welding also sounded a most reliable method, and generally he would prefer to see some chemical union—should he call it?—of the two metals as was carried out by that method.

From what was said still later in the paper it was to be noted that the sprayed metal had very poor shear qualities due no doubt to the mechanical interlocking of the particles. With this in mind they could decide what components could be effectively dealt with. Briefly, he felt that the success of the work depended upon the preparation of the articles, the choice of bonding method, and the spray-gun operator. Where the sprayed metal had to serve as a filling medium there was not the same risk of dangerous disintegration, but very special care would have to be taken when the sprayed metal was subject to vibration, which in time might cause the particles to lose their interlocking edges.

Mr. H. Freeman (Associate Member) said that as far as he was aware there were two schools of thought on the metal spraying process. One maintained that the finer the atomization the better the bond and the other that fine atomization was not in itself of material benefit considering the greater economic rate of deposition of the larger atomization.

With finer atomization there was also a greater degree of oxidization to contend with.

He wondered whether there had been a range of tests from fine to large atomization to ascertain the economic rate of deposition?

Mr. E. Wilson (Visitor) said that on the question of shot-blasting in his experience the general equipment in use was approximately 30lb. per sq. in. pressure, whereas the best results for metal spraying were obtained about 70lb. per sq. in.

He would like to mention one or two examples of metal spraying which might be of interest. One was a bronze drum about 4-feet diameter and 4-feet long which required a polished face on the diameter. The casting when machined had a number of minute flaws so it was decided to metal spray it. The preparation was done by machining a fine thread of approximately 20 to the inch with a rough finish and the drum was sprayed with bronze to a depth of approximately ⅛ inch. This cylinder was turned up and polished and gave good results.

Another example was the use of zinc spraying parts of torpedoes which were approximately 21-inch diameter and 4-feet long and had to be sprayed to a depth of approximately 0·006 inch and then polished. This operation was carried out throughout the war under Admiralty inspection. He had one point to put to the author, namely the building up of a machined flat face. He found it very difficult to get a good bond.

Another point he wished to refer to was the use of aluminium. He had used a considerable amount of this on pots for heat treatment and it had been most successful. A coat of aluminium was sprayed on the shot blasted surface and heat treated to approximately 800 deg. C., again shot blasted and sprayed and heat treated again. This had prolonged their life by approximately 100 per cent.

Mr. T. P. Gibson (Visitor) referred to metal spraying of Diesel cylinder liners. He was speaking of liners which were hydraulically tested when new and then left to atmospheric conditions. How did metal spraying stand up under service conditions? How did it react later on, after the testing, and after it had been in service for some time?

Mr. J. Pike (Visitor) said that from the marine engineer's point of view many talks on preparation had taken place during recent years. They submitted that screw cutting of shafts might show stress and fatigue. There had been no experience of this actually happening and this preparation prior to metal spraying was generally used in most cases. The author had suggested that they could not carry on with the use of "Sprabond" because of the dollar position—the wire coming from the U.S.A.—but now sprabonding was being done by means of molybdenum, which was very easily obtained in this country.

Mr. S. A. Hunn (Visitor) wrote that mention was made on p. 04 that "The human element enters into sand blasting to such a degree that it cannot be considered reliable . . .". Although this appeared in the first section of the paper he wondered to what extent it also applied to the preparation of the surface for protective coatings. He believed that sand blasting machines had been developed in America that recovered most of the abrasives, and it would be interesting to know whether these machines were suitable for ships' work such as preparation of the hull surface when in drydock, and also whether any of these machines were yet available in this country.

It was interesting to note the remarks concerning the necessity for completely spray coating the hull of the ship with zinc due to the failures that had been encountered when only coating a portion of the hull. In this connexion it was stated on p. 253 that "some partial failures of zinc sprayed hulls occurred before the necessity to coat bronze propellers and shafts with monel-metal was fully appreciated", and not knowing the full background he was not clear whether this application was to prevent corrosion of propeller, shaft or hull—in the case of the latter one might have imagined that the zinc sprayed coating would have been sufficient protection.

Mention was made on p. 252 that "Red lead must not be used with zinc coatings, nor must anti-fouling paints be employed with them since most of these contain metallic copper which would result in rapid corrosion", and in this connexion he would be pleased to know what types of paint were recommended for application between sprayed zinc and the anti-fouling coating.

The reference on p. 253 to the cycle of cargoes and ballast carried on a tanker no doubt referred to gasoline and not to oil fuel because he understood that no corrosion troubles were experienced with the latter.

As there appeared to be a considerable quantity of occluded oxide film in a sprayed coating it would be interesting to know whether the presence of this oxide had any effect on the electrical conductivity between the steel and the exterior of the coating.

Was it known how any of the new zinc-rich paints such as "Zinc-Rich Polystyrene" compared in performance with zinc sprayed coatings on ships' hulls.

Finally, it was appreciated that the condition of the metal to be sprayed determined to a considerable extent the costs involved in preparation and actual spraying but it would be very interesting to have some idea of the maximum and minimum costs likely to be experienced for example, in spraying a ship's hull with zinc.

Lieut. Col. N. McCallum, B.Sc. (Member) wrote that, in his opinion, the main virtue of the paper lay in the note of caution which pervaded it. Many specialized processes have been cut off at the roots by too glowing a description or by too much optimism at the outset, but all actual and potential users of metal spraying process were duly warned that discretion must be used in its application. He fully agreed with the author that the process had many outstanding points of merit where speed, serviceability and cost were concerned, but each particular application must be fully analysed.

In the works with which he was connected a considerable amount of work was done on the reclamation of worn components, and three building up processes were in general use—(1) gas and electric welding, (2) hard nickel and chromium electro-deposition, and (3) metal spraying. In deciding which process should be used the following considerations were made—(a) the service to which the object was to be put, (b) type and degree of preparation required and, in the case of metal spraying, whether the preparation would unduly weaken the object, (c) type and degree of machining required both before and after building up, (d) the manner in which the object had to be stressed in service, (e) cost, to which was allied the quantity to be done. The ratio of work given over to each of the processes is at present roughly 5/3/1.

The paragraph on particle hardness gives interesting facts but drew no conclusions, but that might be due to the lack of experimental and analytical data available. He would commend to the author's attention the excellent work carried out by Taylor* on the micro-hardness testing of metals whereby accurate hardness figures could be obtained on metal specimens at intervals of 0·02 mm. and less. Loadings could also be as small as 5 gm. at which loads accurate readings were possible and local disturbance small.

The stress which the author placed on surface preparation was well warranted and that was, in his estimation, the precise point at which the process succeeded or failed, and too much attention could not be given to this when it was realized that the bond between the two metals was of a mechanical nature only. The preparation of soft metals presented no difficulty provided standard methods were used, and his experience had shown that grooving with a round-nosed tool and afterwards breaking down the crests with a knurl was the best. Where a thin coating was required for building up a ball race housing or seating, grit blasting sufficed.

The preparation of hardened surfaces presented a more difficult problem, the difficulty being to provide an efficient keying surface. The fusebonding method was simple in operation and was effective. An examination of Fig. 9 showed a wide margin of material which was the electrode material deposited as a result of the arcing of the current between the electrode and the parent metal. A very strong bond resulted as there was penetration and chemical combination between the two metals. The extent of the keying surface was clearly seen and he had specimens which show this keying action to an even more marked degree. His experience with sprabonding was very limited and, while the strength of bond between the sprabond and the parent metal was understandable, perhaps the author could explain why the efficiency of the bond between the sprabond coating and the sprayed metal was so high, especially as the sprabond surface displayed little more irregularity than would be obtained by chemical etching or grit blasting. The explanation might well lie in that the sprabond coat presented a random distribution of "splashed" globules, whereas the grit blasted surface comprised mainly open pinnacles.

There was one other matter respecting preparation which he did not think the author had mentioned, and that was the link between preparation and spraying. For small components he had found it advantageous for the operator to do both the preparation and the spraying, the interval between them being as short as possible. The method of having surfaces prepared in a machine shop and then transported to the metal spraying department could not be deprecated too strongly, and if it is essential, by virtue of machining facilities, that the preparation was done in the machine shop, then the spray plant and the operator should be transferred to the job there.

The hard ring formed at work shoulders mentioned by the author could be a very real nuisance in subsequent machining, and partly for this reason and partly for general finish he advocated a ground finish wherever possible. The fact that the flattened particles of sprayed metal were mounted "on edge" also meant a higher concentration of oxide as the relative oxide content in a flattened particle was higher in the thinner section. It would be interesting to know whether the author had considered, or had experimented with the principle of enclosing the metal spray in a shield of inert gas, e.g. argon. It would appear that many possibilities would be opened up if this oxidation, which was detrimental both to surface finish and to cohesion, despite the author's theory of oxide cementation, was eliminated. There would also be a reduction in porosity, but to what extent it was difficult to visualize.

Finally, he would quote the maxims to which success in metal spraying could be attributed:—

(1) Meticulous preparation wherever possible, ensuring the preparation and spraying be done by the same operator wherever possible.

(2) For steel deposits use a high carbon steel when proper machining facilities were available.

(3) Grind finish.

(4) Cautious application of the process on its merits.

Mr. J. G. Robinson (Member) wrote that the first point that he would remark on was that the small particles of sprayed metal were not fused together, their adhesion depended mainly upon a "mechanical interlocking of the torn edges of the particles". Here then was a serious weakness.

In Fig. 4 the author showed that the spray gun should be arranged 4 inches to 10 inches from the area to be sprayed. In addition to this regulating distance there were other varying circumstances which would influence the force at which the particles struck the target, and it would not therefore be easy to produce the best particle size and shape. Apart from this factor, the torn edges were the most highly stressed parts of the particles, stressed beyond the normal limits (otherwise the torn edges would not be there), so it would appear that the sprayed metal was composed of a proportion of sound metal (core of particle) and the highly stressed jagged interlocking shapes.

From these statements, it would appear that the sprayed metal should have very little elasticity or tensile stress properties and should not therefore be used for any purpose where such properties were likely to occur in any magnitude.

Could the author supplement the information given in Table 2 by recording the elongation and tensile strength of the respective

* E. W. Taylor, 1948. Jl. Inst. Metals, Vol. 74, p. 493, "Micro-hardness Testing of Metals".

wires before they were atomized in the spray gun? With such information, it would be possible to decide just how effective the mechanical interlocking really was. Further, could the author estimate the percentage of highly stressed metal in each sprayed particle.

The author on several occasions made reference to the possibility of the sprayed metal cracking. Just how serious was this risk? It was of course understood that if experts did the work, then the degree of reliability would be greatly enhanced, but what happened when the ordinary spray gun operator did the job?

The idea of reclaiming worn parts such as cylinder liners, crankshafts, tailshafts, etc., appealed equally to all engineers, but in the marine sphere where large capital was invested in a ship, a very reasonable guarantee of success must be given otherwise the demurrage incurred by the vessel for repairs or renewals would far outweigh the apparent initial economic gain.

What was the attitude of the Classification Societies to this reclamation practice? They invariably recommended that tail shaft liners should be renewed when they were worn to any marked degree, so it would appear that they did not accept metal spraying for such important parts.

Ship repairers in this country were not very enthusiastic about recommending the reclamation of worn parts which were subjected to heat variation or stressing and as such people were in a position to obtain far more first-hand information than the individual marine engineer, it would appear that their experiences did not confirm that metal spraying of the important parts referred to, had reached the stage of perfection required for marine work. He was aware that certain ship repairers in this country prohibited the use of metal spraying for any working part, i.e., any part which had movement relative to another.

In conclusion it would appear to him that metallizing of certain parts carried out by experts with the proper facilities could be satisfactory, but reclamation of worn parts on the scale envisaged in this paper was with the present technique rather optimistic. Time would however show whether this opinion was correct or not.

Com'r(E) W. R. Stewart (Member) wrote that the paper emphasized the mechanical nature of the bond betwees the base metal and the coating in the case of the simple sprayed-on coat. On this basis it would seem that, providing the preparation of the base metal surface had given sufficient mechanical anchorages, the absolute cleanliness of the base metal before spraying would not be of any great importance. On the other hand when dealing with "preheating" the author said that oxidation must be avoided and when discussing the spraying of ships' hulls it was mentioned that spraying should be carried out immediately after shot blasting inferring perhaps that otherwise surface oxidation might take place and in some way spoil the adhesion. It would be interesting to have the author's views on what degree of cleanliness was necessary before spraying, i.e., what was the effect of a thin oxide film or of a residual layer of oil or grease left after the part to be sprayed had been "wiped clean".

He had had some small experience during the war of attempting to reclaim parts by metal spraying on board one of H.M. ships while operating in the Pacific area. The parts concerned were mainly brass or bronze spindles from small centrifugal salt or fresh water pumps which had become deeply scored in way of the gland packing. The degree of success achieved varied but in general they were not very successful probably owing to lack of experience and knowledge of the process and the difficulty of the overall conditions. At the time most of the failures were attributed to lack of sufficient cleanliness of the surface since, after shot blasting or rough turning, it was not always possible to metal spray at once. In consequence the part had to be "cleaned" again before spraying and it was felt this cleaning by wiping with rags might have left a surface film which spoilt adhesion. It would be interesting to have the author's views on this possibility.

He would also like to have the author's views on the general suitability of the metal spraying process for this purpose of reclaiming journals in way of soft gland packing. It frequently happened in practice that a gland was temporarily over-tightened in an attempt to stop leakage resulting from bad packing or a spindle not running true. This caused considerable friction and heating which would be noticed eventually and the gland slacked back. In the case of a plain metal surface no great harm would have been done but it seemed possible that a sprayed metal surface might fail quickly under these circumstances. Owing to the many layers of oxide interspersed with the metal in a spray coating it was to be expected that its coefficient of heat transfer would be low—at least in a direction normal to the surface. Therefore the temperature rise and expansion of the outer layers would be greater than in the case of a solid metal spindle, since the heat generated by the friction must be carried away through the spindle in the absence of appreciable leakage. Hence the expansion due to heating would tend to enlarge the circumference of the outer layers and so cause a tensile stress normal to the surface to be set up in the sprayed coat which was weakest in this direction and might therefore fail more readily than would have been expected from its normal ability to withstand rotary shear.

Incidentally the presumed low coefficient of heat transfer of a sprayed coat in a direction normal to its surface might lead to useful applications in cases where this property was desirable to reduce heat flow.

Mr. R. Zubiaga, B.Sc. (Member) wrote that due to scarcity of steel forgings and bronze in the last few years, metallizing was very widely used in marine engineering in Spain. At first there were objections from engineer surveyors but these were based mainly on lack of knowledge of bond strength, and results had completely eliminated suspicion. As shown by the author, using the Metco method of surface preparation the bond strength was of a very high order, even bigger than the ultimate strength of the sprayed coating. When considering for instance metallized tail-shaft liners a very simple calculation would show that the bond strength per square inch was very much higher, with any good preparation, than the surface friction per square inch which had to be resisted tangentially, and it was a much better bond than that obtained with the old way of fitting liners. If necessary, bond strength could be tested previously for any method of preparation but this was superfluous with present experience considering that metallized coatings were used very successfully not only for bearing surfaces but also for breaking surfaces.

Another objection had been the stress concentration factor due to surface preparation for spraying, in this respect the results given in Table 3 might be misleading to marine engineers. Firstly, the fatigue concentration factor on hard steels was more than in the mild steel forgings used in marine engineering, which were ideal for metallizing. Secondly, the size effect was very important in fatigue endurance limit. Considering for instance the Metco method of shaft preparation, the grooving for different diameters of shafts was the same, therefore, the stress raiser was decreasing with the increase of the diameter. For a half inch test piece $\frac{\text{Deepness of grooving}}{\text{Diameter of shaft}}$ = about 1/20 while this ratio for a 12-inch diameter shaft was only about 1/500 which was much less than the stress concentration in keyways, oil holes and some fillets.

One of the best applications of metallizing in marine engineering was tail-shaft liners. In Spain they had saved from scrap many bronze liners of shafts from 4- to 18-inch diameter by spraying on deeply scored zones or by metallizing, from the steel upwards, the end parts of liners which did not fit; also by spraying stainless steel on corroded shafts of the bare steel type.

But they were now using with great success metallized tail-shafts of a new type. The technique was different to that adopted

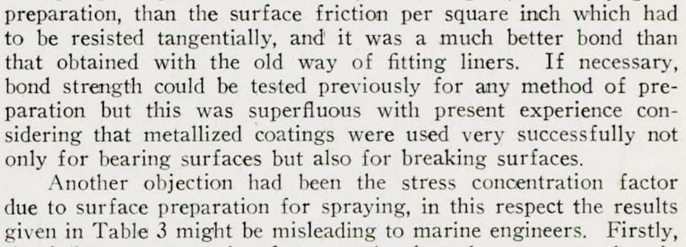

FIG. 24.—*Metallized tail-shafts*

with the old liners, the thickness did not have to be half to one inch as before—⅛ inch or less was sufficient. There was a very recent Spanish patent which fully protected the cone of the screwshaft, as shown in Fig. 24.

According to Lloyd's Register statistics about 80 per cent of screw shafts fractures come from fatigue corrosion at the cone, as this new type of liner was the only one which protected it against corrosion and it was expected that these fractures would be reduced in the future.

The salvaging and surface hardening of worn cylinder liners of big Diesel engines and of worn thrust surfaces was another use of metallization in Spain. They had had also the experience of the S.S. *Apolo* in May 1947 its 1,800 h.p. triple-expansion steam engine, when medium and low-pressure cranks became loose due to heavy weather in ballast. The low-pressure ones were metal sprayed and the same crankweb was shrunk on. This crank was fitted to the high pressure rod. The medium pressure one was renewed. In August 1947 the medium and low-pressure cranks were loose again, and the metallized high-pressure crank was still working well.

The author's reply will be published in a subsequent issue of the Transactions

Minutes of Proceedings of the Ordinary Meeting Held at the Institute on 9th November 1948.

An Ordinary Meeting was held at the Institute on Tuesday, 9th November 1948 at 5.30 p.m. A. Logan (Vice-Chairman of Council) was in the Chair. A paper entitled "Metallizing in Relation to Marine Engineering" by J. Barrington Stiles (Member) (published in this issue of the Transactions) was read and discussed. Seventy members and visitors were present and nine speakers took part in the discussion.

Mr. J. P. Campbell proposed a vote of thanks to the author which was accorded with acclamation.

The meeting terminated at 7.25 p.m.

JUNIOR SECTION

Lecture at Sir John Cass Institute

A Junior Section Lecture entitled "Photo-Elasticity" was given by J. Ward, Ph.D., B.Sc., at Sir John Cass Institute on 19th November 1948.

Approximately thirty-five attended the lecture and the majority of this number were members of the Physical Society. Dr. Ward, in his usual manner, made the lecture extremely interesting and was rewarded by a very warm expression of appreciation from the audience.

After the lecture the remainder of the session was taken up with questions on various points covered in the paper rather than a critical discussion.

Finally, Mr. F. D. Clark (Associate Member of Council) spoke briefly on the advantages of apprentices and students joining the Institute as Student or Gradute Members. It was realized however that such words were probably somewhat inappropriate since as far as was known no junior members of the marine engineering profession were present. This was indeed unfortunate because the main object of the Junior Lectures was to develop interest in the Institute and help both actual and prospective junior members of the Institute.

Lecture at the Hull Municipal Technical College

A Junior Section Lecture entitled "Diesel Engined Trawlers" was delivered by A. C. Hardy, B.Sc. (Associate Member of Council), at the Hull Municipal Technical College on Thursday, 16th December 1948. The chair was taken by Mr. F. Walker, M.C., B.Sc.(Lond.) the Principal of the College. There were over 100 students present, including many marine engineers studying at the school for their certificates of competency, and several representatives of the leading oil and engineering firms. The lecture was most appropriate for the city of Kingston-upon-Hull and was received with great interest. Mr. Hardy, after giving a general outline of the present situation regarding the application of oil engines to trawlers, explained all the advantages of this type of drive. After the lecture a large number of questions were answered by the speaker.

Mr. F. C. M. Heath (Vice-President) proposed a cordial vote of thanks to the lecturer, seconded by Mr. W. A. Rhodes (Member) which was carried with acclamation, and a very pleasant evening ended with a vote of thanks to the chairman.

ANNUAL CONVERSAZIONE

The Annual Conversazione was held at the Connaught Rooms on Friday, 3rd December 1948. The President, Com'r Sir Robert Micklem, C.B.E., R.N.(ret) and Lady Micklem, supported by Mr. R. K. Craig (Chairman of Council) and Mrs. Craig, received the 700 Members and guests between 6-6.30 p.m. Dinner was served at 6.30 p.m. after which the tables were re-arranged to allow for dancing, which continued from 8 p.m.-11 p.m. to the music of Sydney Jerome and his Light Orchestra. There were two cabaret interludes which included performances by The Marquis Trio, Veronica Martell, Syd Plummer and finally at 10.15 p.m. The Famous Dagenham Girl Pipers.

After the dinner, a toast to the President and Lady Micklem was proposed by Mr. R. K. Craig, and accorded with enthusiastic applause, to which the President replied.

The evening terminated with those present singing Auld Lang Syne at about 11.30 p.m.

Mr. R. K. Craig (Chairman of Council) and Mrs. Craig

INDEX

Papers and Discussions, Annual Report and Institute Notes

Index

Additions to the Library

Index

Election of Members

MEMBERS

* Transfer

Index

* Transfer

* Transfer

* Transfer

Index

* Transfer

* Transfer

Engineering Abstracts

Index

Index

Index

Index

Index

ENGINEERING ABSTRACTS

Section 3. Shipbuilding and Marine Engineering

Compiled and published by The Institute of Marine Engineers in co-operation with The Institution of Naval Architects

Volume XI, No. 1, February 1948

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

General Motors Two-cycle Diesel

A recent Diesel engine, developed by General Motors, was exhibited at the 1948 Motor Boat Show in New York. This model is a 2-cycle, 12-cylinder engine embodying the General Motors unit fuel injection system and uniflow scavenging, and developing 1,200 h.p. Designed for ship propulsion, this engine was used during the war in providing propulsion and auxiliary power for all types and sizes of American war craft. Six, eight, or twelve cylinder units of this engine are supplied with direct connected generators for electric drive or with airflex clutch and reverse gear. Auxiliary engines range from 2 cylinders of 20 kW. to 6 cylinders of 60 kW.—*"The Shipping World", Vol. 118, 28th January, 1948, p. 164.*

B. and W. Two-stroke Single-acting Crosshead Engine

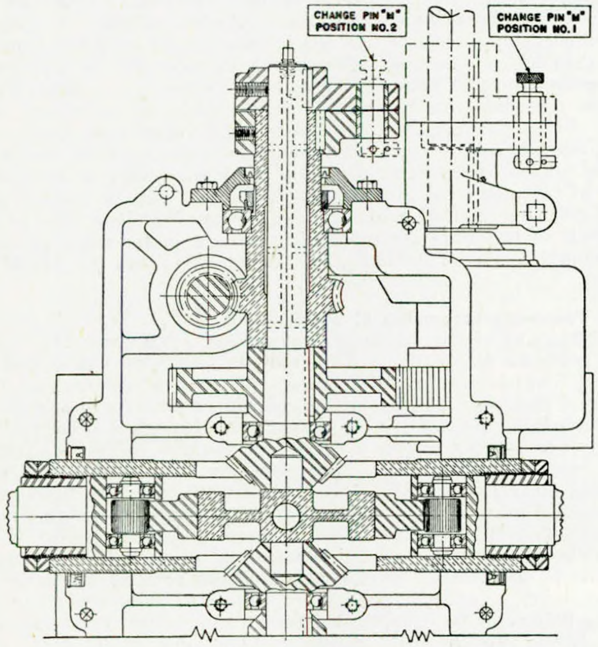
The first ship to be propelled by this new class of engine was the m.s. Fernplant built at Copenhagen in 1939. This engine shares the following features with the earlier B. and W. two-stroke engines: (1) the uniflow scavenging principle, providing a maximum of combustion air supply with minimum blower work; (2) short overall length owing to the arrangement of the blowers at the back of the engine; and (3) simple reversing system. In this engine the consumption of bearing oil has been reduced to a minimum by the complete separation of cylinders and pistons from the crankcase. This was achieved by realizing that in a uniflow engine it is unnecessary to have the scavenging ports covered by the piston skirt during the entire piston stroke; the piston skirt has therefore been made of only sufficient length to carry the piston rings and lead-bronze rings guiding the piston in the liner. A row of scavenging ports is evenly distributed around the entire circumference of the cylinder, and the opening and closing of the ports is controlled by the uppermost piston edge. The scavenging air moves under a rotary motion towards the combustion space and forces the exhaust gases out through the exhaust valve. The piston rod passes through a stuffing box in the bottom of the scavenging air box. The stuffing box contains a pair of scraper rings and a tightening ring which prevent the passage of bearing oil and loss of scavenging air. Also, the stuffing box is surrounded by a collar which prevents scraped-off cylinder oil and sludge seeping down to the stuffing box and penetrating into the crankcase. The engine installed in the Fernplant is a 9-cylinder unit for a continuous output of 5,500 i.h.p. at 122 r.p.m., the mean indicated pressure being 6·5 kg. per sq. cm. The designed continuous output is 6,750 i.h.p. or 750 i.h.p. per cylinder at 150 r.p.m. Cylinder diameter is 620 mm. and piston stroke is 1,150 mm. The completion of the Fernplant engine was followed by the design of an engine with a cylinder diameter of 740 mm. and a stroke of 1,400 mm. developing 1.090 i.h.p. per cylinder in continuous service at 125 r.p.m. Later on, an engine with a cylinder diameter of 740 mm. and a stroke of 1,600 mm. having an output of 1,150 i.h.p. per cylinder was developed. The engine differs from the original Fernplant type only in the design of the cylinder liners and cylinder covers. A collar on the cylinder liner rests on the upper face of the cylinder frame and the cylinder is clamped between the cylinder frame and the cylinder cover by studs fitted in the cylinder frame, from which the combustion pressures are transmitted to the bedplate by means of staybolts. For the inspection of the piston and the cylinder liner the cover is lifted, the piston rod is detached from the crosshead and the piston and piston rod lifted. Recently an engine with a cylinder diameter of 500 mm. and a stroke of 1,100 mm. with a continuous output of 530 i.h.p. at 170 r.p.m. has been designed, and the first propulsion units of this class are reported to be now under construction. *—Soren Hansen, "The Motorship", Vol. 28, January, 1948, pp. 382-385.*

Mail and Passenger Steamship El Malek Foad

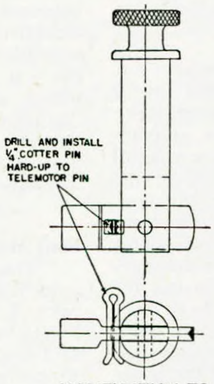
The El Malek Foad which is a vessel of 2,500 tons d.w. was launched from the Woolston yard of John I. Thornycroft and Company, Ltd., Southampton, on 19th June, 1947, and was completed in December of that year. The propelling machinery consists of two sets of Parsons steam turbines driving two screws through double-helical single-reduction gearing to give a maximum power of 8,000 s.h.p. at a propeller speed of 250 r.p.m. The propellers have a diameter of 9ft. 8in. and mean pitch of 8ft. 11¼in. The high-pressure turbines are of the impulse-reaction type, while the low-pressure ahead turbines are fitted with reaction blading only. A three-row impulse wheel for astern working is arranged at the exhaust end of each low pressure turbine and is designed to develop about 40 per cent. of the normal full ahead power. The main condensers are of the Weir regenerative type. The boilers of the single-sided three-drum water-tube type are of the latest Thornycroft design. One side and part of the back and front of each boiler consists of radiant heat absorbing tubes only. The other side of the boiler contains the main generating tubes and the superheater; all products of combustion pass across these tubes. On the water wall side the downcomers are of large diameter and unheated. Each boiler is fitted with an airheater which can be by-passed on the air side when starting up. The superheaters which are proportioned to give a steam temperature of about 600 deg. F. at normal full power, are of the Thornycroft "straight through" type. An important feature of this design, which employs two headers, is that it is self-draining and self-venting. In addition, any tube can be sighted from end to end, and when necessary, individual tubes can be removed without disturbing the superheater as a whole. The two water drums are securely tied together so as to form a very rigid structure. Boiler efficiency without economizer or air heater is approximately 82 per cent. at full power. The boiler air inlets are arranged at about waist level in the ship, which ensures good air circulation throughout the boiler room and comfortable temperature conditions for the boiler room personnel. The boilers are oil-fired by the latest Thornycroft pressure-jet system and are arranged to work in a closed stokehold. They are supplied with air by two W. H. Allen turbo-driven forced-draught fans. It is expected that in service the vessel will do 18 knots on 75 per cent. of the normal full load evaporative capacity of the boiler.—*"The Marine Engineer", Vol. 71, January, 1948 issue, pp. 5-11.*

Telemotor Pin Modification

Referring to the narrow escape from stranding of an American T2-SE-A1 tanker due to the working loose of the steering gear telemotor pin, an article in a recent issue of the "Proceedings of the Merchant Marine Council of the U.S. Coast Guard", deals with preventive measures that have been suggested to guard against the occurrence of similar mishaps. The telemotor pin referred to is the horizontal change pin in the differential control at the after steering-gear telemotor, which is in the position marked "No. 1" in the accompanying drawing when the ship is being steered from the wheelhouse by hydraulic telemotor or electric steering. When steered by the trick wheel or from the after deck the pin is removed from that position and engaged in the differential control level (position No. 2), the usual condition of the steering gear after arrival in port and the engines are finished with. In the horizontal position this telemotor pin is liable to slip out due to the vibration of the ship, and to prevent this from happening the pin is locked in place by providing it with a hinged toggle designed to drop freely when the pin is engaged in the bell-crank levers. This toggle should prevent the pin from working loose and disengaging, but in the case reported above the toggle was found to have seized at the hinge and required freeing before it would drop freely into the locking position. Instructions have now been issued to the masters of all the vessels operating in the tanker fleet requiring their chief engineers to examine these telemotor pin toggles and "free" them, if found necessary, to enable them to drop freely. As an additional safety precaution, a ¼-in. split pin is to be fitted at the top centre of the toggle in a hole drilled as close as possible to the pin, as shown in the sketch. This split pin will retain the toggle in a vertical position always normal to the horizontal telemotor pin, thereby preserving the locking feature of the toggle under adverse service conditions.—*"Shipbuilding and Shipping Record", Vol. LXX, No. 22, 27th November, 1947, p. 628.*



Differential control of steering gear



MODIFICATION TO TELEMOTOR PIN

Separation of Valve Flanges

The dismantling of valve boxes for internal inspection or refit is often rendered difficult on account of the adhesion of the cover mating flanges, more especially where the gasket material interposed is of the sheet asbestos variety. The writer cites an instance in which the flanges of a main turbine stop valve were so securely wedded together that the usual expedient of employing a sharp chisel to separate them involved a considerable amount of difficulty because there was no gap between their edges into which the point of the chiesel could be inserted. The writer suggests that two or even four, diametrically-opposed slots should be milled or cast in the abutting faces of the two cover flanges, as shown in Fig. 1, to facilitate the opening up of valve boxes, etc., and points out that the purpose of these slots would then be so obvious that any other method of effecting the separation of the two flanges would scarcely merit a moment's consideration. It might be argued that the provision of such slots would give rise to the possibility of fracturing one or the other of the mating flanges, but this risk could always be avoided by applying two chisels (or four where necessary) simultaneously, either by giving each chisel a tap in turn, or by two men applying themselves to the task, both tapping in unison.—*G. H. Pearson, "Mechanical World", Vol. 122, No. 3,176, 28th November, 1947, p. 569.*

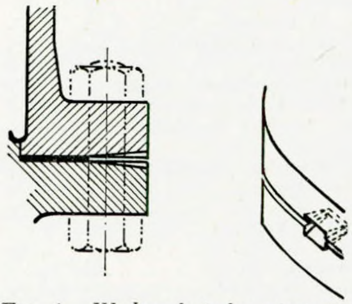


FIG. 1.—*Wedge-shaped recesses to facilitate parting of valve flanges.*

Single- and Double-acting Oil Engines

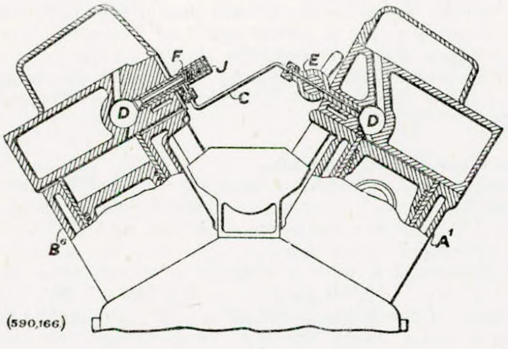
Out of a total of 661 motorships on order, of which the machinery details have been analysed (there are over 700 ocean-going motor vessels under construction or on order throughout the world at the present time) no fewer than 542, or 82 per cent., are being equipped with single-acting two-stroke engines, as against 91 which are to have double-acting two-stroke machinery and only 28 that are to be equipped with four-stroke engines. In 1938 s.a. two-strokes were installed in 50 per cent. of the ships built, whilst in 1931 the figure was 40 per cent. It is clear that shipowners favour the two-stroke engine despite the fact that the d.a. type is lighter and more compact, the space taken up by such a unit is so much smaller than that required for a s.a. two-stroke installation of equivalent power as to make possible a saving of 10ft. in the length of the engine room of a 12,000-b.h.p. vessel equipped with such machinery. There is nothing to choose between s.a. and d.a. two-stroke engines as regards reliability in service, although there have been some cases of piston-rod fracture at the thread in d.a. engines after a considerable period of operation, as well as damaged piston-rod packings, more especially when fuel with a high sulphur content has been used, and such failures cannot occur in s.a. engines. These defects can, of course, be prevented from developing by arranging for more frequent routine replacements, but there are conditions of present-day labour which militate seriously against d.a. engines—conditions which did not exist, to the same extent, before the war. It takes longer to open up such an engine and draw the pistons than with a s.a. engine, and this extra time, compared with pre-war days, amounting to as much as 50 per cent., may involve the ship remaining in port for a day or two solely on that account, whereas formerly the work could easily have been carried out whilst discharging cargo. The real cost of such an inspection becomes artificially exaggerated when, as now, the cost of a loss of a day at sea may be extremely high. As things are, it is difficult to see how this disability is to be overcome, so that it is scarcely surprising that the d.a. engine is suffering a temporary—if not permanent—eclipse.—*"The Motor Ship", Vol. XXVIII, No. 334, November, 1947, p. 281.*

Unaflow Steam Engine in Marine Application

At a meeting of the newly-formed technical section of the Canadian Shipbuilding and Ship Repairing Association a paper on the Skinner-Unaflow Steam Engine (now made under licence in Canada) was presented by Geo. L. Lindsay, chief engineer of the Skinner Engine Co., Pa. He described it as a "vertical, multi-cylinder, poppet valve, double-acting, single-expansion, uniflow steam engine", in which steam at full boiler pressure and temperature (less the normal line drop) enters each cylinder at the ends, after passing through steam-jacketed heads. The steam exhausts directly to the condenser when the ports are uncovered by the piston at the end of the power stroke. The control of power and speed is effected entirely by the cut-off, except while starting or manœuvring at high speed, and this elimination of throttling contributes to a flat steam-rate curve. The design permits the use of from two to eight identical cylinders and six different strokes, resulting in a relatively smooth torque curve and making it possible to start up the engine in any crank position without barring over. The output of the engine is from 500 to 7,000 i.h.p. and the speed from 90 or less to over 300 r.p.m., according to the steam conditions, propeller characteristics, space available, weight limitations and other factors. The steam pressures used have varied from 150 to 325lb./sq. in. and the steam temperatures from 365 to 640 deg. F. The relative speed usually corresponds to a piston speed of 900ft./min., but linear vibration is minimised at all speeds by the uniform and relatively low weights of the reciprocating parts. The total engine weight is moderate, and varies from about 45 to 95lb./i.h.p., depending on specifications. Though invented as far back as 1857 and in use for many years for stationary purposes, it was not until 1929 that the sea-going installations were put in service. One of the main objects of the uniflow design is the elimination of the initial condensation that constitutes such a great loss in conventional reciprocating steam engines.—*"Canadian Shipping and Marine Engineering News", Vol. 19, No. 2, November, 1947, pp. 19, 32 and 33.*

Starting Compression-ignition Engines

A recently-published British Patent covers an arrangement developed by Davey, Paxman & Co., Ltd., which is claimed to facilitate the starting of a multiple-cylinder compression-ignition engine having a low compression ratio. For this purpose, pairs of cylinders, as shown in the sectional diagram, are connected by pipes C, with



valve controls, by means of which one cylinder of each pair is, during the compression stroke, given a supplementary charge of air heated by compression to a temperature that is high enough to ensure ignition of the injected fuel when the engine is rotated. The cylinders are divided into compression cylinders and receiving cylinders, the former delivering to the latter, during the starting of the engine, a supplementary charge of air heated by compression. The outlet from the cylinder A^1 is controlled by the shut-off valve E, and the inlet to the receiving cylinder B^6 is controlled by a non-return valve F. As the engine is rotated, the cylinder A^1 has its fuel supply temporarily cut off, so that the compression stroke in this cylinder results in the delivery of a charge of air, heated by compression, to the combustion chamber D of the receiving B^6. The delivery of this heated air is timed to take place during the early stages of the compression stroke in the receiving cylinder. The delivery cylinder A^1 is fitted with a shut-off valve E which can be left fully open for the delivery of hot air during the starting operation, whilst the receiving cylinder B^6 is fitted with a non-return valve F, loaded to a predetermined pressure by a spring J, which can be opened from the delivery side and closed automatically from the receiving cylinder side as soon as the pressure is high enough in the receiving cylinder.—*"Engineering", Vol. No. 4, No. 4,270, 28th November, 1947, p. 528.*

The Future of the Two-stroke Supercharged Engine

Despite the fresh lease of life given to the four-stroke engine by the introduction of supercharging, less than 5 per cent. of the total number of motorships under construction at the present time are being equipped with such machinery and it has been suggested that ultimately four-stroke engines will drop out of the field of marine propulsion as regards ocean-going ships. About 80 per cent. of the motorships now on order are to have s.a. two-stroke engines, but in no case will any of these be fitted with superchargers, although a good deal of experimental work in the use of supercharging with s.a. two-stroke machinery has already been carried out. The advantages claimed for such a development include substantial reductions in the weight and first cost of high-speed engines in particular, although it has been pointed out that two-stroke supercharged engines operating at normal speeds and directly coupled to propeller shafts might also show sufficiently great savings in weight and cost to justify serious consideration being given to this matter by manufacturers of marine oil engines. Admittedly the higher pressures used would call for increases in the sizes of the crankshafts, connecting-rods and bearings, to say nothing of other design difficulties, but the problems involved should not prove insoluble and the net result would be a considerably lighter and cheaper engine of equal reliability and needing no greater discrimination in fuel than the average s.a. two-stroke unit of the present day. There should be no increase in fuel consumption, rather the contrary, in view of the higher mechanical efficiency attainable with pressure-charged engines. The exhaust-gas-driven supercharger might be regarded as an additional complication in the E.R. plant, but experience with four-stroke engines indicates that pressure chargers of this type are highly reliable in service. It is probable that within a year or two some interesting developments in the application of supercharging to marine oil engines of the s.a. two-stroke type of moderate or high power will take place.—*"The Motor Ship", Vol. XXVIII, No. 335, December, 1947, p. 317.*

Condensate Corrosion in Thick Boiler Drums

In a paper read by J. A. Keith at a meeting of the National Association of Power Engineers and summarised in "Power", it is stated that so-called "corrosion fatigue" is liable to occur at points of high stress concentration or at points of cyclic stresses in the presence of a corrosive agent. The cases discussed by the author occurred in and immediately adjoining the deeply counterbored holes provided for the rolling-in of the lower connections of water gauges in thick-walled boiler drums. Trouble can also develop at the feed connections. In both instances the in-coming water may be considerably cooler than the metal of the drum, with the result that high stress is caused, and this together with the low *p*H of the condensate or relatively pure feed-water, gives rise to cracks at the sharp edges of the inlet holes. In the forged drums of the two high-pressure boilers with 1¾-in. diameter water column connections rolled into about 1¼in. of the wall thickness from outside the drum, shown in Fig. 1, cracks developed radiating across the face of the step in the counterbore and also at the inner rim of the hole. Microscopic examination of samples showed the cracks to be transcrystalline and therefore not in the category of caustic embrittlement, but definitely of a corrosion-fatigue nature. The temperature of the water returned from the water columns was about 250 deg. F. lower than that of the main body of water in the drum, and the returning water was of low *p*H (6·9 to 7·3) and therefore corrosive. The tube holes were in the

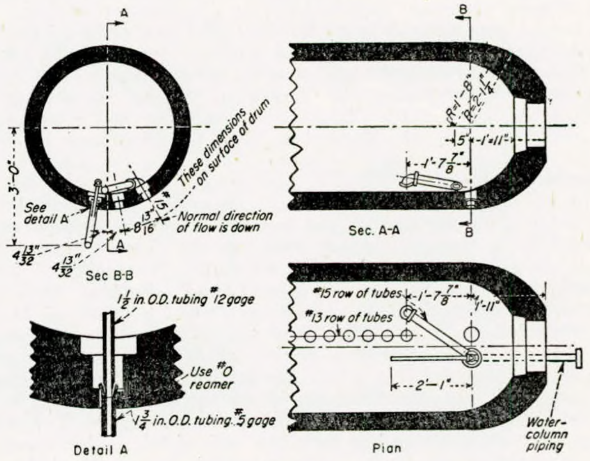


FIG. 1.

drum ends, beyond the point of circulation, hence little if any mixing with boiler water occurred. The trouble was corrected by boring out the cracks and bringing the water column connections right through the drum wall into a part of the boiler where active circulation existed. An extension pipe with a tapered joint, as shown in the drawing, carries the water column discharge into the active boiler circulation (*p*H 9·5 to 10·0) and water from the tubehole counterbore is made to flow to one of the main boiler tubes in which there is a definite downward flow, thus putting the water from the cavity into active circulation. Since making these changes, no further cracking has occurred during several years. At this establishment, cracking had not occurred at the feed-water entrance, but as a precaution, a "thermal sleeve" was fitted to keep the incoming water away from the drum metal, at the same time preventing cooling of the latter.—*"Power and Works Engineering", Vol. XLII, No. 498, December, 1947, p. 379.*

American Passenger Liner "President Cleveland"

The twin-screw turbo-electric passenger liner "President Cleveland", now fitting out at the Alameda Shipyard (Cal.) of the Bethlehem Steel Co., for the California-Orient service of the American President Lines, was designed as a P-2 class troop transport of the U.S. Maritime Commission and has had to be largely re-designed during the later stages of the construction to fit her for peace-time duty as a luxury passenger liner. She has a hull of combined riveted and welded steel construction divided into 14 watertight compartments and having four complete decks. The main dimensions of the ship are an o.a. length of 619ft. 6in. (573ft. b.p.), a moulded breadth of 75ft. 6in. and a depth moulded to the upper deck of 52ft. 6in., with a d.w.c. of 10,224 tons and a displacement of 22,574 tons at a full load draught of 29ft. 2in. The register is given as 15,450 gross tons. There are eight holds for general cargo and 13 refrigerated cargo compartments with a total capacity of 52,350 cu. ft., in addition to the nine refrigerated compartments totalling 17,575 cu. ft. reserved for ship's use. No. 4 cargo hatch is served by a side-port loading-discharging crane which operates in conjunction with two athwartship trolley bridges each of 2½ tons' capacity. There is accommodation for 552 cabin- and tourist-class passengers and a crew of 338, practically all this accommodation being air-conditioned. The original design of the ship is reflected in the unusual arrangement of her machinery which, apart from the P. and S. propulsion motors installed in separate compartments aft, is made up of two entirely self-contained units located amidships and separated by O.F. and fresh-water tanks. Each of these power units comprises a 6,890/7,650-kW. turbo-alternator set running at 3,600/3,715 r.p.m. and delivering three-phase 60-cycle current at 3,500 volts to a 9,000-s.h.p. propulsion motor driving its propeller at 120 r.p.m. The turbo-alternator is supplied with steam at a pressure of 600lb./sq. in. and 840 deg. F. total temperature by two Combustion Engineering type V2M boilers fitted with convection type superheaters, extended-surface counterflow economisers and soil type desuperheaters. The boilers are equipped with automatic combustion-control gear. The specification call for a fuel rate of 0·601lb. of fuel oil per s.h.p.-hr. for all purposes and for a cruising speed of 19 knots at the normal full output of 18,000 c.h.p. With the exception of the main feed pumps and a few stand-by pumps, practically all the auxiliaries are motor driven. The ship has four General Electric turbo-generator sets, each consisting of one turbine and three generators, these being a 450-volt, three-phase a.c. ship's service machine; a 240/120 volt d.c. three-wire machine for excitation purposes; and a 100-volt d.c. booster exciter. Each ship's service generator delivers 600 kW. and any three of them will suffice to carry the normal sea load without exceeding 90 per cent. of their combined full-load ratings. One generator serves as a stand-by machine. A sister ship, the "President Wilson", is nearing completion at the same yard.—*"Marine Engineering and Shipping Review", Vol. LII, No. 11, November, 1947, pp. 78-79 and 122-124.*

Trawler to Coaster

One of the most successful ship conversion jobs carried out in this country since the end of the war is claimed to be one recently completed by a Grimsby repair yard on the former minesweeping trawler "Juliet" of 452 gross tons, which has been adapted for service as a motor coaster for Air Power, Ltd. Built at Beverley, in 1941, the "Juliet" had an o.a. length of 164ft., a beam of 27ft. 6in. and a moulded depth of 15ft. Her propelling machinery consisted of an 850-h.p. triple-expansion engine of standard trawler pattern. The conversion of the ship into a coaster involved the lengthening of her hull by 20ft. 2in., the lowering of the midship deckhouse by 1½in. to a new sheer line and the construction of two new W.T. bulkheads between the two holds and at the after end of the engine room. The steam machinery and boiler were removed and replaced by a reconditioned Crossley oil engine. As converted, the motor coaster "Peterjon", as the vessel is now named, has a d.w.c. of 690 tons, a register of 585 gross tons and a full-load displacement of 1,112 tons on a draught of 12ft. 9in. She has an assigned freeboard of 2ft. 2¼in. and two cargo holds, forward of the machinery space, with a total bale capacity of 25,460 cu. ft. Each hold is served by an electric cargo winch and tubular steel derrick. Electro-hydraulic and hand steering gear has been fitted and an electric anchor windlass is to be installed, although for the time being the original steam windlass is to be retained, having been modified to operate by messenger chain in conjunction with a 12-h.p. electric motor. The propelling machinery consists of a reconditioned Crossley type H.R.8 direct-reversing 8-cylr. oil engine developing 480 b.h.p. at 325 r.p.m. and coupled direct to the original propeller shaft and propeller, a Michell thrust being fitted. The engine drives its own scavenging-air pump, circulating water, bilge and lubricating-oil pumps, as well as a starting-air compressor. Electric current at 220 volts is supplied by two 32-kW. generators, each driven at 1,200 r.p.m. by a 68-h.p. type B.W.C/4 Crossley oil engine. There is also an auxiliary generator set comprising a 7½ kW. dynamo driven at 1,000 r.p.m. by a 28-h.p. type BW 2 Crossley engine. The various E.R. pumps are motor driven. The normal fuel consumption for all purposes at the service speed of 10 knots is stated to be ¾-ton per day. The vessel can carry 18·5 tons of fuel in the D.B. tanks at the after end of No. 2 hold, and 14 tons of fresh water in two tanks in the after recess of the engine room. Water ballast is carried in the fore- and after-peaks and trimming tanks. The accommodation for the ship's company is on a lavish scale for this type of vessel. The entire conversion was completed in eight months at a total cost of about two-thirds the price of a similar new vessel. The "Peterjon" is extremely well equipped in every respect and scarcely differs from a conventional Diesel-engined coaster in general appearance.—*"The Syren", Vol. CCV, No. 2,675, 3rd December, 1947, pp. 317-320.*

Performance of Passenger Motorship "Aorangi"

The Union Steamship Co. of New Zealand's motor vessel "Aorangi", built by the Fairfield S. and E. Co., Ltd., in 1924, has now completed over 22 years in the passenger and mail service on the Vancouver-Auckland-Sydney route. In her first 20 years she covered more than 1·6 million sea miles without any serious trouble with her Diesel engines, although the latter have, of course, undergone periodic overhauls. The propelling machinery of this 19,491-ton vessel was constructed by the shipbuilders under licence from and to designs prepared by Sulzer Bros., Winterthur. It consists of four 6-cylr. two-stroke Sulzer engines, each developing 3,250 b.h.p. at 127 r.p.m. and giving the ship a service speed of 18 knots. In design and construction these units are generally similar to the large marine oil engines of the present day, the typical A-shaped columns with double crosshead guides being used.—*"Sulzer Technical Review", No. 2, 1947, p. 65.*

Fast Cargo Liner for Johnson Line

The twin-screw motorship "Seattle", the first of the five high-speed cargo and passenger liners ordered by the Johnson Line, of Stockholm, for their service between Europe and the North Pacific, has now been placed in commission. She is a closed shelter-deck of all-welded construction with a register of 6,910 gross tons and a d.w.c. of just under 10,000 tons on a draught of 28ft. The cargo capacity (bale) of the holds is 490,600 cu. ft., and in addition to this general-cargo space, there are six compartments for refrigerated cargo with a total capacity of 95,000 cu. ft. To facilitate rapid handling of cargo, the ship is equipped with 14 ASEA electric cranes, each served by three motors, one for hoisting, one for topping and one for swinging. Accommodation is provided for 12 passengers in single and double staterooms with attached bathrooms. The propelling machinery consists of two 7-cylr. d.a. two-stroke Kockum-M.A.N. engines with cylinders of 720 mm. diameter and a piston stroke of 1,200 mm. They have a total output of 14,000 b.h.p. at 110 r.p.m. and are designed to give the vessel a sea speed of 19½ knots in the fully-loaded condition.—*"The Motor Ship", Vol. XXVIII, No. 335, December, 1947, p. 329.*

Cargo Steamers for Brazil

The turbine cargo s.s. "Loide America", recently delivered to her Brazilian owners by the Ingalls Shipbuilding Corporation, is one of eleven similar vessels built or building at their Pascagoula yard, Miss., for the Lloyd Brasileiro. Five more vessels of this class are being constructed for them at Montreal, by Canadian Vickers, Ltd. The "Loide America", like her sister ship, is a shelter-deck vessel of 5,460 gross tons, 425ft. by 59ft. by 38ft. 8in., with a d.w.c. of 7,530 tons on a mean draught of 25ft. 7in. The hull, of all-welded construction, is transversely framed and subdivided by eight watertight bulkheads. There are six cargo holds with upper and lower 'tween decks, the machinery spact being located between Nos. 3 and 4 holds. The total bale capacity of the general cargo spaces, including that of the deep tank in No. 4 hold, is 404,000 cu. ft., in addition to which the ship has compartments for the carriage of 16,000 cu. ft. of refrigerated cargo in the upper and lower 'tween-deck spaces of No. 3 hold. All the general cargo holds are provided with Cargocaire ventilating and de-humidifying equipment. The cargo-handling gear comprises fourteen 5-ton and two 10-ton derricks served by electric winches, with an additional 25-ton derrick at No. 2 hatch. No passengers will be carried, but in addition to accommodation for a crew of 51 officers and men, tht ship has an owner's suite and two spare single staterooms. The propelling machinery consists of a set of General Electric cross-compound D.R. geared turbines developing 6,000 s.h.p. at 92 r.p.m. of the propeller and designed to give the vessel a service speed of 16½ knots. The astern turbine can develop 40 per cent. of the ahead power. Steam at a pressure of 440lb./sq. in. and 740 deg. F. total temperature is supplied to the turbines by two Combustion Engineering cross-drum, single-pass, sectional-header boilers fitted with inter-deck convection-type superheaters, counterflow economisers and de-superheating coils in the steam drums. Each boiler is fired by three Todd mechanical-atomising oil burners and operates under forced draught with Hagan automatic combustion-control gear. The ship normally carries 350 tons of oil fuel giving her a cruising range of 10,000 sea miles. Electric power at 240/120 volts is provided by three 200-kW. Westinghouse turbo-generator sets, supplemented by a 25-kW. Diesel-generator set for emergency use. There are also two General Electric 115-volt d.c./120 volt a.c. motor generator sets for the provision of alternating current for certain services.—*"Marine Engineering and Shipping Review", Vol. LII, No. 11, November, 1947, pp. 108 and 132.*

Conversion of L.C.T.s to Cargo Coasters

The two 500-ton L.C.T.s "Soulac" and "Foncillon" have been converted to coastal cargo vessels for the French colonial service by the Ateliers Métallurgiques, of Bordeaux. The vessels now have a normal stem in place of the ramp and their shallow draught of 6ft. 6½in. in the loaded condition should prove useful for coastal trading. A single hold of 17,650 cu. ft. capacity is arranged forward, with two derricks on each side served bv an electric winch. Forward of the hold a compartment with 12 berths for the crew has been arranged. A bridge structure aft of No. 2 hatch contains accommodation for the captain and the engineer, whilst the deckhouse below it contains a saloon galley, steward's room and accommodation for ten passengers, six in one room and four in two two-berth cabins. A Thermotank system of ventilation is provided. The propelling machinery consists of two 500-b.h.p. Paxman Diesel engines running at 1,300 r.p.m. and driving twin propellers through reduction gears. The fuel consumtion is stated to be 440 gall. of gas oil per 24 hours, and as the fuel capacity is 12,200 gall., the vessels should have a range of 6,000 sea miles at their service speed of 10 knots. The auxiliaries include two 70-ton/hr. pumps and three 15-kW. Diesel-generator sets, in addition to which there is a generator driven off one of the main engines that is capable of supplying all the current required for power, lighting and refrigeration while the vessel is at sea. Up to 32 tons of fresh water can be carried.—*"The Marine Engineer", Vol. 70, No. 846, December, 1947, p. 570.*

Powerful Rhine Tug

The Rhine tug "Schwyz", under construction for the Swiss Navigation Co., of Basle, by Jos. Boël et Fils, was recently launched from their shipyard at Tamise, Belgium, 3½ months after her keel was laid. She is 251ft. 6in. in o.a. length, with a breadth of 31ft. 3in. and a draught of 10ft. Her propelling machinery consists of four Sulzer directly-reversible Diesel engines, each developing 900 h.p. at 350 r.p.m. The four propellers, 72½in. in diameter are fitted in tunnels, and there are four rudders. To enable the tug to make the round trip from Rotterdam to Basle and back, she is provided with five large fuel tanks having a total capacity of about 175 tons. There are two towing winches, and a total of over 21,000ft. of towing cable will be carried. The tug will be able to tow nine Rhine barges, of a total of 12,000 tons, between the Ruhr and Mannheim, and five barges totalling 3,800 tons, between Strassburg and Mannheim. The vessel will have a crew of nine.—*"Lloyd's List", No. 41,469, 6th November, 1947, p. 9.*

Launch of the R.M.S. "Edinburgh Castle"

The new Union-Castle liner "Edinburgh Castle", recently launched at Belfast and named by H.R.H. Princess Margaret, is a sister ship of the "Pretoria Castle" now in course of completion at Belfast. Both ships are twin-screw passenger vessels of some 28,500 tons gross, 750ft. in length and with accommodation designed for about 750 first-class and cabin-class passengers, but unlike other ships of the Union-Castle fleet built during recent years they will not be equipped with Diesel propelling machinery, but with Parsons-type geared turbines supplied with steam by three Babcock and Wilcox watertube boilers. Each ship will have seven holds for the carriage of general and refrigerated cargo. The temperature in the refrigerated-cargo spaces will be regulated by brine-cooled batteries with air circulation. Electric power will be supplied by three turbo-generators when the vessel is at sea, and by two Diesel generators while in port.—*"The Marine Engineer", Vol. 70, No. 845, November, 1947, p. 548.*

The Cunard White Star Liner "Caronia"

The twin-screw passenger liner "Caronia", launched at the Clydebank shipyard of John Brown & Co., Ltd., on 30th October, by H.R.H. Princess Elizabeth, is of 34,000 tons gross and the largest vessel under construction in the world. She is the fifth largest ship in the Cunard White Star fleet, and has been designed either for world cruising or for service on the North Atlantic route. She has an o.a. length of 715ft., a length b.p. of 665ft. and a breadth of 91ft. On North Atlantic service, the "Caronia" will provide accommodation for first-class and cabin-class passengers. All the public rooms will be air-conditioned. The propelling machinery, which is also being constructed by the shipbuilders, will consist of two sets of Parsons impulse-reaction geared turbines, each set comprising an H.P., an I.P. and L.P. turbine grouped around a main gear wheel. The drive from the H.P. turbine, which will run at 3,686 r.p.m. when developing full power, will be transmitted to the main gear wheel through D.R. double-helical gearing, whilst the drive from the I.P. and L.P. units, running at 1,990 r.p.m., will be through S.R. double-helical gears, to give a propeller speed of 140 r.p.m. The astern turbines will be incorporated in the casings of the I.P. and L.P. ahead turbines. The main condensers, which are of the single-flow type, will each have a cooling surface of 16,500 sq. ft. obtained from 6,554 tubes 3in. in external diameter. Steam at a pressure of 600lb./sq. in. and total temperature of 800 deg. F. will be supplied by six five-drum side-fired watertube boilers of Yarrow design, fitted with superheaters and air heaters. The boilers are installed in one boiler room and will operate on the balanced closed-trunk system of forced and induced draught. Four of the boilers will each have a generating heating surface of 8,387 sq. ft. and a superheating surface of 2,945 sq. ft., while the other two will each have a generating heating surface of 5,861 sq. ft. and a superheating surface of 2,224 sq. ft. With the exception of the turbo feed and extraction pumps, all the auxiliary machinery serving the main engines and boilers will be electrically driven, the electrical requirements of the entire ship being supplied by four turbo-generators situated in a compartment forward of the boiler room. The "Caronia" will be equipped with 14 Diesel-engined lifeboats, carried in gravity-type davits. Six of the boats are being fitted with 130-b.h.p. engines and have been designed for tender duty when the ship is cruising.—*"Engineering", Vol. 164, No. 4,267, 7th November, 1947, p. 451.*

New Salvage Vessel for the Mersey

The twin-screw salvage tanker "Salvor", recently delivered to the Mersey Docks and Harbour Board by her builders, Ferguson Bros. (Port Glasgow), Ltd., is claimed to be one of the best equipped vessels ever designed for dealing with stranded, sunken or damaged ships. She is also capable of dealing with dock and ship fires, laying heavy moorings, attending buoys and lights, and carrying out general surveying work in Liverpool Bay and the River Mersey. The ship has a length of 164ft. 2in., a beam of 34ft. 2in., a depth of 15ft. 1in., and a register of 600 gross tons. For wreck work she has two fire and salvage pumps, each driven by a 350 h.p. motor and having their discharges connected to two high-pressure monitors with nozzles 2in. in diameter. There are also six swivelling fire guns or monitors which can either deliver high-pressure jets of water or drench the vessel herself with spray to prevent the fire from spreading inboard. There is also likewise a special foam discharging hose for dealing with oil fires. For laying moorings the "Salvor" has a special type of bow, and her deck machinery includes a steam-driven winch and heavy-duty bollards and fairleads to take 100-ton loads. A turbo-driven air compressor is installed for diving operations and for supplying compressed air for wreck raising and handling, when required. Electric power is supplied by two 2900-kW. Diesel-generators which are capable of shunt regulation and excitation, and although normally operating at 220 volts, are capable of generating current at up to 300 volts' tension. These machines can be used to supply power to a stranded ship, if required. There are also two 25-kW. 100-volt dynamos for supplying the ship's circuits, one of these being driven by "Salvor" is of mainly riveted construction, although the superstructure and overhung upper deck that eliminates the need for any stanchions, are welded. In addition to accommodation for the surveying staff, the ship has ample living quarters, since she is manned by two crews, from the master downwards. Each crew includes 10 seamen and three firemen. The propelling machinery consists of two sets of triple-expansion engines developing a total of 1,300 i.h.p. at 200 r.p.m. and designed to maintain a speed of 13½ knots. An unusual feature is the provision of a single Weir-type condenser for both engines, sluice shut-off valves being fitted for use in the event of either engine being out of action. Steam at a pressure of 220lb./sq. in. is supplied by two three-furnace Scotch boilers arranged to burn oil fuel.—*"The Journal of Commerce (Shipbuilding and Engineering Edition), No. 37,355, 13th November, 1947, p. 2.*

Launch of the "Commandant Queré"

The twin-screw turbine s.s. "Commandant Queré", recently launched from the Woolston Yard of John I. Thornycroft & Co., Ltd., has been ordered by the French Government for the passenger, mail and cargo service between Marseilles and Corsica, maintained by the Cie de Navigation Fraissinet, the oldest shipping line in France. She is a vessel of 4,400 gross tons, 365ft. in o.a. length with a moulded breadth of 50ft., a depth to upper deck of 28ft. and a mean draught of 17ft. There are three holds with a total capacity of about 1,000 tons of general cargo, in addition to refrigerated cargo spaces, large mail compartments and 'tween deck spaces arranged for the carriage of motor-cars. The cargo-handling equipment comprises seven derricks of from 5 to 15 tons' lifting capacity, operated by steam winches. The hull is divided into 10 W.T. compartments by bulkheads extending up to the main deck and there is a continuous double bottom that includes tanks for the carriage of fresh water and oil fuel. There are three complete decks, above which are the promenade deck and boat deck. The passenger accommodation includes single and double-berth cabins for 158 tourist-class passengers, four- and six-berth cabins for third-class passengers and large compartments for the use of 700 fourth-class passengers. The 5,400-s.h.p. Parsons turbines drive the two propeller shafts at 210 r.p.m. through double-helical reduction gearing to maintain a speed of 18 knots. The H.P. ahead turbines are of the impulse reaction type, whilst the L.P. turbines have only reaction blading. A three-row impulse wheel for astern operation is arranged at the exhaust end of each L.P. ahead turbine and is designed to develop about 40 per cent. of the normal ahead power. The two Weir regenerative type condensers work in conjunction with a Weir closed-feed system which embodies two turbo-feed pumps and a d.a. auxiliary feed pump. Steam is supplied by two oil-burning watertube boilers of the latest single sided 3-drum Thornycroft design. Most of the E.R. auxiliaries are motor-driven, electric current being provided by three 175-kW. Diesel-generator sets, with an additional 25kW. set on the boat deck for emergency use.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 37,390, 24th December, 1947, p. 8.*

Conversion to Oil-burning

The Todd Shipyards Corporation, New York, are carrying out numerous conversions of coal-burning steamers to oil-burning, and report that about 80 per cent. of these conversions are of cylindrical boilers having three or four furnaces and operating under Howden's forced-draught system. The company make special registers and furnace fronts for such boilers, by means of which their existing coal-firing apertures can be utilised and the entire installation rendered capable of reconversion to coal-firing, if necessary. The usual procedure is for the vessel concerned to be inspected prior to her arrival at the company's yard, and for the necessary drawings and fittings to be prepared before she is taken in hand for conversion. The general practice is to adapt the double-bottom compartments for use as fuel tanks and to release as much of the former coal-bunker space for cargo stowage, as is possible. Cofferdams have frequently to be constructed to separate the D.B. fuel tanks from adjacent reserve feed-water tanks, but even where the fuel tanks are next to salt-water ballast tanks, it becomes necessary to render the separating bulkheads oiltight by caulking and welding. The O.F. storage capacity to be provided must, of course, depend on the nature of the service on which the ship is to be employed, but ordinarily a vessel that is to maintain the same service after being converted to burn oil, requires about 65 per cent. of her former coal-bunker capacity for O.F. storage. Despite preliminary surveys, it is frequently found that some of the tank floors, steel plates and beams near the boilers are corroded or damaged, and require strengthenin~ or replacement. Under normal circumstances, however, the conversion work proceeds as follows: Remove all coal from the bunkers, dismantle all coal-handling equipment such as saddle-backs for sliding coal into bunkers and the trolley systems used for conveying the coal to the stokeholds, any openings caused by such removals being blanked up; scale the interior surfaces of the coal bunkers to remove all accumulations of dirt and rust, etc., by means of pneumatic chipping hammers, the areas not intended for oil storage purposes then being coated with paint or other rust-preventing material; remove all defective plating and beams, blanking up or renewing as necessary; and construct oil-fuel tanks of the sizes required, utilising existing bulkheads or frames for the installation of new sections where possible, in accordance with the classification societies' requirements. The fuel tanks usually include one settling tank in or near the boiler room, holding about one day's supply of oil, two or three main fuel tanks (deep tanks) and two or more D.B. or ballast tanks adapted for use as fuel tanks, their capacity depending upon the total amount of oil fuel to be carried and on the space available. The fuel pumping arrangements normally provided by the Todd Corporation comprise one transfer pump, two service pumps (one in use and one as a stand-by), two O.F. heaters and two sets of duplex strainers, these being fitted on the suction and discharge sides of the service pumps, respectively. Although in some cases it is necessary to instal the pumps, heaters and strainers in the boiler room as separate units, the normal practice, where space permits, is to instal the whole of this equipment as a single unit assembled on a common base, with all the inter-connecting pipes, valves and fittings shop-erected and tested to classification societies' requirements. With cylindrical boilers having Howden's forced draught and three or four furnaces per boiler, the furnace doors are removed, together with the fire-base, bearer bars and bridge walls. The funnel dampers are either removed or locked open. This equipment is usually stored somewhere in the ship so as to be available in the event of a reconversion to coal firing. Todd mechanical atomising oil burners are attached to a door that fits into and covers the firing apertures of the coal-burning boiler front, an expanding diaphragm fitting into the front end of each furnace for the purpose of directing the heated air into the atomised oil spray, thus ensuring good combustion and effective control of the air-fuel ratio. The remaining items to be installed comprise the cold-starting equipment that is used for raising steam in the boilers when they are cold; the steam and exhaust connections for the oil pumps and heaters, etc.; the torches, etc., employed for lighting up the oil burners; and the fire-fighting appliances called for by the underwriters. Very often ships that have their boilers converted from coal- to oil-firing have the galley range similarly converted. The Todd Corporation make a special oil-burning galley range for this purpose, to which a fuel pipe from the main O.F. system can be fitted. The time required to complete the average conversion job is stated to be from three to four weeks, depending on the amount of extra work involved and on the number of boilers.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 37,361, 20th November, 1947, p. 4.*

Lubricating-oil Filters for Steam Turbines

Waste-packed filters can be employed for filtering turbine oils, although they are not suitable for use where large quantities of oil have to be dealt with as they are slow and do not remove water. The filtered oil is often passed through water and zinc cones, or other materials, to reduce its acidity. Waste-packed filters should be fitted with steam coils for heating the oil to a temperature of about 140 deg. F. prior to filtration, but when the oil is drawn direct from the lubrication system of a turbine in use, no further heating is called for. Fig. 13 shows the construction of a typical filter of this kind. The dirty oil is placed in the chamber A and flows through the perforated cap B, which is high enough to prevent large deposits and

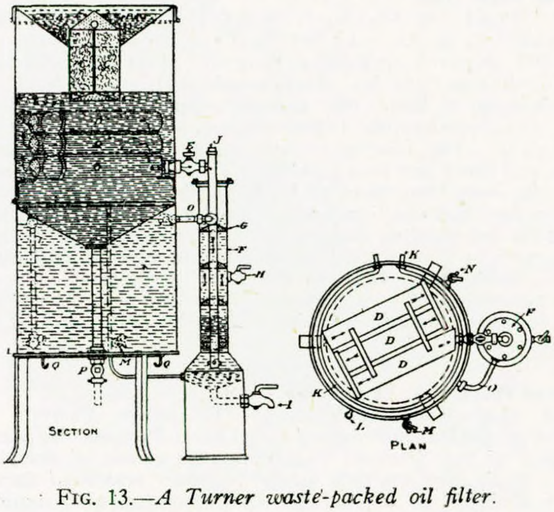


FIG. 13.—*A Turner waste-packed oil filter.*

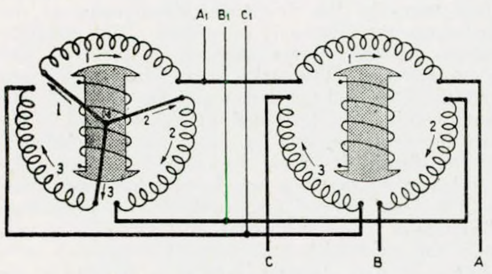
sludge from passing through. The filter tubes C and D are packed with clean unsized filter waste through which the oil passes to be discharged at E and flow up the water column F through the perforated zinc cones G. The water column is fitted with a level tap H, a flushing tap I and a screwed plug J for filling to working level. Other fittings comprise the steam coils K, a sight feed L for the filtered oil, a drawn-off cock M, a sludge test cock N, the pipe O through which the filtered oil passes from the water column to the container, a flushing cock P, and hooks Q, Q for hose. Present-day waste-packed filters are equipped with pumps to force the oil through the filter packs and to increase the rate of flow of the filtered oil. Although centrifuges are simpler to operate and therefore more popular amongst turbine operators, waste-packed filters are claimed to be more efficient, even though they will not remove water. They are particularly effective for filtering dirty oil containing carbon, etc., from the sumps of internal-combustion engines.—*E. V. Paterson, "Mechanical World", Vol. 122, No. 3,176, 28th November, 1947, pp. 557-561 and 575-576.*

Ship Wiring Cables

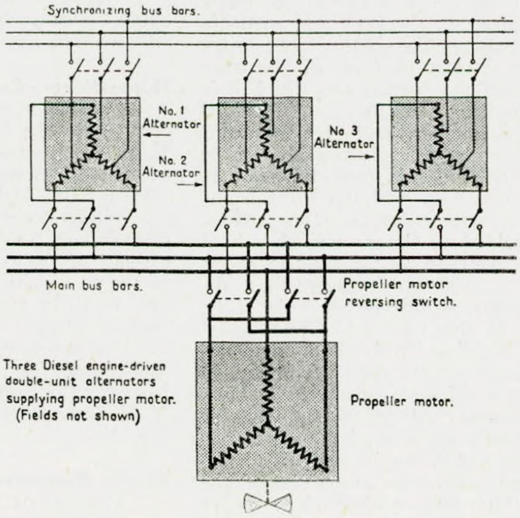
A leading firm of cable manufacturers in this country have recently placed on the market a new varnished cambric Polychloropene insulated taped and braided cable which has just been approved by Lloyd's Register. P.C.P. is used in this cable as an alternative to the familiar lead sheathing, the compound being applied by means of a rubber extrusion machine similar to that used in T.R.S. cable production. The principal advantage to be derived from the use of varnished cambric insulated P.C.P. cable is the saving to be achieved by its light weight. A typical ship installation would probably show an overall saving in weight of about 40 per cent. if wired with the P.C.P. cable instead of lead-covered cable. A further advantage lies in the fire-resisting properties of P.C.P. This, whilst not rendering the cables immune from fire, does help to localise an outbreak and minimise the danger to fire-fighting personnel. The use of varnish cambric insulation also permits the conductor to be operated at a higher current density than is possible with vulcanised rubber insulated cable, although not so high as in the case of varnished cambric insulated lead-covered cable. Furthermore, the new cables are definitely easier to instal on account of the greater flexibility of P.C.P., while the resilient nature of the covering makes the cables considerably more resistant to mechanical damage.—*"The Marine Engineer", Vol. 70, No. 845, November, 1947, p. 518.*

B. T-H. Diesel Electric Alternating Current System

The B. T-H. Diesel electric a.c. propelling machinery of the Anglo-Saxon Petroleum Co.'s tanker "Auris", now fitting-out on the Tyne, is designed to operate on a system that permits any number of alternators to be maintained constantly in synchronism, although dead-circuit operation of the contactor switch is provided for when reversing the propulsion motor. The control of several alternators is, therefore, just as simple as that of a single one. Each of the 830-KVA Diesel-engine-driven alternators is of the double-unit type and has two magnetically-operated stators with two salient-pole rotors mounted on a common shaft in correct electrical alignment. The stator connections are shown in Fig. 1, and it will be seen by tracing the connections in their numerical order from the neutral point N, that the corresponding phase windings of each half-unit alternator are connected in series with each other and brought out to the main busbars A, B and C, while the junctions of the phase windings of each half-unit are brought out to the synchronising bars AI, BI and CI. When the two field windings of each double-unit alternator are excited equally and with the same polarity, the phase voltage at the main busbars will be twice the voltage across the synchronising busbars. It follows conversely that if the two field windings are excited equally, but with opposite polarity, then the voltage across the main busbars will be zero, while the voltage across the synchronising bars will remain unchanged. The main busbars are connected to the propulsion motor, and this arrangement gives the required conditions, because when this motor is reversed, zero volts are obtained at the motor terminals, thus enabling the reversing contactor switch to be opened on a dead circuit. At the same time, the voltage on the synchronising busbars remain unchanged, so that the alternators will not fall out of step. The operation of this Diesel-electric installation is similar to that of the B. T-H. turbo-electric system in that changes in the speed of the propulsion motor are effected by varying the speed of the generating units, and reversal by interchanging two of the three phase connections to the motor. Control gear is provided for either hand-wheel or lever operation, and provision can also be made for the controls of the propelling machinery to be actuated directly from the bridge, duplicate sets of control gear being fitted in the engine room for use with the ship's telegraph. With the B. T-H. Diesel-electric a.c. system of ship propulsion there is no need to provide separate engines for auxiliary power, since this can be obtained from the motor generators supplied from the main power circuit. When in port, any one of the main generating units can be used for this purpose.—*"The Shipping World", Vol. CXVII, No. 2,839, 26th November, 1947, p. 450.*



Stator and field windings of double-unit alternator.



Three Diesel engine-driven double-unit alternators supplying propeller motor. (Fields not shown)

FIG. 1.

Ventilation of Main Electrical Generators on Board Ship

The author explains why it is desirable that the temperature in the spaces containing the main electrical generators of a ship should not be allowed to exceed 95 deg. F., and discusses the methods that may be adopted to ensure this. The two main systems in common use for the ventilation of electric-generator compartments on board ship are: (1) open-circuit ventilation, the air capacity of the compartment being included in the system; and (2) closed-circuit ventilation in which the air capacity of the compartment is excluded from the system. In regard to (1), an open-circuit system may provide for the circulation of air drawn from the atmosphere and through the compartment by an exhaust fan discharging to the atmosphere, or, alternatively, it may comprise a natural system of ventilation supplemented by an air cooler and fan drawiing heated air from the compartment and replacing it by cooled air. The author states that the latter method, although frequently used in power stations on land, is rarely employed on board ship. As regards (2), closed-circuit ventilation is to be preferred where the vessel concerned is required to operate under conditions that will normally cause the temperature in the electrical-generator compartments to exceed 95 deg. F., where the size of these compartments is small in relation to the plant they contain, or where the atmospheric air available for ventilation purposes is of doubtful purity. A closed-circuit ventilation system must, in all cases, include provision for cooling the air that is in continuous circulation by some external agency, but apart from this it may operate without a separate circulating fan if the generators are high-speed machines which incorporate their own air circulating fans, the discharge from which is led through an air cooler and back to the machine concerned. Alternatively, where the generators or motors are of the slow-running type without cooling fans, an independently-driven fan drawing heated air from them through an air cooler and delivering cooled air to the machines may be employed. The author gives sectional diagrams representing typical installations and tabulated tables of the thermal heat losses from generators, Diesel engines and electrical equipment.—*K. A. Vassiliev, "Sudostroyenie", Vol. 17, No. 4, July/August, 1947, pp. 12-17.*

The Design of Contraflow Heat Exchangers

When designing heat exchangers, engineers are usually satisfied if the intended output is reached; they tend to neglect the expenditure of weight and energy involved. In aircraft turbines, where heat exchangers have to be used for transmitting heat from the hot gases leaving the turbine to the compressed air before its entry into the combustion chamber, more care has to be taken to avoid excessive weight and volume, and the author therefore explains a method of calculation for contraflow heat exchangers for gases at turbulent flow, in which the essential dimensions are given as functions of the initial design conditions and the properties of the fluid. The method is not restricted to aircraft, but is applicable to contraflow-heat exchangers for gas turbines or other purposes. The method may also be accommodated to any specialised conditions.—*Summary of paper for discussion, by Prof. E. Schmidt, Dr. Ing., "Journal of the Institution of Mechanical Engineers", December, 1947, p. 156.*

Welding in Marine Engineering

The author refers to his article on the above subject in the August, 1947 issue of *The Transactions of the Institute of Marine Engineers,* and describes the present paper as a more detailed discussion of certain particular applications of welding. The first of these is to the structural members of large marine Diesel engines, which are cut by portable cutters and fixed machines working to template. The thickness of the material varies from about ½in. to 12in., and the flame-cut housings have usually to be machined before assembly. Most of the plates are flat, but the semi-circular sump-plates that constitute the backbone of the bedplate must be made true to form and have their ends square with the radius. When assembling, work is started on the heavy cross girders consisting of flat plates carrying a heavy flame-cut bearing housing, that is machined and "bedded in" accurately prior to welding. These sub-assemblies are completed by the addition of radial stiffeners which support the housings. The adoption of a welding sequence in which the runs are alternated from one side to the other eliminates the difficulty of keeping the sub-assemblies flat enough to take the semi-circular sump-plates which have then to be secured to them. To facilitate assembly, level C.I. floor plates are provided, on to which machined C.I. girders are bolted. These girders give ready access to the underside during assembly and to any projections below the general base level. The author then discusses the choice of electrodes and joint preparation for welding the combustion-chamber stays of Scotch boilers. After referring to the methods of constructing combustion chambers employed in the U.S. and in this country, the author considers the relation between degree of jigging, use of automatic machines and choice of joint detail. He also mentions some alternative details that avoid any chipping out for sealing runs inside the chamber. The welding of the furnaces to the combustion chamber is becoming common practice, the choice lying between two methods. With the welded corner method, the furnace can be flanged and have its edge shaped to make a joint with the combustion chamber wrapper plate around part of the circumference, while at the top it is connected to the tube plate by a butt weld. Where the thickness of the tube-plate greatly exceeds that of the furnace tube, it may have to be thinned down to match up, and as the welding work involved has to be carried out down hand, due provision for this has to be made during the preparatory stages by chipping out the back and ensuring reasonable access for the pneumatic tools. The latter factor may even control the weld positions. In the alternative form of construction the tube plate is flanged out to meet the furnace, to which it is joined by a circular weld. As such circular joints have to be welded down hand, the entire assembly may have to be rolled over by means of special tackle. The flat top of the combustion chamber has to be stayed to withstand full boiler pressure, and this used formerly to be achieved by the provision of pairs of plates bridging the top and supporting the crown with one or more screwed stays. In a welded design incorporating a single plate welded to the crown, the shear loads carried by the weld joining the stiffener to the wrapper plate are small, but the weld has to be considerably larger than the theoretical minimum to allow for temperature differences in the plate, scaling with age, etc. The efficiency of this type of stiffener, particularly in relation to the amount of welding involved, is compared to that of the stay design. The author stresses the difficulty of having to select different types of electrodes for different aspects of welding on one job, as, e.g., where general-purpose rods, electrodes suitable for thick plate, and vertical and overhead rods may all be needed on one job. Mention is also made of the added requirements of high-quality welds in boiler work and some indications are given of the scope for improvements open to manufacturers of electrodes.—*Paper by J. A. Dorrat, read at a meeting of the South London Branch of the Institute of Welding on the 11th December, 1947.*

Rated Output Capacity of Ships' Evaporating Plant

The author discusses the basis on which designers assess the output capacity of ships' evaporators for meeting make-up feed and domestic requirements. He refers to the standards adopted by the U.S. Navy, as the result of many years' experience, which provide two distinct methods of rating for the low-pressure evaporators in general use at the present time on board American warships. The first method is that by which the evaporator output after 30 days' continuous use without any hand cleaning of the coils is taken to be the rated output capacity of the plant. The second method consists in taking the "clean coil" output of the evaporator during a given period of time as its rated output capacity and stipulating that this must exceed the distilled water requirements of the ship during the same period by 30 per cent. The argument in favour of this second method of rating is that whereas the "clean coil" output capacity of the plant is a specific amount that can serve as a basis for the designer, and which should be attainable at the time of the ship's acceptance trials, the so-called normal evaporator output under service conditions must necessarily depend on the thickness of the scale on the coils and is, therefore, a quantity that cannot possibly be assessed by the designer of the plant. After describing the procedure adopted for gauging the "clean coil" output of an evaporator not exceeding a prescribed brine density in the shell, with a steam pressure of approximately 19lb./sq. in. in the coils and taking salt-water feed at a temperature of 86 to 95 deg. F. from the main circulating discharge, the author enumerates the design requirements of single- and multi-stage evaporating plant for merchant vessels. Although admitting that fresh-water consumption is a matter that must primarily depend on operating experience, he suggests that the make-up feed requirements of watertube boilers normally amount to from 2 to 4 per cent. of the total steam used in a given period, while the domestic fresh-water consumption should not exceed about 40 gal. per person/per 24 hours. He goes on to declare that a "clean coil" output capacity of an evaporating plant based on quantity 30 per cent. in excess of the figure corresponding to the above consumptions should prove ample for all purposes, including the provision of substantial amounts of distilled reserve feed and domestic fresh-water supplies. —*A. N. Brilinsky. "Sudostroyenie", Vol. 17, No. 3, May/June, 1947, pp. 28-29.*

Synthetic Resin to Lock Nuts and Seal Joints

An article in a recent issue of "Le Génie Civil", points out that although more than 2,000 ways have been devised for locking screwed connections, most of them are of limited applicability and do not ensure locking for a sufficiently long period. The nature of the contact between the threads of a tightened nut and bolt, and the causes of loosening in service are discussed at some length, and it is then claimed that the application of synthetic resin to the threads, after the removal of grease, results in the interstices being filled, thus securing a tightly sealed and firmly locked connection. A mixture of vinyl compounds with a plasticiser and volatile solvent, known as Plasticol, is stated to be a suitable material, as it retains an adequate degree of plasticity and elasticity, and is able to withstand temperatures of up to 212 deg. F. This sealing compound can also be applied to screwed covers, pipe joints and other connections, practically regardless of the form and dimensions of the joint and the materials concerned. In some cases, it may be advantageous to use the resin with a filler of hemp, mica, wood, flour or other material.—*"Power and Works Engineering", Vol. XLII, No. 498, December, 1947, p. 380.*

Shipgrafting—Certain War-time Ship Repairs

The paper gives an account of five major ship repairs carried out within the last few years by the dry docks department of the N.-E. Coast firm with which the author is associated. The grafting of new forward halves on the motor tankers "Pontfield" and "Vardefjell", and the cargo vessel "Treworlas" (ex-"Harpagus"), and the joining together of the fore and after ends of the tanker "Giert Torgërsen" (ex-"Thorshovdi"), are described in some detail. The essence of the problem, in each case, was the same, viz., the locating of the two portions of the ship in dry dock, the correct distance apart and in their proper relation to one another in the horizontal and vertical planes. The fifth case, that of the Anglo-Saxon Petroleum Co.'s motor tanker "Standella", involved what was virtually a surgical operation, though the principles and method employed were basically the same.—*Paper by E. J. Hunter, read at a meeting of the N.-E. Institution of Engineers and Shipbuilders on the 14th November, 1947.*

Recent Developments in Photo-Elasticity

The author begins with a short historical survey of the science of photo-elasticity up to the year 1938, and goes on to give a detailed explanation of the new technique of using monochromatic circularlypolarised light and counting interference fringes. He also describes the construction of a polariscope for quantitative stress analysis. He discusses the properties of plastic materials of the kind used for making models and puts forward a suggestion for overcoming creep. The paper includes examples of stress analysis for discs and rollers, gear teeth, material cut by a lathe tool, material subjected to internal radial pressure due to a forced fit, eccentric loading, and for a boiler tube-plate. The author then explains the application of the frozen-stress technique and the scattered-light method to three-dimensional work, and discusses the utilisation of the former for dynamic loading. The paper concludes with some examples of where the photo-elastic method has been used successfully for the solution of problems in engineering design and production, and some observations of the author on the future of photo-elasticity in this country.—*Paper by J. Ward, B.Sc., Ph.D., "Transactions of the Institute of Marine Engineers", Vol. LIX, No. 11, December, 1947.*

Mechanical Stokers

Although mechanical stokers have become firmly established for use with coal-fired watertube boilers, their application to Scotch marine boilers has been less general. The development of the sprinkler principle, however, has led to the design of a number of mechanical stokers suitable for use with small-furnace boilers, and one of these designs incorporates some improvements which, it is claimed, make it particularly suitable for handling low-grade fuels. In this design, a sprinkler bore having only two moving parts is employed, the upper one being the measuring valve that regulates the fuel supply and the lower one being the distributor which actually spreads the fuel on the fire. There are no springs, shovels or plungers exposed to the effects of heat and grit. An independent axial-flow screw fan is provided for each furnace and the gas velocities have been reduced to a minimum, thereby practically eliminating the carry-over of fires brought about by burning slack and unscreened coal. Another feature is that owing to the uniform fuel distribution, the stoker operates with a much thinner fuel bed than is usually considered desirable, its thickness being only 2 to 3in., so that a strongly oxidising atmosphere is provided, in consequence of which combustion is more efficient. The speed of the measuring valve is controlled by an infinitely-variable clutch in the gearbox, and all the moving parts are immersed in oil.—*"Shipbuilding and Shipping Record", Vol. LXX, No. 19. 6th November, 1947, p. 523.*

Ship Welding

In his presidential address to the Institute of Welding Mr. J. L. Adam (chief surveyor of the British Corporation Register of Shipping), declared that much of the criticism of ship welding, particularly in relation to the vessels built in the U.S. under the emergency programme, was ill-informed and unfair. The proportion of all-welded American ships in which serious trouble developed was relatively small and many of the defects were due to faulty detail design and would probably have caused trouble in any ship. As 2,600 ships of 10,000 tons d.w., representing eight million tons of steel were built to the same design (something that had never been done before) it was not surprising that some 4 per cent. did develop faults. The steel used did not, in all cases, conform to the usual specification, while the time factor affected routine procedure and normal practice. The speaker dealt at some length with American ships because he considered it necessary to correct the idea that there was danger in building welded vessels in normal times to classification rules and requirements. That war-time experiment, apart from being justified by the exigencies of the situation, had been of the greatest value to the shipping community generally.—*"Electrical Review", Vol. CXLI, No. 3,651, 14th November, 1947, p. 735.*

Fabricated Methods of Oil Engine Construction

In a paper read by Mr. J. Botwright, engine works manager of Wm. Doxford & Sons, Ltd., at a recent meeting of the Manchester Association of Engineers, some particulars were given of the great savings in weight and reduction of machining that has been made possible by the substitution of all-welded fabricated components for some of the iron castings formerly used in Doxford marine oil engines. Thus, e.g., the cast-iron bedplate, which weighed 60 tons in the rough as against 24 tons of the steel structure, had to be machined on the top and bottom, whereas only the top of the steel bedplate is now machined, the bottom being sufficiently level to allow chocks to be fitted without any machining. Furthermore, the amount of machining involved is considerably smaller as compared with that which had to be carried out on the C.I. bedplate, only about ⅛in. having to be taken off as against 1-1½in. on the casting. Similar gains are achieved in the construction of the columns, as one steel column now takes the place of two C.I. columns, thereby saving about 2½ tons. The savings on the entablature are very considerable, the steel structure being built in one piece and leaving only ⅛in. for machining on all faces, whereas the C.I. entablature required eight separate castings—four for the air chambers that carried the cylinder liners and camshaft, and four for the cylinder supports. All these castings required machining top and bottom, as did the joints of the air chambers. The total weight of the castings amounted to 56 tons as against 13 tons 10 cwt. for a steel entablature, whilst the total weight saving achieved by the adoption of welded construction for the Doxford engine exceeds 41 per cent., the weight of the C.I. engine being 400 tons and that of the steel engine only 235 tons. A further advantage is that no patterns are required for the welded steel fabrication.—*"The Shipping World", Vol. CVII, No. 2,837, 12th November, 1947, p. 411.*

Fire Precautions in Ships Under Refit and Repair

The author points out that many of the large passenger vessels now undergoing large repairs and reconversion in shipyards are old vessels being gutted, or having temporary plywood divisions, plates and doors removed for repair and W.T. doors inoperative, in consequence of which draught conditions between decks are at their worst for the rapid spread of fire, particularly when the woodwork is tinder dry. In many such ships defective piping and fittings make their own fire-fighting appliances of doubtful value in an emergency. These conditions are temporary and abnormal, and the risk may be expected to lessen as time goes on, but in the meantime it is of the utmost importance that everything possible should be done to reduce both the risk and the effect of an outbreak of fire on board such ships. The causes of these fires are considered to be smoking, temporary lighting and defective ships' circuits, and works processes. Draught conditions, and means of protection during repairs are considered. The functions of fire patrols are discussed, including efficiency checks on the performance of their duties, and the importance of entrusting the control and planning of these to responsible officials. Two particular cases are considered in detail as regards the number of men required for fire-protection duty and the actual nature of this duty—firstly that of a ship dead electrically, with no work in progress and the petrol base ashore, and secondly that of a vessel with live circuits and other factors requiring more intensive patrols. Shipyard fire appliances, such as monitors and hose directors, fire break nozzles, etc., are briefly surveyed, while other sections of the paper deals with liaison with the N.F.S. authorities; access conditions, and new construction. Some typical detailed fire precaution yard regulations and instructions are appended.—*Paper by E. L. Champness, M.Sc., read at a meeting of the N.-E. Coast Institution of Engineers and Shipbuilders on the 12th December, 1947.*

Lloyd's Ship Vibration Exciter

A motor-driven machine capable of forcibly exciting vibrations in a ship's hull for research purposes has recently been constructed by W. H. Allen, Sons & Co., Ltd., for the British Shipbuilding Research Association. This test machine was designed jointly by the technical staff of Lloyd's Register of Shipping and its makers to a specification prepared by Lloyd's. It is a transportable self-contained unit weighing under 10 tons and arranged for easy mounting and operation on the open deck of a vessel under test. The machine is capable of imparting sinusoidal exciting force of known value in any plane, the maximum of which was determined by Lloyd's, to be as follows: (a) 3 tons plus and minus at 40 r.p.m.; (b) 15 tons plus and minus at 90 r.p.m.; and (c) 15 tons plus and minus at 200 r.p.m. Provision is made for easy variation in the value of the exciting forces from zero to the values given above, and the design of the machine permits rapid changes in the direction of the exciting force to be effected when necessary. On completion of tests at the makers' works, the machine was despatched to Falmouth, where it was used on the first ship to be tested. Some valuable data was obtained from this test, and the machine has since been run up to a final speed of 300 r.p.m. with an out-of-balance force of 4 tons.—*"The Allen Engineering Review", No. 17, November, 1947, pp. 12-13.*

Preliminary Experimental Voyage of the Tanker "Niso" under Winter North Atlantic Conditions

The authors explain that the observations made of the structural behaviour of the Anglo-Saxon 12,000-ton d.w. tanker "Niso" on a voyage from Gourock to New York during the winter of 1944-45, constituted part of the research programme undertaken by the Admiralty Ship Welding Committee. The hull of the "Niso" was mainly of riveted construction, but included a number of welded connections, which made it possible to compare the effects produced on riveted and welded joints when subjected to similar stresses caused by external forces. Details of the instruments used and of the readings obtained with them are described in the paper, extracts from the ship's log are given where necessary, and a number of explanatory drawings are presented to show the location of strain readings, etc. The data obtained is tabulated and illustrated by graphs. The voyage is considered to have fulfilled its purpose by providing valuable experience which led to improvements in instrumentation and made it possible to determine the ranges to be catered for with a reasonable degree of accuracy. The close contact with actual rough-weather conditions at sea clarified the main problem and resulted in some radical alterations of the original scheme envisaged.—*Paper by G. M. Boyd, F. B. Bull, M.A.B.Sc., and K. J. Pascoe, M.A., read at a meeting of the Institution of Engineers and Shipbuilders in Scotland, on the 2nd December, 1947.*

Auxiliary Engine Alignment

If a high-speed oil engine has an outer bearing, as in an electric generator, it is always good practice to test the alignment from time to time. An efficient method of carrying out this test consists in turning the crankshaft so that the crankpin next the flywheel is at the bottom centre. When in this position, the distance between the crank webs at the centre of the shaft should be measured with a micrometer. After this figure has been accurately ascertained, the engine should be turned until the same crankpin is on the top centre. When it is in this position, the distance between the crank webs at the centre of the shaft should be measured again. If there is a difference between the two readings, the outer bearing is not in alignment. If the first measurement is greater than the second, this is an indication that the outer bearing is too low, if it is less, then the bearing is too high. It should be added that a difference between the measurements must be expected, but under no circumstances should this exceed 0·001in. If it does, the height of the outer bearing must be adjusted by metal packing between the pedestal and the seating.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 37,379, 11th December, 1947, p. 6.*

Marine Engine Failures

When a piston rod is in process of being threaded, care is essential in the form of the radius at the end of the thread, particularly when the rod is secured in the crosshead by a thread and nut. An example of the class of failure that may occur was provided recently in a reciprocating engine where the L.P. piston rod parted—at the cone of the crosshead. The L.P. piston then smashed through the cylinder cover and carried away a portion of the cylinder wall. After the debris had been cleared away, in order to effect a repair the L.P. slide valve was removed and a special framework made from spare hatch covers was fitted over the steam ports leading to the L.P. cylinder, which were further sealed with shredded asbestos lagging mixed with cement. The engine, thus compounded, was running again in under 12 hours and the ship made her home port at 7½ knots.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 37,390, 24th December, 1947, p. 6.*

Marine Engine Repairs

From the far-off days when one of the triple-expansion engines of the then Atlantic record-breaker "City of Paris" collapsed in a heap on the bottom of the ship after having been too tightly stayed, when the Cunard liner "Umbria" broke her thrust shaft and the engineers serving in her drilled through the thrust collars and bolted them together, enabling the liner to get to the Azores, there are many instances on record where the engineers have saved a ship. In these days of improved machinery and wireless, major engine breakdowns at sea are not so numerous or so serious in their effect as they were 50 years ago, except to the people immediately concerned with the repair. To them a breakdown means a continuous "field day" until the machinery can be started again. This happened recently in a ship which experienced very heavy weather in mid-Atlantic, when she broke her thrust block casting. The fracture allowed all the oil to escape, and as the thrust bearing was of the single collar Michell type, the white metal in the pads promptly ran out. Spare pads saved the situation so far, but the base had to be made oiltight. This was done by improvising a cement box round the casting, which was supplemented by a stiff wire rope lashing wrapped round the base and tightened by stretching screws secured to adjoining ship frame girders.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 37,385, 18th December, 1947, p. 6.*

Oil Engine Developments

In his paper recently presented to the N.-E. Coast Institution, Mr. H. Pyk surveyed the trend of developments in oil-engine design, with special reference to two-stroke machinery. In discussing the scavenging process, he suggests that the loop system seems to offer such possibilities that it is only the question of getting the metal of the piston, cylinder head and liner to stand up to the conditions imposed upon them by service. As is mentioned in the paper, there are disadvantages in adopting loop scavenge, one being the uneven heating-up of the liner. Arrangements can be made, however, to counteract this tendency. Regarding the charge that a loop scavenge system results in a dirty engine, Mr. Pyk does not agree. He states that the main cause of the carbonisation of the exhaust ports is the impossibility of preventing lubricating oil from passing through the ports. If, however, due care is taken to prevent oil from passing the sealing rings, the crankcase should be kept just as clean as in most other types of engines. Speaking of supercharged two-stroke engines, the author observes that, at the moment, there is an economic optimum somewhat about 100 per cent. supercharging, and at this point there is a very considerable saving in weight and space compared with a similar engine without the supercharger.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 37,385, 18th December, 1947, p. 6.*

Whitemetal Bushes

Owing to the scarcity of whitemetal during the war, instructions were issued by the Government that every effort was to be made to conserve supplies, and the thickness of all filled whitemetal bearings was to be reduced. Under some circumstances, this economy might have resulted in improved running conditions, but this reduction in thickness was frequently accompanied by variations in the quality, and therefore hardness, of the metal. The successful running of a filled whitemetal bearing is dependent upon the measure of its bonding to the bearing housing bush, and, with hard metal, efficient bonding becomes increasingly difficult. Moreover, in carrying out this work, it is almost impossible to be assured that a satisfactory and continuous bond has been made unless there is an adequate thickness of metal to work on. A large number of the steam and oil engines built during the war years are afflicted with this thin metal disease. There is, of course, only one remedy for it, which consists in renewing the bush housings when repeated failures occur. In some instances they may be machined to take a greater thickness of bearing metal, but even this makeshift does not provide the essential dovetail strips which prevent the metal from flaking.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 37,385, 18th December, 1947, p. 6.*

Doxford's New Research Department

A new department has been set up by Wm. Doxford & Sons, Ltd., for technical and practical research work. It will have its own technical staff, who will be free from all routine work and ready to give help and advice to present owners of Doxford-engine ships. The department will be equipped to investigate and deal with suggestions, new inventions and methods of manufacture tending to improve efficiency and reduce production costs. On the occasion of the annual general meeting of the company, the chairman stated that during the financial year their engine works had built seven sets of oil engines of 25,500 b.h.p. for ships constructed by Doxfords, and supplied six sets totalling 19,800 b.h.p. to other shipbuilders, making in all a total of over 45,000 b.h.p. as compared with 50,000 b.h.p. in the preceding year. There are at the present time 11 marine engineering firms building the Doxford engine under licence in the U.K. and four abroad, and the power of the engines under construction or on order exceed 1,000,000 b.h.p. During the year the licensees completed 29 Doxford engines of 131,000 b.h.p., making a total of 176,000 of Doxford-type machinery.—*"The Motor Ship", Vol. XXVIII, No. 335, December, 1947, p. 331.*

A New Fire Detector

A Sussex firm of engineers recently carried out a demonstration of an improved design of electric fire detector for ships. The device was originally evolved for use in jet-propelled aircraft. For ships, the unit is designed to operate on ambient temperatures without actual contact with the flame, and responds immediately to any abnormal rise in temperature due to spontaneous combustion or any similar cause. There is a control device which can be pre-set to give the alarm at any particular temperature. Visual warning is given on the bridge, where coloured lights show the position of the danger area, thus allowing the necessary precautions to be taken before a fire has actually started. The apparatus was also demonstrated for the detection of overheated bearings, and gave immediate warning when a predetermined temperature was reached on an experimental shaft bearing. In the course of the demonstration, the unit, which was contained in a small case measuring only a few inches each way, was subjected to rough usage to show its reactions to vibration. The lights flickered when a warning was being transmitted, but the detector continued to function. An automatic fuel temperature controller working on the same principle has also been developed by the firm. In this case, the control unit opens or closes a valve to maintain the temperature within 1 per cent. of the desired figure.—*"The Motor Ship", Vol. XXVIII, No. 335, December, 1947, p. 337.*

Seal-tight Fittings for Diesel Fuel Liner

In the Ermeto fitting freedom from leakage is achieved by the radial compression of a cutting ring which brings the ring's cutting edge into shearing engagement with the tubing, causing a bead of metal to be sheared up on the outside diameter of the tubing against which the ring seats and holds. In other words, the sealing action is produced by a cutting ring which grips the tube as the fitting nut is tightened. The seal produced by this cutting action is completed by the seal of the fitting shoulder and the ring against the fitting bevel. This type of fitting does away with upsetting the ends of fuel line tubing—*N. J. Paquin, "Diesel Progress", Vol. 13, November, 1947, pp. 54-55.*

Steam Condensers with Rolled-in Tubes

The author explains that the older methods of fixing condenser tubes left at least one end free to slide in a gland. Skilful maintenance can hold such a condenser leak-free; but any sudden heating or slight neglect leads to leakage. The obvious solution is to roll the tubes at both ends into the tube plates. The question whether a condenser with no packed joints but with tubes rolled-in at both ends will remain leak-free in practice is answered by the author in the affirmative. However, when applying this method attention must be paid to the following points: (1) the method of allowing for differential expansion between the steel of the shell and the brass of the tubes; (2) alterations to staying; (3) the possibility of effects on vibration characteristics; and (4) how to make reliable rolled-in joints quickly. Provision for expansion can be made either by fixing the tube plates and suitable bowing of the tubes; or by putting an expansion joint in the shell and leaving the tubes straight. The latter alternative was adopted by the author, and accordingly, a Rose's patent expansion ring of rolled steel was incorporated in each condenser shell. Later measurements showed on the completed condensers that almost all the differential expansion movement appeared at these rings, and that the tubes were under no compressive stress beyond that required to move the joint. In view of the large force required to compress the tubes axially, no stays were needed between the tube plates. To minimize leakage risks, the only holes through the tube plates should be tube holes. The author is of the opinion that it is quite unnecessary to support the tube plate by any stays and that means can be found to seal the water-head diaphragms against the tube plate on the inlet/outlet end of a two-pass condenser without cutting any other holes in the tube plate; a simple rubber seal would meet the case. Rolling-in requires that uniformly tight joints shall be produced at high speed and that the sequence of closing in the second ends shall be so ordered as to avoid distortion of the tube plates or unforeseen stresses on the tubes. Following American practice the author employed a current-limiting relay to define the end point of the rolling-in operations. According to American findings, verified by the author for ¾-inch tubes 18-gauge thick, the push-out strength of the joint is related to the horse-power applied to the rollers at the end of the rolling-in process. The article under review contains a detailed description of the tool kit used, and it is stated that this particular tool can be used comfortably to roll-in tubes at the rate of six to eight per minute.—*W. H. Dunkley, "Engineering", Vol. 164, 19th December, 1947, pp. 592-594.*

The Foster Wheeler Boilers in the Orcades

The twin-screw geared-turbine passenger steamship Orcades, at present being fitted out afloat by Messrs. Vickers-Armstrong, Ltd., Barrow-in-Furness, for the Orient Line, is being equipped with four Foster Wheeler water-tube boilers of the two-furnace type, constructed by the shipbuilders. The steam-generating plant, which will supply the 42,500 s.h.p. propelling installation with superheated steam at a pressure of 525lb. per sq. in., and a temperature of 850 deg. F. is of interest on several counts. Not the least of these is the large size of two of the units, which, it seems probable, are the most powerful ever installed in a British merchant ship. Technical data for each of these two boilers are given below:—

Working pressure, lb. per sq. in.	525
Temperature, deg. F.	850
Evaporative capacity, lb. per hour	165,000
Overall thermal efficiency, per cent.	88
Fuel rate (oil fuel), lb. per hour	12,100
Height to top of air preheater, feet	40
Width, feet	27
Length, feet	20
Installed weight, including economizer and preheater, tons	160

The output from each of the two large units is sufficient to provide 16,000 or 17,000 h.p.; while each of the smaller units has a capacity equivalent to 8,500 or 9,000 h.p. In accordance with normal modern practice, the boilers are designed for burning fuel oil, on the balanced system of forced and induced draught, combustion air for the larger units being supplied to the furnaces by means of a forced-draught fan, of 100 h.p., while the induced-draught fan requires 170 h.p.—*"The Shipbuilder and Marine Engine-builder" Vol. 55, No. 468, January, 1948, pp. 47-48.*

Whale-oil Factory Ship Kosmos III

The whale-oil factory ship Kosmos III constructed by A.B. Götaverken for A./S. Kosmos is the largest vessel ever constructed in Scandinavia and the first vessel of this type built in Sweden. She is also the second largest whale-oil factory ship in the world. The overall length is 638ft. 6in.; moulded breadth 78ft.; deadweight 25,100 tons; and draught, 35ft. 1⅝in. The vessel has the usual characteristics of the whale-oil factory ship, with the propelling machinery aft, deep tanks, etc., forward and a range of oil tanks, with two pump rooms, occupying the remainder of the hull below the factory space, the dimensions of which are approximately 341ft. by 78ft. by 17ft., equivalent to 450,000 cu. ft. The decks are without sheer. The flensing areas on the upper deck amount in all to about 25.000 sq. ft. and the erections comprise a poop, with deck-houses above, and both upper and lower forecastles. The range of oil tanks, of which there are eleven, is separated from the ends of the ship by terminal coffer-dams, and is subdivided into three groups by the two pump rooms. The tanks are subdivided by three longitudinal bulkheads, that at the centre-line being of the Götaverken special corrugated type. The hull, which is strengthened for navigation in ice-filled waters, is almost entirely of welded construction. Both the seams and butts of the shell and bulkhead plating are welded, though the frames are riveted to the shell. The decks have been largely constructed by means of automatic welding machines. Electric power is extensively employed to operate the deck machinery, which includes an electric windlass, electro-hydraulic steering gear, a large number of electric winches, two electric capstans and a number of electric boat winches. The three whale-handling winches, two of which are of 50 tons capacity, are, however, steam-driven. The propelling installation consists of a Götaverken single-acting, two-stroke cycle, nine-cylinder Diesel engine of the crosshead design, the cylinder diameter being 680 mm. and the piston stroke 1,500 mm. At 112 r.p.m. the engine develops 8,300 i.h.p. which is sufficient to maintain a service speed of 13½ knots.

The layout of the engine room follows conventional tanker practice, with electrically driven circulating pumps for the lubricating oil and cooling water circuits, and two electrically driven air compressors for charging the manœuvring air receivers. Steam required for heating and operating certain auxiliaries is provided by six all-welded Scotch boilers, installed on a flat which forms the crown of the wing tanks and cross-bunker at the forward end of the machinery space. Each boiler has a heating surface of 3,230 sq. ft. and is designed for 180lb. per sq. in. working pressure. The boilers are arranged to burn fuel oil on the Howden system of forced draught, the combined capacity being approximately 45 tons of steam per hour. About half the steam generated is employed in the evaporating plant which has an output of 640 tons of fresh-water per 24 hours, and provides make-up water to replace the steam consumed in the pressure-boilers in the factory. Electric power for the factory machinery, etc., is provided by five 240 kW. Diesel-driven generators. The other three generators are installed in the engine room; there are two 140 kW. Diesel-driven units and one 110 kW. steam-driven set.—*"The Shipbuilder and Marine Engine-builder", Vol. 55, January, 1948, pp. 42-45.*

Collier With Geared Diesel Machinery

Trials were recently made of the motor collier Fulham VIII, built by the Burntisland Shipbuilding Company, Ltd., to the order of the Fulham Borough Council. This vessel, which has been specially designed for navigation on the Thames, has three large self-trimming cargo holds. All the deck machinery is electrically driven, and the masts are arranged to telescope into the hull; while the funnel and deckhouses have been designed to the limits set by the Thames bridges. The principal particulars are: length b.p., 260 feet; breadth, 39ft. 6in.; depth moulded, 18ft. 9in.; draught loaded, 17ft. 5⅜in.; gross tonnage, 1,773 tons; and deadweight tonnage, 2,630 tons. The machinery arrangement is the first of its type to be fitted in a British collier. The propulsion plant consists of two Mirrlees, Bickerton and Day 12-cylinder 35 deg. V supercharged four-stroke engines. The cylinder diameter is 8·5 inches and the stroke 13·75 inches; the normal rating is 820 b.h.p. per engine at 600 r.p.m. Each engine is coupled through a David Brown cone-ring flexible coupling to a Vulcan Sinclair scoop controlled hydraulic coupling as shown in the figure. The driven members of the hydraulic couplings are connected to double helical pinions in a David Brown gearbox which mesh with a common gearwheel, the gearbox ratio being 5·1/1·0. The gearwheel is coupled through intermediate and tail-end shafting to a single four-bladed propeller of 13-feet diameter which has a maximum speed of 114·7 r.p.m., allowing for 2·5 per cent. slip in the hydraulic couplings. A separate fuel pump is provided for each cylinder, mounted on the column and driven direct from the camshaft. A governor driven by bevel gears off the end of the camshaft controls the fuel pumps through the engine speed range. Stopping, starting, and speed variation is controlled by a single wheel; while for reversing a small hand-operated lever is used to admit air to one end of a pneumatic cylinder; this moves the piston to the ahead or astern position, so that by means of a connecting lever the ahead or astern cam followers are brought into operation. Fresh water cooling is provided for the main engines. The scoop-controlled fluid couplings supplied by the Hydraulic Coupling and Engineering Company, Ltd., have their input shafts supported in self-aligning roller bearings and are equipped with multi-disk flexible couplings. The runner shaft is rigidly mounted. The self-aligning bearing gives a certain degree of angular flexibility at the input side, while the flexible coupling provides for similar angular flexibility at the output side. The complete unit therefore acts as a short cardan shaft and is capable of compensating for small errors in alignment of the driving and the driven shafts. Also, the weight is distributed between the driving and the driven shafts, so that the rotating weight of the coupling is not overhung from the driving shaft alone. At full load and speed the coupling has an output speed of 585 r.p.m., the slip being 2½ per cent. By means of the scoop control gear infinitely variable speed regulation can be obtained over a range of about 3/1 when low propeller speeds are required with the engine running at its minimum governed speed of 230 r.p.m. At higher engine speeds the coupling is operated with the scoop fully engaged, and speed regulation is obtained by the engine fuel control.—*"Shipbuilding and Shipping Record", Vol. 71, 22nd January, 1948, pp. 105-106.*

Large American Ore Carrier

It is reported that the first of four very large identical bulk ore-carrying vessels, the Chilore, was recently completed for the Ore Steamship Corporation, a Bethlehem Steel Company subsidiary, by the Bethlehem-Sparrows Point Shipyard, Sparrows Point, Maryland. This vessel is of 8,564 tons gross and 24,427 tons displacement weight, and is 560 feet long b.p., 78 feet beam, and 43ft. 9in. depth. Loaded displacement is 32,450 tons and sea speed is 15½ knots. The single-screw propulsion plant, placed at the after end of the ship consists of double reduction geared turbines developing 13,000 s.h.p. with two high-pressure water-tube boilers. There are two watertight longitudinal bulkheads running throughout the cargo holds. The spaces outboard of these bulkheads and below the comparatively high tank top are used for ballast only and are divided into twelve compartments on each side and in the double bottom by intermediate transverse watertight bulkheads. All bulkheads are built on the Frear system of corrugated plates.—*"Shipbuilding and Shipping Record", Vol. 71, 15th January, 1948, p. 77.*

Cargo and Passenger Vessels Nova Scotia and Newfoundland

Two 15-knot geared-turbine single-screw steamships, the Nova Scotia and the Newfoundland, each of some 7,500 tons gross and 15 knots service speed, have been built by Vickers Armstrong Ltd. at Newcastle-on-Tyne for the Johnston Warren Lines Ltd. The first-named was placed in service in September, 1947, while the second ship will be among the early deliveries of 1948. These vessels, which are sister ships as far as technical features are concerned, have a length b.p. of 415ft.; breadth moulded, 61ft.; and depth moulded to upper deck of 34ft. 9in. Gross tonnage is 7,438 tons and displacement weight is 6,550 tons. Propelling machinery consists of one set of Parsons-type turbines driving a single screw through reduction gearing. There is one high-pressure impulse-reaction single-geared rotor, one intermediate pressure all-reaction single-geared rotor, and one low-pressure all-reaction single-geared unit, arranged in series, and driving separate pinions engaging with the main gear wheel. Normal power is 6,000 s.h.p. with a propeller speed of 100 r.p.m., the power margin being sufficient to maintain a service speed of 15 knots. The overload power of 6,500 s.h.p. is developed at 103 r.p.m. The astern turbines consist of one three-row high-pressure impulse wheel, incorporated in the intermediate-pressure ahead turbine casing, in series with one three-row low-pressure impulse wheel, incorporated in the low-pressure ahead-turbine casing, the total astern power being approximately 66 per cent. of the ahead power. The turbines are designed to operate at 425lb. per sq. in. and 750 deg. F. All the rotors are of the solid type, in forged carbon steel, the impulse wheels being forged with the drums. The reaction blading is of stainless iron in the high-pressure and intermediate pressure turbines and of monel metal in the low-pressure turbine, with mild steel packing and side locking strips of Low Moor iron. All the impulse blading is of Hecla A.T.V. steel with impulse nozzles of phosphor bronze and "Staybrite" steel vanes, cast in. There are three Yarrow water-tube boilers with "Melesco" superheaters and tubular air heaters; the steam conditions at the superheater outlet are 450lb. per sq. in. and 750 deg. F. Total boiler heating surface for all three boilers is 14,586 sq. ft.; total superheating surface is 3,510 sq. ft., and total air heating surface is 13,860 sq. ft. Each boiler has an evaporative capacity of 33,000lb. per hour. The boilers are arranged to burn oil only under a forced-draught closed-duct system, with open stokehold; combustion air is supplied by three Howden electrically driven forced-draught fans.—*"The Shipbuilder and Marine Engine-builder", Vol. 55, No. 460, January, 1948, pp. 28-41.*

Modern Developments in Marine Refrigeration

The marine transportation of frozen products now requires temperatures so low that under certain conditions single-stage operation of Freon-12 reciprocating compressors is no longer practical. In the article referred to the author presents some of the more important features of two cargo refrigerating plants which are claimed to successfully solve the problem. In one of these plants a Freon-11 centrifugal compressor is used; while in the other multiple Freon-12 reciprocating compressors are arranged for two-stage cascade operation. The author gives a list of installations of centrifugal refrigerating machines on shipboard and notes that the first installation was made in the Koan Maru of the Imperial Railway Steamship Company of Japan in 1935, which was also the first extensively air conditioned ship in the world. In 1942 centrifugal machines were applied for the first time on ship board for cargo refrigeration. This was in six completely refrigerated meat carriers requiring a temperature of 15 deg. F. in all spaces. The author describes various features of a typical centrifugal plant which consists of two four-stage F-11 marine centrifugal compressors each driven by a 250 h.p. four-stage impulse turbine. Each unit consists of a shell and tube type sea water condenser, shell and tube type brine cooler, compressor, steam turbine, and interstage cooler. Only one unit is required to carry the load, the other serving as standby. The cascade reciprocating plant of approximately the same capacity consists of five F-12 compressors, each driven by a 60 h.p. motor. This gives 25 per cent. standby capacity. Both plants produce 225 deg. F. brine for low temperature operation and are designed to maintain −10 to +55 deg. F. in all compartments. The author gives a comparison of the space requirements of the two plants and finds that in spite of the greater capacity of the centrifugal plant the reciprocating plant requires 33 per cent. more space. Surveys indicate that centrifugal machine maintenance is appreciably less than with other compression systems, and its efficiency is higher than that of other type compressors under comparable operating conditions. The author concludes that while the centrifugal machine has many advantages, experience nevertheless has shown that each installation must be considered on its own merits. Centrifugal plant is limited to relatively large tonnage operation. The reciprocating plant, on the other hand, can be furnished for practically any capacity range by varying the number of compressors. The naval architect and the marine designer therefore should consider all the features which influence the design of the plant. Both systems have their place in marine installations and the decision as to which should be used should be governed by a careful study of the case in point.—*S. W. Brown, Paper presented at the Annual Meeting of The American Society of Refrigerating Engineers, 9th December, 1947; "Refrigerating Engineering", Vol. 55, No. 1, January, 1948, pp. 36-41, 86, 88, 90.*

Development and Testing of a Gas-turbine Combustor

This paper treats of the development work carried out by the Westinghouse Electric Corporation (U.S.A.) on a combustion chamber for a 2,200 h.p. gas turbine and its subsequent performance and tests. The design involved a simple and compact unit operating on the open cycle without regenerator, reheater or intercooler. Because of the necessity of using No. 6 or bunker C fuel with inherent burning difficulties imposed by the specification, many problems had to be overcome before an efficient combustion chamber could be assured. Various types of igniters were tried and it was found necessary to use a gaseous fuel such as propane or acetylene instead of light fuel oil. This flame lighter is equipped with a spark plug and operates with gas and air pressures of 5 to 7lb. per sq. in. above the pressure in the burner. The problem of flame stability is considered. Completion of cumbustion was measured in accordance with the definitions given by the Navy Bureau of Ships in the Gas Turbine Gas Chart, Res. Memo No. 6-44, December, 1944.—*A. E. Hershey, "Transactions A.S.M.E.", Vol. 69, No. 8, November, 1947, p. 859-867.*

ENGINEERING ABSTRACTS

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Magnetic Couplings

Magnetic couplings are used mostly as clutches between Diesel engines and gearing for marine propulsion and as variable speed slipping devices for boiler fan drives in conjunction with squirrel cage motors. The author explains that the magnetic coupling or eddy drag coupling consists of two rotating members one revolving inside the other, separated by an air gap. One part is connected to the motor or engine, the other to the load. In the original type, the Salient-Pole Marine Type, shown in Fig. 1, the inner member consists of salient poles excited by coils through which direct current flows. This normally is called the primary or field unit and produces a magnetic flux which traverses the air gap and the laminated magnetic material on the outer member in which are slots carrying copper bars connected together like the rotor winding of a squirrel cage motor. When the primary field is excited, any difference in speed between the two parts produces an alternating magnetic flux in the secondary member, the action being similar to that of squirrel cage motor in which the rotating field produced by the alternating current in the stator causes induced currents in the bars of the rotor. It is obvious that the aforementioned arrangement can be reversed and the field or primary part may be the external part if more convenient. This may be the case in large marine clutches. Similarly, either member may be connected to the motor or engine shaft and the other to the load shaft. A magnetic coupling only transmits whatever torque the engine can give, and this it does without any change in its average value except for the very small friction and winding torque. The magnetic coupling therefore definitely is not a torque converter. The simple type of salient pole coupling described above is that originally used by A.S.E.A., a Swedish firm, as a flexible coupling and as a conveniently detachable clutch for connecting Diesel engines to ship propulsion gears, in which application it has various advantages. Since in this type the poles are large, the air gap can be tolerably wide, say 0·25 to 0·4in. radially, and the two motors can be freely overhung from their respective shafts, provided the latter are sufficiently aligned to prevent a very appreciable variation in the concentric air gap. Later developments of this type has simplified its construction, the laminated secondary member is now in some cases superseded by a solid steel ring with the necessary slots cut in it to take the squirrel cage windings. A rather different type of magnetic coupling for industrial purposes has been

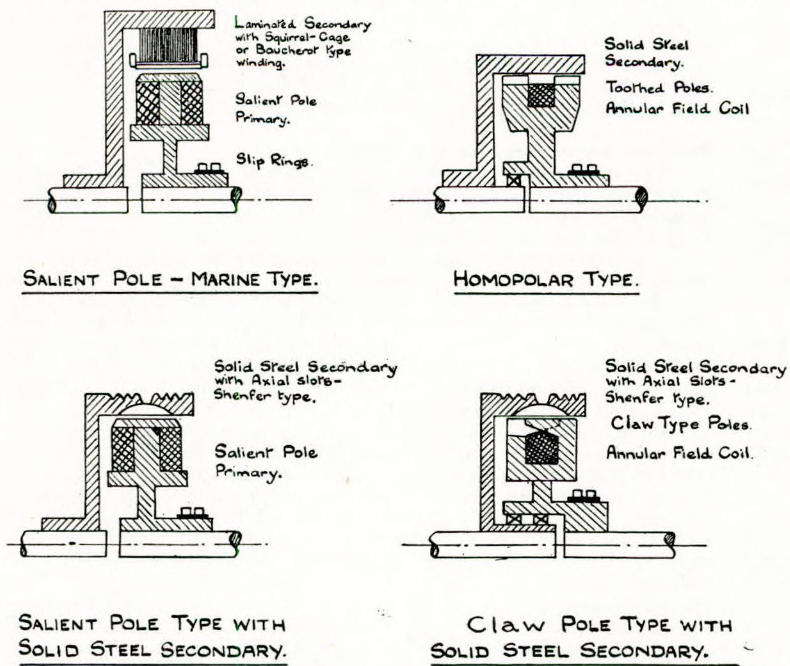


FIG. 1.—*Diagram showing types of magnetic couplings*

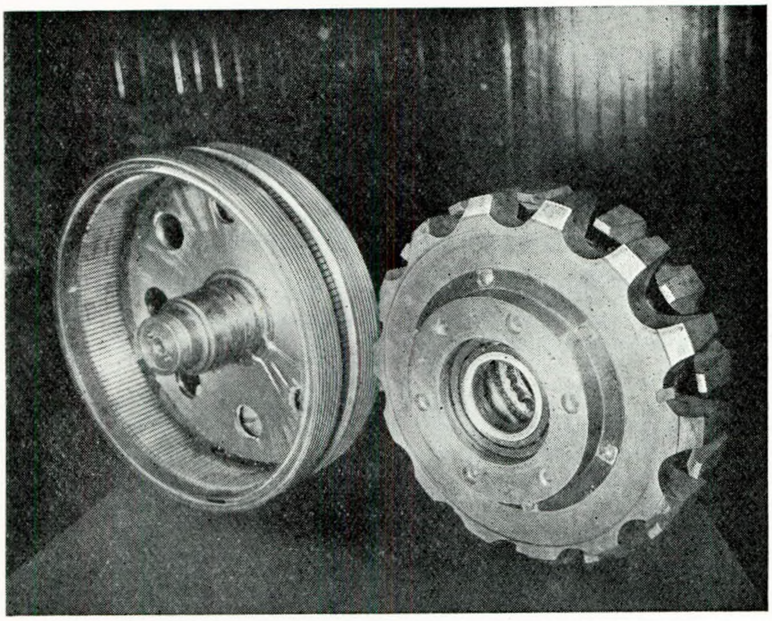


FIG. 9.—*External secondary and inner claw type*

developed in America and is made in this country by Heenan and Froude and B.T.H., as shown in the right hand top part of Fig. 1. This coupling consists of an internal solid steel ring with teeth in the two end portions like a straight tooth spur wheel having a single excitation coil wound circumferentially on this ring. This gives a series of north magnetic poles on one side of the coil and south magnetic poles on the other side. The magnetic flux in this case does not alternate but only varies at a particular point on the secondary surface from a maximum density when the middle of the pole is opposite it. This type requires much less exciting power in the field coils than the salient pole type, but is not so suitable for very large diameter marine-couplings because of its inherently small air gap. An intermediate type (left hand bottom part of Fig. 1) has also been designed and tested in this country on a 170 h.p., 1,500 r.p.m. model for special purposes. From the latter model the type shown in the last sketch in Fig. 1 has been developed by the English Electric Company for fan and similar drives and for powers from 20 to 1,200 h.p. or so. This has an internal field with a single circumferential exciting coil for the smaller sizes as in the homopolar type; but the teeth in this case are formed into overhung claws alternating right and left like the fingers of clasped hands, Fig. 9. In the homopolar and claw type magnetic couplings the use of a single exciting coil, whilst very economical, gives a continuous magnetic flux in the shaft; the latter flux can be minimized by the use of a two-coil magnetic coupling, but it has not been found necessary to adopt any special safeguards to ensure satisfactory running.—*H. S. Carnegie, Belfast Association of Engineers, Lecture read at Meeting on 4th February 1948.*

Five-bladed Propellers

In connexion with the "Owasco" class of cutters for the U.S. coast guard service, the preliminary trials of the first of thirteen vessels of the type revealed undesirable vibrational characteristics, and an investigation was undertaken to determine the cause and possible corrective measures. The natural frequencies of the hull were determined experimentally, and it was found that the readings were substantiated by the vibrations experienced with the three-bladed screws. Subsequently the diameter of the propellers was reduced, thereby increasing the tip clearance, and the amplitude of the vibrations was thereby diminished; but these were still objectionable. Four-bladed propellers were then tried and a great improvement was obtained; and when five-bladed screws were used the results obtained are described as "outstanding". So remarkable was the difference that the vessels of the class were fitted with screws of the type, and these proved to be free from vibrational tendencies. While it is accepted generally that increase in number of blades brings about a loss in propeller efficiency the fact that vibrational effects may be eliminated (in certain cases) by increase in number of blades must offset any minor loss in power and speed which this entails.—*Shipbuilding and Shipping Record", Vol. 71, 12th February, 1948, p. 187.*

Hydraulically Operated Variable-pitch Propeller

A British patent recently granted to the Escher Wyss Engineering Works of Zurich covers a variable-pitch propeller. Referring to Fig. 3, a piston (6) is connected to a rod (9), which

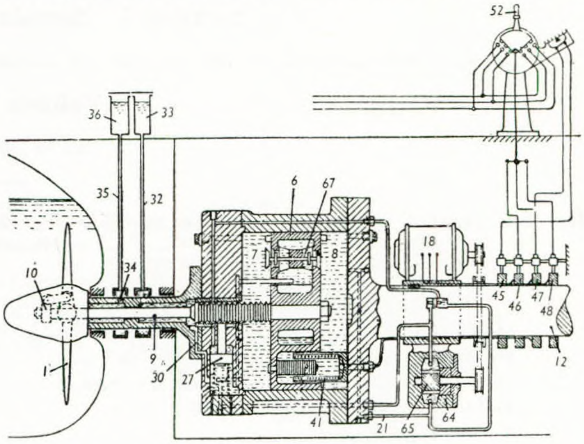


FIG. 3.—*Escher Wyss hydraulically operated variable pitch propeller*

moves links (10) for adjusting the blades (1). Hydraulic operation is provided by a motor (18) driving a pump (64), a feature of the arrangement being that the pump and motor are secured to the propeller shaft (12) and rotate with it. The piston (6) is hollow and contains a change valve (67), which controls communication between the hollow space in the piston and the spaces (7, 8) on opposite sides. The valve prevents any tendency to overflow from one of the spaces in which pressure is to be produced, into the piston cavity. An induction coil (41) is connected to slip rings (45, 46) and two more rings (47, 48) supply current from the mains to the motor (18). When the pump wheel (65) rotates, oil is drawn from the space on the left of the piston (6) and delivered into a space on the right through a pipe (21). The right-hand disk of the change valve (67) is, therefore, moved on its seat· while the left-hand disk opens communication between the hollow space in the piston and the chamber on the left. In order to adjust the blades in the opposite direction, the motor (18) is reversed by operating the lever (52). The space below the plunger (27), which locks the main piston, is connected by a passage (30) and a pipe (32) to an overhead reservoir (33). A second reservoir (36) is connected by a pipe (35) and a passage (34) to the interior of the propeller hub, which is thereby filled with oil. (Patent No. 588,795. Escher Wyss Maschinenfabriken, A.G., Zurich). —*"The Motor Ship", Vol. 28, February, 1948, p. 460.*

Problems Encountered in U.S. Ships

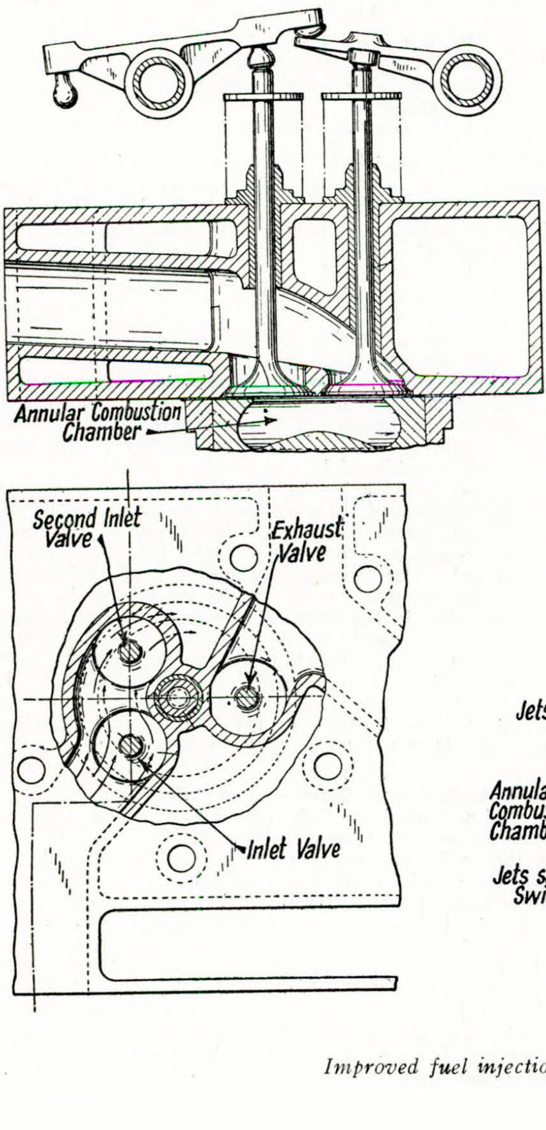
The causes and cures of certain failures and problems relating to American-built ships, were described by Mr. J. Lewis Luckenbach, president of the American Bureau of Shipping, at the annual meeting. Referring to forthcoming recommendations to overcome the failures encountered in the propeller shafting of Liberty ships, he stated that these failures are attributed to two causes. One cause, now believed remedied, was a defective seal at the propeller. The other is attributed to a torsional critical developed at certain rotational speeds. A torsional vibration analysis of the propulsion system was made by the staff of the American Bureau of Shipping. Their findings were subsequently confirmed by torsiograph tests conducted aboard ship by the General Electric Company. These tests indicated that there is a third order critical speed in the normal operating range which induces a stress of about 4,500lb. per sq. in. This vibratory stress is sufficiently high to cause a failure of this type, but only after the shafting has been run at or near the peak for a considerable length of time. Reports received in the spring of 1947, of the failure of rudders on Liberty vessels led to the manufacture of spare or replacement rudders of the original design being stopped immediately. In collaboration with the original designers and various owners, new improved designs were developed to be used as replacements. Furthermore, instructions were widely distributed to surveyors, owners and operators, covering the methods to be followed in the examination, repair and reinforcement of the existing rudders. To date, out of approximately 1,700 vessels operating and in class with A.B.S. about 500 have been either fitted with rudders of the new design or have had the original rudders reinforced. Of these vessels, there have been no reports of failures, and similar work on other vessels is proceeding at the rate of between 20 to 30 a week. Cases of crankcase explosions on Diesel engines also resulted in considerable investigation by the American Bureau of Shipping in conjunction with the Diesel Engine Manufacturers' Association. From this, revised specifications which will, it is believed, eliminate this difficulty, have been included in the rules. These revisions, having been submitted and approved by the respective technical sub-committees, are expected to be ready for distribution early in spring.—*"The Shipping World", Vol. 118, 18th February, 1948, p. 225.*

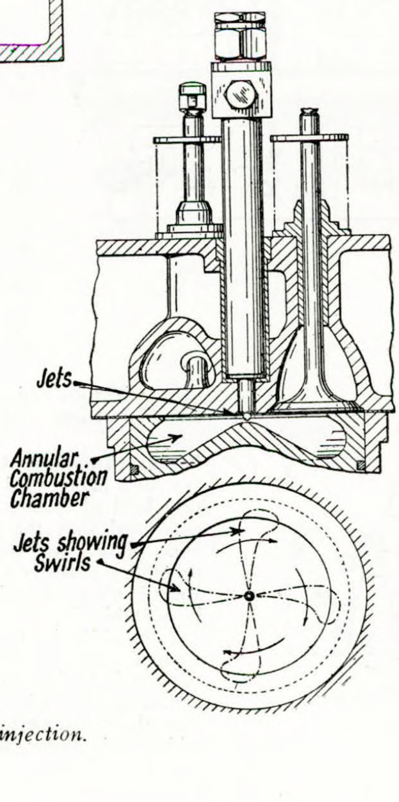
Automatic Steering

At the recent New York motor boat show an automatic magnetic compass was exhibited which was claimed to provide "reliable means for automatic, unattended steering for yachtsmen, fishermen, and work boat operators". This Magnetic Compass Pilot is said to combine successfully a standard magnetic compass with a reliable control mechanism and to be suitable for craft as small as 25 - 30ft. A controller with a knob and course indicator is attached to the top of the compass. The control is applied by an electronic amplifier to the steering engine. A small hand-held remote controller with a flexible cable permits rudder changes to be made from any point on deck away from the helm.—*"Canadian Shipping", Vol. 19, February, 1948, p. 25.*

Improved Fuel Injection

A British Patent, No. 587,276, has been granted to F. Perkins Ltd., and W. Spoor, of Peterborough, on this subject. The specification states that: "It is well known to be important that the fuel injected into the engine cylinder should be rapidly mixed with the compressed air which is present and this is promoted if the air has a swirling movement in the combustion chamber. It is also important that the combustion chamber should be effectively scavenged so as to be as free as possible from burnt gases, and a further condition considerable is that the direction of injection of the fuel should be such that the whirling movement of the air is calculated to bring as much air as possible into contact with the jets of fuel as the combustion proceeds. In order to prevent variation of output between one cylinder and another, the combustion chamber should be readily reproduced with exactitude to the designed shape; in other words a combustion chamber made from rough castings is undesirable". In the invention air is introduced into the cylinder with a tangential component of movement relatively to the cylinder axis; an annular combustion chamber is located in the piston, and fuel is injected in a direction transverse to the direction of circulation of air in the annular combustion chamber; thereby a swirl is set up in the air in the cylinder during the inlet stroke, which swirl persists during the compression stroke when the air is compressed into the combustion chamber, the air circulating round the annular space of the combustion chamber. The axis of the circulation extends lengthwise of the cylinder. The fuel, being injected transversely to the motion of the air in the annulus, is deflected as it burns and carried round with the air, with the result that freshly injected fuel continually meets a fresh portion of the air and complete combustion is facilitated. Details of the new combustion chamber are shown in the accompanying illustration.—*"Gas and Oil Power", Vol. 43, February, 1948, p. 52.*





Improved fuel injection.

Grain Carrier Steered by Propellers

The 596ft. grain carrier "Cartasca" operating on the Upper Missouri is equipped with three 300 h.p. "Harbourmaster" Diesel units for propulsion and steering and one 165 h.p. Diesel in the bow to be used solely for steering. Each of the "Harbourmaster" units is powered with a General Motors Diesel engine delivering 300 h.p. at 1,600 r.p.m., the total reduction being 5·9/1. Hydraulic remote controls for clutch and throttle are provided. The employment of Harbourmaster units does away with the need for a rudder and the craft is steered solely by the thrust of the propeller, which can be swung through a full 360 deg. The propeller-thrust steering control is motivated electrically from the pilot house. With this control the operator can instantly direct full propeller thrust in any direction, and can thus eliminate the usual loss of time involved in manœuvring in and out of locks. The chances of becoming wind-bound, even when the vessel is light, are claimed to be remote; the bow steering unit serves to prevent skidding and speeds up progress on tight bends. Each of the propulsion units is equipped with a power-lifting mechanism which makes it possible to elevate the entire submerged assembly to a position directly overhead, thus facilitating repairs. Propellers can thus be straightened or changed without recourse to drydocks or divers.—*"Marine Engineering and Shipping Review", Vol. 53, January, 1948, p. 79.*

Lightweight Diesel Engines of the Multiplex Type for High Powers

Large marine Diesels of the conventional type with outputs ranging from 6,000 b.h.p. to 10,000 b.h.p. show less favourable output/weight ratios than small Diesels. This is due to the fact that high powered Diesels with large stroke must operate at slow speed. In order to overcome this difficulty, high powered Diesels must be equipped with large numbers of small diameter cylinders instead of with a small number of large diameter cylinders. In recognition of this basic requirement, American designers have proposed the use of multi-engine installations with eight to twelve Diesel generators for each electric propulsion motor. The author of this article considers that this solution could be justified only by wartime exigencies. He therefore proposes an entirely different solution which consists in the use of "multiplex" engines. This engine type was originally proposed by G. R. Hamel in 1924 and has now been developed by a French syndicate which has built and tested an experimental engine in 1945-1946. The favourable results obtained have led to the formation of a company which is now undertaking the production of the new engine in series. The multiplex engine operates on the two-stroke cycle and is of the opposed piston type. Each engine element comprises one single cylinder, two pistons, two piston rods and two cranks and the fuel injection equipment. The engine cylinder is standardized at 130 mm. diameter and 150 mm. stroke, giving a volume of 4 litres per cylinder. The cylinder arrangement is shown in Fig. 2, while the gearing employed for transmitting the power to

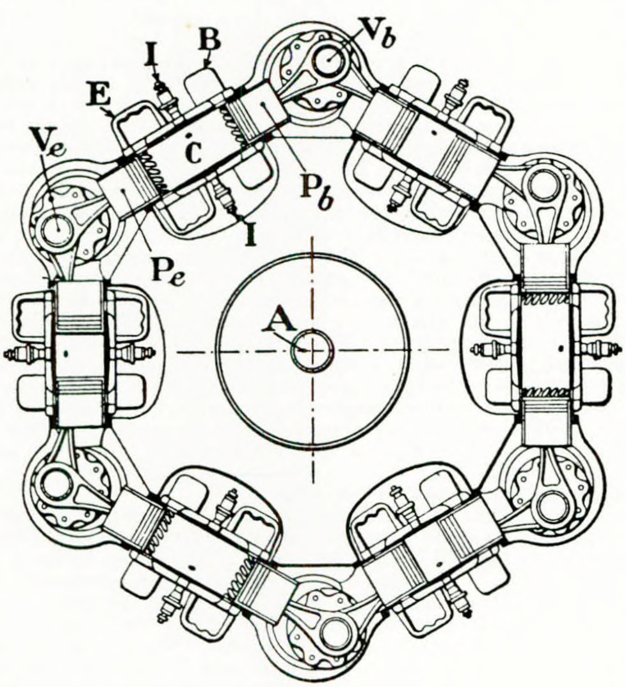


FIG. 2.

A Mainshaft.
B Scavenging air duct.
C Cylinder.
E Exhaust duct.
I Injectors.
P_b Piston on scavenging side.

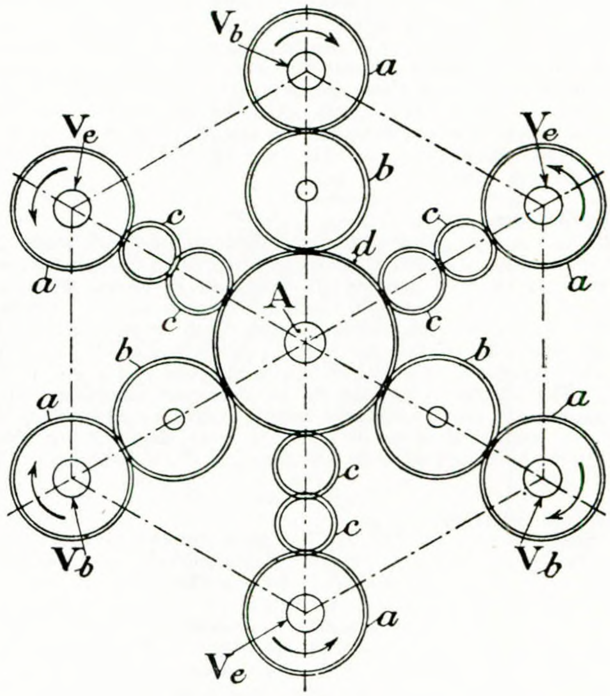


FIG. 3.

P_e Piston on exhaust side.
V_b Crankshaft scavenging side.
V_e Crankshaft exhaust side.
a Gears.
b, c Intermediate gears.

the centrally placed main shaft is indicated in Fig. 3. This polygonal arrangement of the cylinders is claimed to result in perfect dynamic balance and consequent freedom from vibrations. Each cylinder is rated at 35 b.h.p. per piston, equal to 70 b.h.p. at an engine speed of 1,300 r.p.m. The piston speed is 6·5 metres per second with a mean effective pressure of 7 kg. per sq. cm. By assembling five hexagons in line, a 30-cylinder engine is obtained which develops 2,000 b.h.p., and by assembling seven hexagons in line, 3,000 b.h.p. can be obtained from 42 cylinders. An engine comprising four engine groups each having 6 hexagons with 36 cylinders is outlined in Fig. 6. The diameter of the hexagons will be 2·5 metres so that the height of the main shaft above the engine base will not exceed 1·25 metres. Unit weight of the engine will be 5 kg. per b.h.p., while space requirements will be less than 1 cu. metre per 100 b.h.p. Small multiplex units with outputs of 150 to 600 b.h.p. may be used as auxiliary units for marine purposes. The space savings achieved by the use of engines of this type are exemplified by Fig. 7 which shows the space requirements of (1) a nine-cylinder Diesel of conventional design delivering 6,000 b.h.p. at 105 r.p.m., (2) a group of two nine-cylinder Diesels of conventional design turning at 225 r.p.m. and having single reduction gear, (3) two multiplex Diesels having 42 cylinders in hexagonal arrangement each and having an engine speed of 1,200 r.p.m. and a propeller speed of 105 r.p.m. In all three engine types the piston speed lies between 6 and 7 metres per second. The weight of plant (1) is given as 260 tons, that of plant (2) as 200 tons and of the multiplex plant (3) as 30 tons.—*L. Keuleyan, Le Génie Civil, Vol. 134, 1st October, 1947, pp. 373-376.*

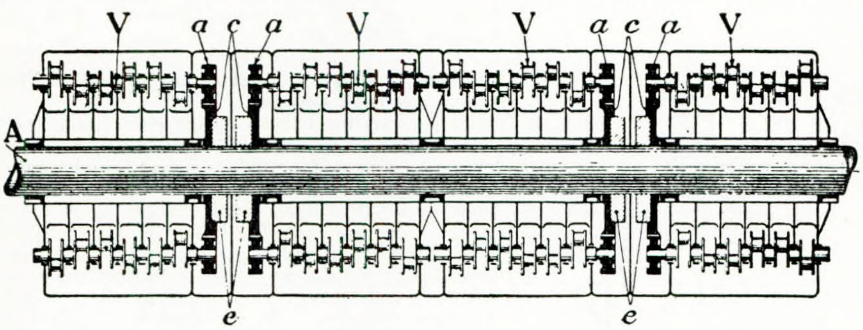


FIG. 6.

A Mainshaft.
V Crankshafts.
a, c Gears.
e Couplings.

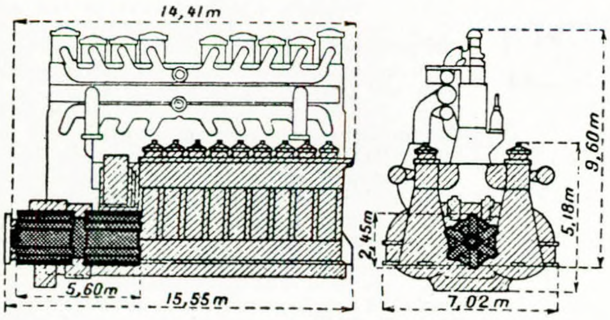


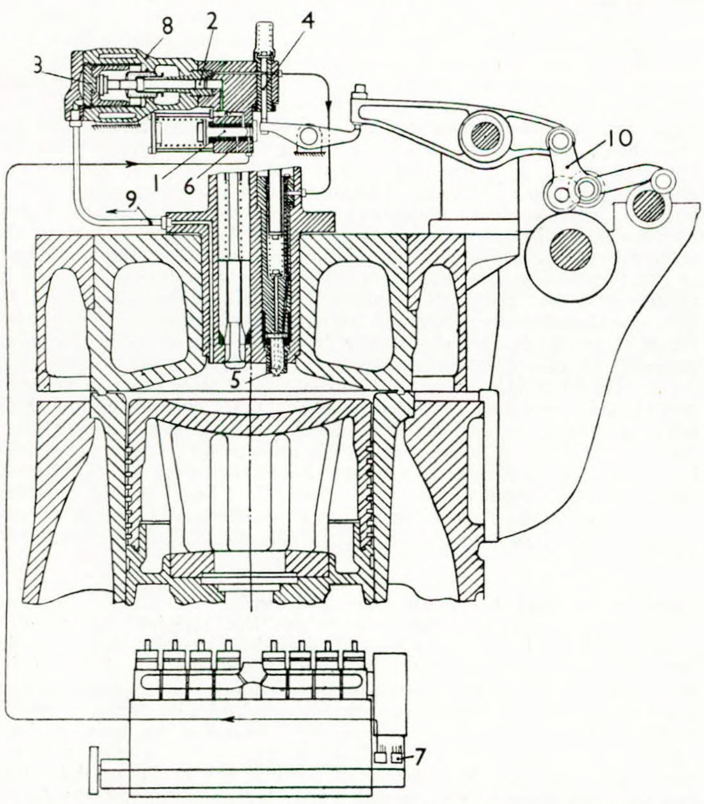
FIG. 7.

Porous-chromium Hardening of Diesel-engine Cylinders

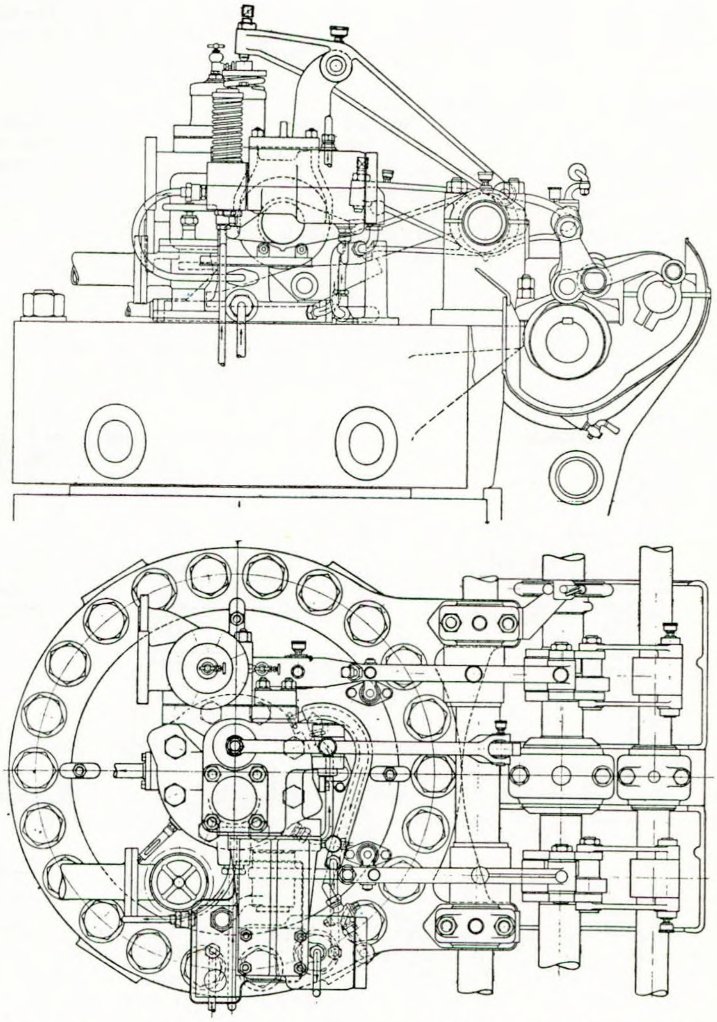
In a paper read at a meeting of the Diesel Engine Users Association held in London on 15th January, 1948, Mr. C. D. B. Williams explained that the main feature of the van der Horst method of bore plating is the provision of a chromium surface having the necessary porosity to hold lubricating oil. This prevents seizure, and wear is also reduced. It is important that the type of porosity should be suitable for the class of engine in which it will be used. There are stated to be two main types of porosity, usually known as the channel and the "pitted" or "cokey" type. In the channel type the surface is broken up into a series of small plateaux interspersed with cracks or channels running in various directions, whereas in the pitted type the plateaux are few and small, while the depressions are both wider and deeper, the surface resembling to a great extent, the surface of a piece of coke. Porosity is produced mainly by a reverse etch treatment after plating, and the type of porosity is controlled largely, but not entirely, by the length and severity of the etching process. The average depth of true porosity is from 0·002 to 0·004in., and it is necessary to be quite sure that the skin thickness of the chromium is sufficient to ensure that no porosity extends to the base metal. Apart from the depth of porosity, the percentage of porosity to plateau area is important. Honing a porous-chromium-plated cylinder bore is an exceptionally skilled operation, as it requires not only dimensional accuracy but correct porosity of the surface as well, and neither requirement must be sacrificed to the other. For this reason, rather wider dimensional limits are usually allowed with chromium hardened bores. The use of a profilometer is unsatisfactory for use on porous chromium, and the most satisfactory method seems to be visual comparison under low magnification with microphotographs of surfaces known to be satisfactory. Average wear figures are : a Diesel engine liner having a bore of 350 mm. after plating showed a wear of 0·0002in. per 1,000 hours running; on a small marine auxiliary engine, plated liners showed a wear of 0·002in. as compared with a wear of 0·02in. with the use of unplated liners under identical test conditions.—*C. D. B. Williams. Paper read at meeting of Diesel Engine Users Assoc. held on 15th January, 1948; "Engineering", Vol. 165, No. 4,280, 6th February, 1948, p. 139.*

Sulzer Airless-injection Equipment

About twenty years ago the Shaw Savill and Albion Company. Ltd. took delivery of four motor cargo ships, each fitted with 7,450 b.h.p.. twin-screw machinery of the Sulzer make. The owners decided some time ago to modernize the engines of one these ships, the "Coptic", by converting them from air blast to airless injection. The engines of the "Coptic" were built by the Wallsend Slipway and Engineering Company, and the conversion took place at their yard. The engines are two six-cylinder units with a diameter of 31in., the piston stroke being 43in. For the maximum output engine speed is 115 r.p.m. The new injection system was devised by Sulzer Bros. at Winterthur, who constructed a single-cylinder experimental unit. When making the actual conversion the compressors were left in position, but the three-stage plungers were removed and a suitable weight preserves the balance. By this means, although the running gear is retained, there is a negligible loss due to friction, and no major alterations need be undertaken at the compressor end of the engine. The system has been termed by the makers "injection with pneumatic



Diagrammatic arrangement of Sulzer airless-injection system with pneumatic accumulation

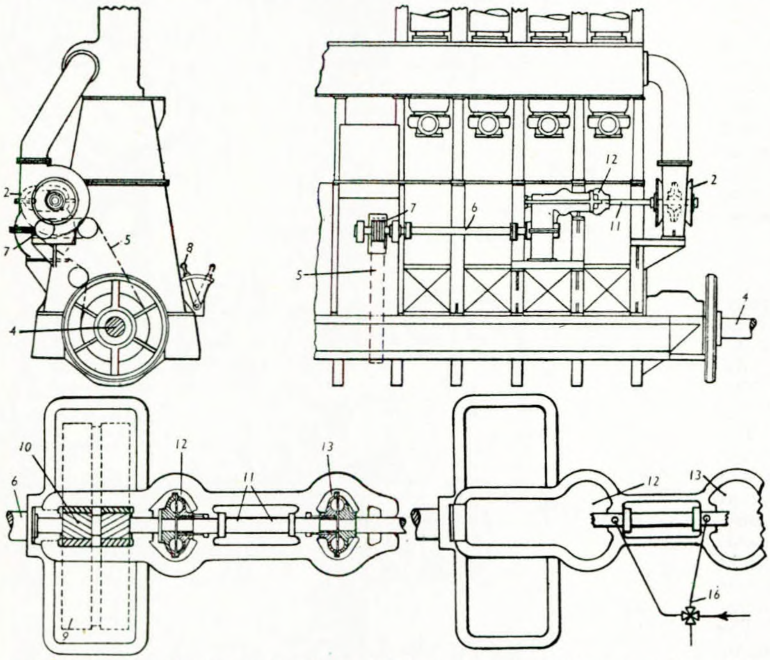


Elevation and plan of cylinder head showing arrangement of new airless-injection equipment

accumulation". The gain in output is stated to approximate to 7 per cent and to be proportionately greater at powers below the maximum loading. The reduction in fuel consumption is stated to be about 5 grammes per b.h.p./hr. The operation of the system is illustrated by the accompanying diagrams. The original fuel pumps (7) are used for measuring the supply and for feeding the high pressure fuel pumps (8). The device includes a spring-loaded storage plunger (1). When the gas pressure in the pipe (9) acting on an accumulator piston (3) has fallen sufficiently low, the storage piston spring discharges the fuel into the chamber (2) of the high-pressure pump, and the compression in the main engine cylinder precompresses the fuel. A control valve (4) allows the fuel to pass into the fuel valve (5), and this operation is accurately timed. Injection continues until the pressure in the fuel pipe has fallen below the closing pressures of the spray valve. This arrangement ensures that the injection starts at the maximum fuel pressure and gives correct atomization from the moment of discharge into the combustion chamber. The gas piston is provided with a special outer ring, which protects the others from the effects of the hot gas discharged through the pipe line from the combustion chamber. This piston (3) operates in a removable liner and any unit can be isolated by closing the cock in the gas pipe (9) without stopping the engine. Both the gas pipe jackets and the gas cylinder are watercooled. The control valve cannot seize in any other than the closed position; and if this occurs, the low pressure pump (7) continues to deliver fuel to the storage piston (1), but as the flow is checked, the increase in pressure drives the plunger (1) back until it uncovers the overflow orifice (6). The usual Sulzer reversing gear is retained, two cam rollers being fitted in a link (10). In converting existing engines the principal new parts are the pneumatic injection pumps together with the necessary piping, the modified fuel valves and their nozzles and springs, and the mechanism for operating the control valves. It is stated that the cost of conversion would amount to about three per cent of the price of a modern Diesel with airless injection, assuming an output of about 7,000 b.h.p.—*"The Motor Ship", Vol. 28, February, 1948 pp. 432-433.*

Scavenge Air Blower Drive

According to Brit. Pat. 592,744 granted to Harland & Wolff Ltd. (W. A. Harper and Sir F. E. Rebbeck), the scavenging air blower arrangement shown in the accompanying figure is provided with two hydraulic couplings which break the transmission into three sections. These are successfully connected in starting and disconnected in stopping the engine, thereby preventing peak-acceleration starting forces



synchronizing, and momenta of the driving parts becoming cumulative when the engine is being stopped. The blower (2) is driven from the crankshaft (4) by a chain (5), the shaft (6) being rotated by a chain wheel (7). A lever (8) is provided for starting the engine. A gear wheel on the shaft (6) drives a pinion shaft (10) and a shaft (11) through a coupling (12). The blower is driven through a coupling (13). In order that the blower coupling (13) shall engage after the coupling (12) when starting, and disengage before it when stopping, the manœuvring valve partially drains the pipe (16) when the control lever (8) is moved to the "stop" position. When the lever is moved to start the engine, the transmission is carried to the pinion shaft (10). Oil enters the coupling (12) and the shaft (11) is then set in motion. Because the pipe (16) partly drains when the engine is stopped, the coupling (13) is later in filling and thereby setting the blower in operation. By moving the lever (8) to the "stop" position, the coupling (13) is emptied before the coupling (12), thereby enabling the blower and its spindle to revolve under their own momentum. The shaft (11) is also free to come to rest in its own time.—*"The Oil Engine and Gas Turbine", Vol. 15, No. 178, February, 1948, p. 360.*

Modern Type of Freighter for Far East Service

A description is given of the design of a modern triple-screw, Diesel-propelled cargo ship intended for service in the Far East. The design was based on the experience of the North German Lloyd in Far Eastern service, and the results of towing tests carried out by the Maierform G.m.b.H. in conjunction with the Schiffbautechnische Versuchsanstalt in Vienna. An order was placed in 1941 for three of these ships, to be built by S. A. John Cockerill in Belgium, and for four to be built by Chantier et Atelier de St. Nazaire Penhoet. The following dimensions were given in the original plans:—

Length b.p.	505·25ft.	approximately
Beam	64·25ft.	„
Depth	33ft.	„
Draught	28·25ft.	„
Displacement	17,000 tons	„
Deadweight capacity ...	11,000 tons	„
Speed	17 knots	„

Diesel oil can be obtained at all the bunkering ports on the Far Eastern route, and therefore only Diesel drive was considered. By using three propellers, directly driven by three separate engines, it was possible not only to use a shorter plant but also to provide for the economical use of the engine when travelling at different speeds. Thus, if full speed were not required the centre screw or the two wing screws could be used separately. The power needed for driving the vessel (totalling approx. 12,000 b.h.p.) was to be obtained from one seven-cylinder engine of 4,550 b.h.p. running at about 140 r.p.m. for the centre screw, and two six-cylinder engines of 3,780 b.h.p. each and 135 r.p.m. for the wing screws. Particulars are given of the modifications made to the original plans, and of the details of the design of the ships. They had a flat keel plate, full-length double bottom, a raked stem, cruiser stern, four pole masts, and six loading posts. Special attention was paid to the provision of easily accessible and unobstructed cargo holds, and of deck accommodation for bulky and heavy cargo such as railway cars, locomotives, boilers, boats, etc. Welding was to be used for the construction of the double bottoms, decks, water tight bulkheads, and deck houses. Only the butt seams of the shell plating were to be welded, longitudinal seams being riveted. Special attention was given to strong reinforcement of the shell plating at the ends of the midship erections. The necessary electric power and lighting was to be provided by three 200-kW. Diesel-driven dynamos, the capacity of two being sufficient for the power required, and the third being kept as a spare. In addition, an emergency dynamo was to be installed in a special room above the bulkhead deck. Particulars are given of the various oil and water pumps, all electrically driven. Heating for the living quarters, etc., was to be provided by three La Mont exhaust-gas boilers and one fuel-oil heated auxiliary boiler.—*Abstract No. 1,457. "The British Shipbuilding Research Assoc. Journal", Vol. 3, No. 1, January, 1948. F.I.A.T. Final Report No. 827.*

The G.S.N. Co.'s Latest 11½-knot Motor Coaster "Teal"

The General Steam Navigation Company's new motor coaster "Teal", has a length of 215ft. b.p., a moulded breadth of 36ft. and a mean draught of 14ft., the corresponding deadweight being 1,135 tons. The two cargo holds have a total bale capacity of 54,740 cu. ft. and their hatches are served by four electric winches and 5-ton tubular steel derricks, an additional 10-ton derrick being provided for No. 2 hatch. The deck machinery includes a motor-driven anchor windlass forward, an electric capstan aft and electro-hydraulic steering gear. There are four D.B. tanks, fuel oil to the amount of about 85 tons being carried in Nos. 3 and 4 tanks, while the forward ones are used for water ballast. The fore-and-aft-peak tanks and a deep tank between the two cargo holds, are also available for the carriage of S.W. ballast. The vessel has accommodation for a crew of 8 officers and 17 petty officers and men, the E.R. staff being made up of three engineers, two donkeymen and two greasers. Every member of the crew has a single-berth cabin and, apart from three messrooms for the crew, there is a smokeroom and dining saloon for the officers. An insulated provision room is located on the main deck aft, together with a refrigerating machinery compartment. The propelling machinery consists of a 7-cylr. two-stroke Polar Diesel engine of the standard type, with a scavenging-air pump driven from the crankshaft at the forward end, as well as a starting-air compressor installed in tandem with and above this pump. The main engine also drives its own circulating-water, bilge and lubricating-oil pumps. The remaining E.R. auxiliaries are electrically driven, current at 220 volts being provided by two 75-kW. generators, each driven at 500 r.p.m. by a 3-cylr. 111-b.h.p. Allen engine. Between these two sets is a general-service unit consisting of a 3-cylr. R.N. Diesel engine developing 27 b.h.p. at 1,000-r.p.m. and driving a 15-kW. generator and a manœuvring air compressor. In addition to this compressor and the one driven by the main engine, there is a motor-driven two-stage s.a. compressor having a rated output of 43 cu. ft./min. The "Teal" may be regarded as representing the most modern type of coasting and general-service vessel.—*"The Motor Ship", Vol. XXVIII, No. 355, December, 1947, pp. 322-325.*

Coasting Oil Tank Motorship "Ben Hebden"

The single-screw oil-tank motorship "Ben Hebden" has recently been completed by the Rowhedge Ironworks Company, Ltd., for the National Benzole Company of London. This vessel is designed for the coastwise transport of home-produced motor spirit. Leading particulars are: length b.p. 135ft., breadth moulded 25ft., depth moulded 12ft., 410 tons gross, 184·2 tons net, 397·5 tons d.w. on designed draft of 10ft. 6in., speed 10 knots. Having regard to the fact that the vessel will, at times, have to lie aground at her berth, special attention has been given to the strength of the bottom structure, the frame spacing being limited to 21in. throughout the length of the ship. The frames are of bulb-angle section, and deep transverse members

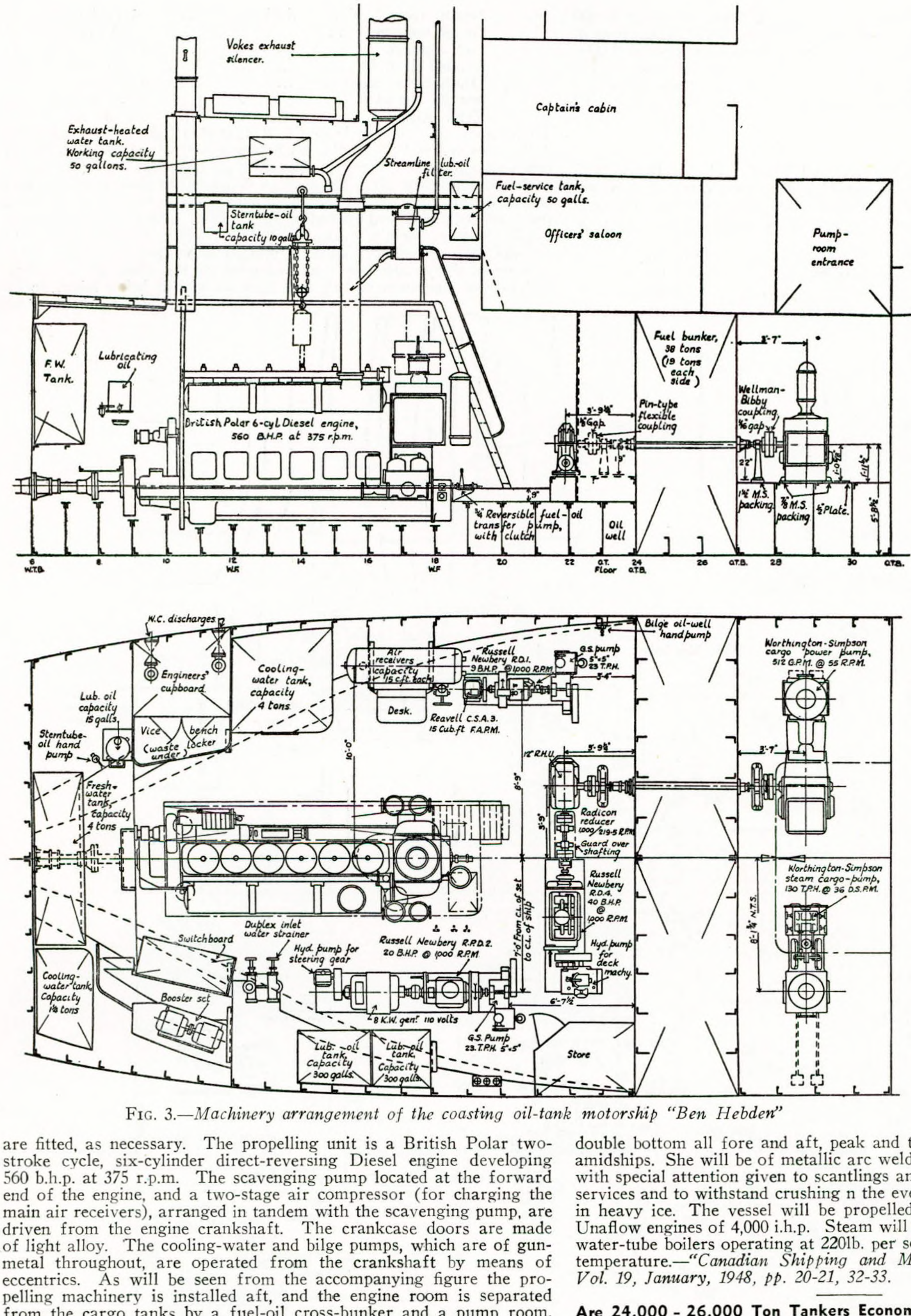


FIG. 3.—*Machinery arrangement of the coasting oil-tank motorship "Ben Hebden"*

are fitted, as necessary. The propelling unit is a British Polar two-stroke cycle, six-cylinder direct-reversing Diesel engine developing 560 b.h.p. at 375 r.p.m. The scavenging pump located at the forward end of the engine, and a two-stage air compressor (for charging the main air receivers), arranged in tandem with the scavenging pump, are driven from the engine crankshaft. The crankcase doors are made of light alloy. The cooling-water and bilge pumps, which are of gun-metal throughout, are operated from the crankshaft by means of eccentrics. As will be seen from the accompanying figure the propelling machinery is installed aft, and the engine room is separated from the cargo tanks by a fuel-oil cross-bunker and a pump room. There are two cargo pumps of the horizontal duplex type, each of which is designed for a duty of 100 tons of spirit per hour against a pressure of 75lb. per sq. in. The port-side pump is seen to be shaft driven from a four-cylinder Diesel of 40 b.h.p. installed in the engine room. This unit, which revolves at 1,000 r.p.m., is flexibly coupled to a worm reduction gear, the gear-wheel shaft of which is carried through the intervening cross-bunker in a tube which has a gland at each end. The worm reduction gear is of the clutch-operated type. The clutch may be operated from the deck as well as from the engine room. The starboard-side pump is a steam-driven unit arranged to take steam from a shore supply; steam pipes are installed between the unit and a valve on the outside of the forward bulkhead of the pump-room entrance, provision being made to facilitate the coupling of the shore steam-supply line. The deck auxiliaries comprising the windlass, capstan and steering gear, are of the hydraulically operated type. Power for the windlass and capstan is derived from a pump driven by the aforementioned 40 b.h.p. Diesel engine.—*"The Shipbuilder and Marine Engine-Builder", Vol. 55. No. 469, February, 1948, pp. 103-107.*

Canadian Vessel for Arctic Patrol

An ocean-going steam vessel specially reinforced for working in ice with a cargo capacity of 1,000 tons, accommodation for 58 passengers and 30 Eskimos, and a cruising range of 10,000 nautical miles, will be built in Canada. The principal dimensions are: length b.p. 276ft., breadth moulded 50ft., depth moulded 26ft., deadweight on 18ft. draft, S.W. 2,615 tons. The vessel will have a raked stem, cruiser stern, continuous upper and main decks, three cargo hatches with steel covers, three holds, transverse framed, double bottom all fore and aft, peak and trimming tanks, deckhouses amidships. She will be of metallic arc welded construction throughout with special attention given to scantlings and framing for ice-breaking services and to withstand crushing n the event that the vessel is caught in heavy ice. The vessel will be propelled by a twin set of Skinner Unaflow engines of 4,000 i.h.p. Steam will be supplied by two oil-fired water-tube boilers operating at 220lb. per sq. in. and 600 deg. F. steam temperature.—*"Canadian Shipping and Marine Engineering News", Vol. 19, January, 1948, pp. 20-21, 32-33.*

Are 24,000 - 26,000 Ton Tankers Economical?

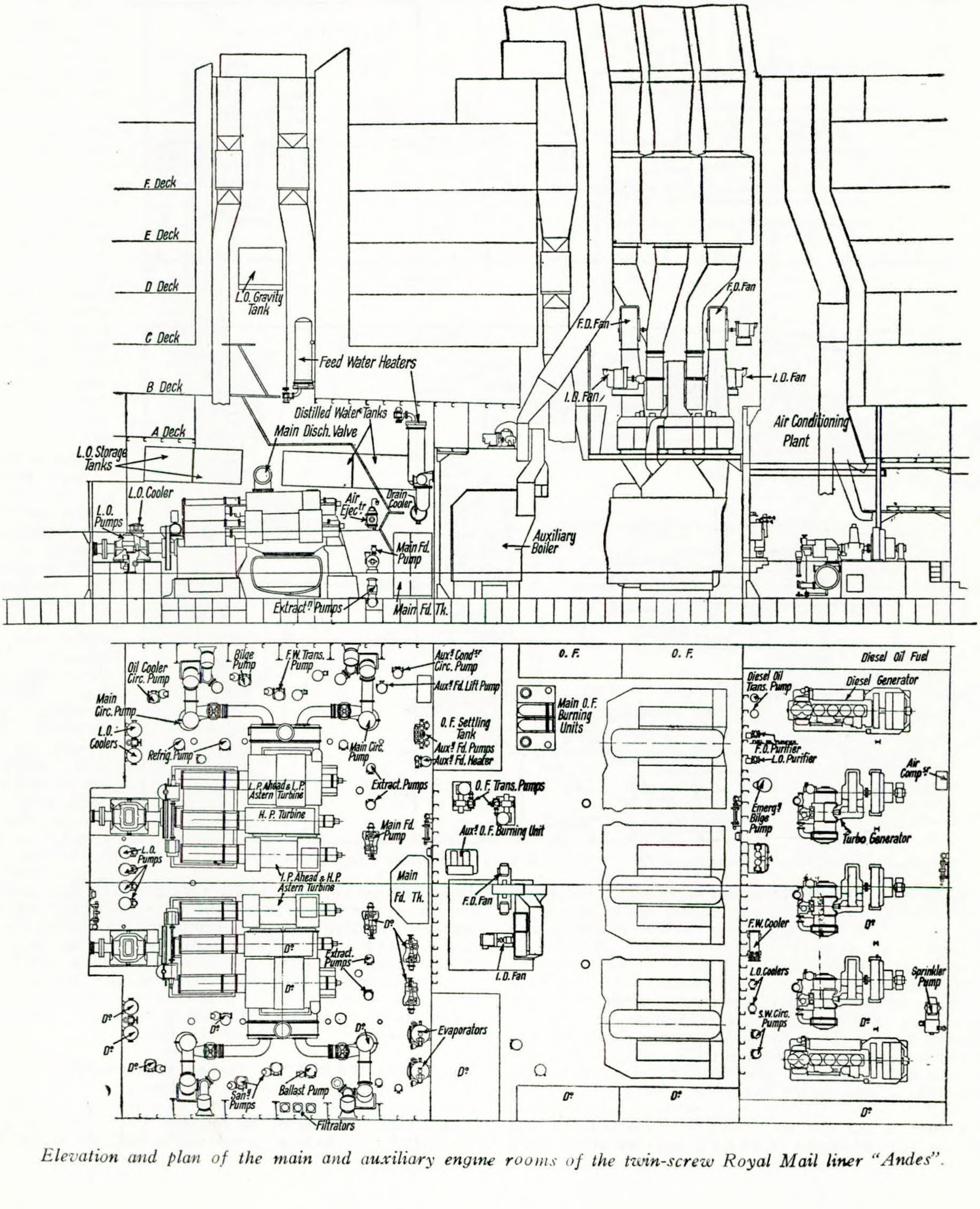
The manager of the Marine Department of the Standard Oil Company of New Jersey recently gave reasons why the studies made by the technical staff of his company had led to the conclusion that the 26,000 tons 16-knot vessel was a suitable design under present conditions. It was found that the T2-type tankers of about 16,000 tons and a speed of 15 knots, enabled oil to be transported in them in most trades about 25 per cent more cheaply than in a pre-war 13,000 tons 12-knot tanker, and for about 30 to 40 per cent less than in the old 11,000 ton 10-knot ships. With a still larger ship it was estimated that transportation costs would be 20 per cent less than with a T2 tanker.—*"The Motor Ship", Vol. 28, February, 1948, p. 425.*

Machinery of the "Andes"

Although completed by Harland and Wolff, Ltd. for Royal Mail Lines just before the war, this vessel is only now entering commercial service, having been requisitioned as a troop-carrying transport during the war. The "Andes" is a twin-screw turbine vessel with the following main particulars:—

Length overall	669ft. 3in.
Length between perpendiculars ...	630ft. 0in.
Breadth moulded	83ft. 0in.
Depth, from keel to C deck	47ft. 6in.
Gross tonnage	25,700 approx.
Net tonnage	14,800 ,,
Loaded draught	29ft. 3in.
Deadweight capacity	10,257 tons.
Service speed	21·5 knots.
Trial speed	23·0 ,,

There are four complete decks (A, B, C and D), also lower and orlop decks forward and aft of the machinery space, forecastle deck, lower promenade deck (E), upper promenade deck (F), boat deck (G), sports deck and sun deck aft. The hull is divided into twelve water tight compartments by eleven water tight bulkheads extending to B deck, the fore peak bulkhead extending to C deck. There is a continuous double bottom for the carriage of fresh water, water ballast and oil fuel. The machinery space is divided into three watertight compartments, the middle one being occupied by the main and auxiliary boilers, the compartments aft and forward of this being taken up by



Elevation and plan of the main and auxiliary engine rooms of the twin-screw Royal Mail liner "Andes".

the propelling turbines and electric generators respectively. The general layout is shown in the accompanying drawings. The propelling machinery constructed by Harland and Wolff, Ltd. consists of twin-screw single-reduction geared turbines of Parsons type taking steam from three Babcock-Johnson boilers constructed at Belfast under licence. The turbines are designed for steam of 375lb. per sq. in. gauge at 700 deg. F. temperature and a vacuum of 27·5in. based on a sea temperature of 85 deg. F. The rated output is 30,000 s.h.p. at 140 r.p.m. of the screws, but in an emergency a 10 per cent overload can be carried. Each set of turbines consists of a h.p., i.p., and l.p. turbine, each driving its own pinion. A h.p. astern turbine is incorporated in each i.p. ahead casing, and the h.p. astern turbine exhausts into a l.p. astern turbine integral with the l.p. ahead turbine. To assist in obtaining maximum economy, end-tightened blading is fitted to the h.p. and i.p. ahead turbines. To make this possible, the h.p. astern turbine has been so designed that there is a constant direction of thrust whether the turbines are going ahead or astern. The h.p., i.p., and l.p. ahead turbines are of all-reaction design, the normal speed of the two former approximating to 1,575 r.p.m. and of the l.p. shaft to 1,375 r.p.m. The h.p. astern turbine is an impulse wheel, but the l.p. astern turbine is an impulse-reaction machine. All reaction blading is of stainless iron, while the impulse blading in both astern turbines is of stainless steel. An emergency governor, with end movement control, is fitted to each turbine and arranged to close the bulkhead self-closing stop valves in the main steam lines when a speed exceeding 16 per cent above the designed revolutions is attained, or in the event of failure of the forced lubrication oil supply or failure of the Michell-type adjusting block pads. The ahead and astern manœuvring valves are of the independently operated type, and a guarding valve is fitted as precaution against leakage at the astern valve when running ahead. The condensers are of the underslung two-flow Weir regenerative type. The condensate temperature, under all variations in steam duty will be within 2 deg. F. of the temperature corresponding to the vacuum measured at the turbine exhaust flange. Each condenser is served by two Drysdale vertical-spindle pumps, each having a capacity of 9,000 gal. per min. For dealing with condensate, a Weir closed feed system is provided. The three Babcock-Johnson boilers are arranged abreast; they are separated from the turbine room by a watertight bulkhead. The combined heating surface of the boilers is 33,735 sq. ft. and that of the superheater is 10,110 sq. ft. On each boiler there are seven oil burners of the Wallsend-Howden type. The air preheaters are of the regenerative Howden-Ljungstrom design.—*"The Marine Engineer", Vol. 71, February, 1948, pp. 49-58.*

Ice-breaking Car Ferry "Abegweit"

This is the heaviest all-welded vessel constructed in Canada. Her principal dimensions are 372·3ft.×62ft.×19ft. loaded draught and her deadweight is 2,000 tons. To withstand the severe ice conditions prevalent in Northumberland Straits during the winter season she was built with unusual strength. For the same reason she has a cut-away bow, trimming and heeling tanks to enable her to be rocked when wedged in ice, and four nickel cast-steel propellers, two forward and two aft. The ship is fully insulated below decks and in the exposed parts of the superstructure with limpet asbestos—a mixture of cement and asbestos, water-applied by spraying directly on the steel surface. The ship has two longitudinal and seven transverse bulkheads, and there are five decks. Nineteen railway freight cars can be accommodated on three sets of rails on the main deck, or, alternatively the ship can carry a complete passenger train, sixty motor cars, and 950 passengers. The Diesel-electric propelling machinery consists of eight sets of Dominion-Sulzer Type T-29 Diesel generators developing 1,500 b.h.p. each, and provides electrical energy for the four propelling motors. The speed and direction of rotation of any one or all four propellers can be controlled from any one of three stations: engine-room, wheelhouse, or docking bridge situated aft. With the exception of the steam-heating plant, the ship is operated completely electrically, and there are 135 electric motors.—*Abstract No. 1,455, "The British Shipbuilding Research Association Journal, Vol. 3, No. 1, January, 1948; "Engr.", 184 (1947), 21st November, p. 489.*

Yangtse-Kiang Ships Building in Canada

In this article the author describes two types of river vessels now building in Canada for operation on the Yangtse-Kiang. Of the steam driven variety three ships with turbines are under construction at the Davie Yard in Quebec. They have a length b.p. of 270ft. and have de Laval turbines driving twin screws; total power is 5,000 s.h.p., giving a speed of about 14 knots. Foster Wheeler water-tube boilers are used, and the ships will be the first to employ this kind of propulsion plant for Chinese up-river service. The author points out considering its kind of water, it would seem at first sight that this great Chinese waterway would be the last to be thought suitable for the employment of water-tube boilers and steam condensers. Six motorships, which are somewhat smaller, are being built by the St. Lawrence Metal and Marine Works at Quebec. Their length b.p. is 160ft., and light metals are being used to a great extent for their superstructure. Each vessel is propelled by two single-acting, two-cycle, airless injection V-type oil engines of the automotive type, developing a total of 1,200 b.h.p. and giving the vessel a speed of 13½ knots. The author reviews similar developments taking place on other rivers and mentions the self-propelled barges for the Irawaddy Flotilla Company, which were recently constructed at the Clyde. In his opinion, the chances of the survival of steam for the propulsion of river vessels are small, and it will probably only be a question of time before the passenger and barge fleets on rivers all over the world will be oil-engine propelled. Attention is also drawn to the fact that, properly handled, river transport in large countries offers a reliable, economical and practical method of transport, particularly of bulk commodities.—*A. C. Hardy, "The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 37,437, 19th February, 1948, p. 5.*

Notable Vessels from Swedish Yard

It is reported that Gotaverken recently delivered to the Swedish-American Line the passenger liner "Stockholm" of 11,700 tons gross. This is the largest passenger liner so far built in Scandinavia. Principal particulars of the ship are: length overall, 524ft. 8½in.; length b.p., 475ft.; beam, 69ft.; depth to main deck, 30ft. 6in.; depth to shelter deck, 38ft. 6in; loaded draught, 24ft. 9in.; displacement, 13,000 tons; contract speed, 19 knots; passengers, 392; crew, 170. On trials the "Stockholm" achieved a speed of over 20 knots. Thirty-two tons of light alloys have been employed in the superstructure, the funnel, wheelhouse and navigating bridge, bulkheads on sun-deck and deckhouse on boat-deck. Six of the eight lifeboats of the vessel are made of light alloy. The vessel has six cargo holds with a total capacity of over 3,000 tons and is equipped with 21,000 cu. ft. of refrigerated space. The propulsion plant consists of two eight-cylinder two-stroke single-acting crosshead oil engines of Gotaverken's own design, driving two propellers and developing a total of 14,600 i.h.p. at 110 r.p.m. The auxiliary machinery is placed in a separate engine-room and consists of three six-cylinder and two three-cylinder Gotaverken oil engines of 380 and 180 b.h.p. respectively. Deck machinery, as well as other auxiliaries, is electrically driven. Two oil-fired boilers of 390 sq. ft. heating surface each are provided. Steam pressure is 100lb. per sq. in. There is also an exhaust gas boiler. The evaporator plant has a capacity of 45 tons per day.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 37,437, 19th February, 1948, p. 2.*

An All-Diesel Drifter-trawler

A Diesel propelled 86ft. drifter-trawler with aluminium alloy superstructure was recently completed by Brooke Marine, Ltd., Lowestoft. The engine room casing and funnel are of salt water-resisting aluminium alloy, the plating being $\frac{7}{32}$in. thick. The whole is of riveted construction throughout. The wheelhouse is also of aluminium alloy. While providing a high resistance against corrosion, the use of aluminium above deck reduces top hamper and adds appreciably to hold capacity.—*"Gas and Oil Power", Vol. 43, February, 1948, pp. 60-61.*

Ship Vibration

This paper gives the results of research on the hull vibration of passenger vessels. The author explains that a ship forms an elastic girder of varying cross-section with a varying load along the length. The natural frequencies of such a beam can be calculated from first principles without the use of any empirical coefficient. Such a method was developed in 1933 and was found to yield remarkably good agreement of observed and calculated values. Three of the problems remaining unsolved were the frequencies of the higher nodes of vertical vibration, the frequencies of horizontal vibration and the effect of superstructures of different lengths upon the calculated frequencies. The paper under review gives the measured and calculated frequencies for a number of ships. In most cases the vibration was measured by means of the Cambridge Low Period Vibrograph. The two-node vertical criticals were measured on thirteen ships, the particulars of which are tabulated in the paper; and a complete calculation was made of these frequencies for eleven of the ships. The greatest percentage differences of 5 per cent or so between calculated and observed values for the two-node vertical frequencies are shown to occur generally with the smaller vessels. The author recognizes the great convenience to the naval architect of having a simple formula which will give the natural frequency with a minimum of calculation from data which are available in the early stages. Proceeding from the formula given by Schlick some sixty years ago, the author develops two approximate formulæ. The first of these involves the detail calculation both of the moment of inertia of the midship section and of the amount and distribution of the entrained water. In the second the moment of inertia has been assumed to be proportional to BD_E^3, where B is the breadth moulded and D_E is an equivalent depth designed to allow for the varying lengths of superstructure, while the amount of entrained water has been assumed to depend on the ratio of beam to draught.—*F. H. Todd, North-East Coast Inst. of Engineers and Shipbuilders, Paper read at Meeting 20th February, 1948.*

Canadian-built Cargo-liners for Brazil

Canadian Vickers, Ltd., Montreal, has during 1947 delivered the first three of a series of six cargo liners for Lloyds Brasileiro. The principal particulars are: length b.p., 424ft.; breadth moulded, 59ft.; load draught, 25ft. 8⅝in.; deadweight, 7,850 tons; gross tonnage, 5,400 tons. Service speed is about 17 knots. The main propelling machinery is a double-reduction geared General Electric turbine developing a maximum of 6,600 s.h.p. Steam conditions are 440lb. per sq. in. gauge, 740 deg. F. total temperature. There are two S.M. boiler units of 40,000lb. per hour evaporation supplied by Combustion Engineering Company, the units being placed above and directly aft of the main turbine. Automatic combustion control equipment is provided.—*"Canadian Shipping", Vol. 19, February, 1948, pp. 16-18.*

Some Considerations in the Design of Modern Ships

This paper deals at length with the design of passenger accommodation in large liners and with problems of air conditioning and of control of fire hazard. Referring to propulsion plant arrangement, the author points out that full advantage of the greatly increased compactness of modern propulsion units has not always been taken. This matter should be given extensive thought in the design stage. The point is also made that another significant consequence of the increasing compactness of propulsion units has been generally overlooked in the design of intermediate passenger vessels. It has become customary to prescribe twin-screws for all passenger-ship horsepowers in excess of approximately 10,000 h.p. But twin-screw installations were developed originally because it was not possible at the time to build and to install in a single engine room a unit of machinery large enough to develop the higher horsepowers and speeds desired. To-day, with ship dimensions increased, and machinery sizes and weights much reduced, this condition no longer exists; yet there seems to be a strong reluctance to use a single-screw for the higher horsepowers. This the author ascribes to the prevailing conviction that twin screws offer a necessary and desirable factor of safety in the event of propeller or shaft damage. Yet, around the turn of the century, first-class single-screw passenger ships, as, for instance, the "Umbria" and the "Etruria" ran for many years without experiencing any noteworthy difficulties due to propeller or shaft damage. In the opinion of the author, this feature of the twin-screw installation has been over-emphasized, and more serious consideration should be given to a single-screw arrangement for some of the larger horsepowers, in view of the substantial economies involved..—*G. G. Sharp, The Society of Naval Architects and Marine Engineers, New York. Paper presented at annual meeting, 13th and 14th November, 1947.*

Lloyd's Register Review of 1947

During the year 1947 there were launched in Great Britain and Northern Ireland 393 merchant vessels, of 1,202,024 tons gross, comprising 156 steamers, of 630,103 tons, 187 motorships, of 562,656 tons, and 50 non-propelled craft, of 9,265 tons. The output for 1947 is 6·1 per cent more than that for 1946. In 36 vessels of 372,690 tons the propelling power is derived from steam turbines. One of these vessels, of 12,200 tons, is fitted with electric drive, and reduction gearing is employed in the remainder. In addition to these, 14 vessels, of 59,639 tons are fitted with a combination of steam reciprocating engines and turbines. The tonnage of vessels fitted with internal combustion engines launched during 1947 is 47·2 per cent of the total output of steam and motor tonnage during the year.—*"Lloyd's List and Shipping Gazette", No. 41,563, 26th February, 1948, Shipbuilding and Engineering Section, p. 4.*

Classification Societies and the Efficiency of Hull Structures

This paper illustrates the societies' requirements for a number of structural members. The subject matter discussed includes keel, stern posts and rudders, double bottoms, bottom forward, beams, girders, bulkheads, deep tanks, deck construction and deck houses. The author points out that classification societies will give every encouragement to the production of more efficient structures.—*J. L. Adam, Paper read at a meeting of the N.-E. Coast Inst. of Engineers and Shipbuilders on the 23rd January, 1948.*

A Small Hydraulic Pump

Two types of an improved design of hydraulic pump are now being manufactured by a firm in the Isle of Wight. One type of pump is designed to give a constant delivery of 5 g.p.m. at a pressure of 2,000lb. per sq. in. The body of the pump contains a hard close-grain cast-iron rotor, which has axial cylinder bores along its full length and is rotated by the driving shaft at a speed of 1,400 r.p.m. In each cylinder bore are two opposed pistons, which are reciprocated as the rotor turns by two cams at each end of the pump. Interposed between each of the pistons and the cams are phosphor-bronze slipper pads, which have a small degree of oscillation. Each of the opposing pairs of pistons are held apart and in contact with respective slipper pads by a spring. Each cam face is formed with a pair of diametrically opposed high points, and between these points are corresponding diametrically opposed low points. As the pads turn with the rotor, they pass over the successive high and low points of the cams and impart a reciprocating motion to the pistons. In one revolution of the rotor each pair of pistons is forced inwards and drawn apart twice to produce two pressure and two suction strokes. A stationary valve spindle has at its inner end two opposed inlet ports, leading to the oil supply passage, and two delivery ports opening into the central delivery passage. As the rotor turns, these inlet and delivery ports communicate in succession with the ports leading to each of the cylinder bores. The valve, whilst stationary, is not rigidly fixed in the pump body, but is free to move slightly in a longitudinal direction and about its own axis, this small degree of movement serving to give the valve a long working life. As the oil pressure from the diametrically opposite cylinders is balanced, a minimum running clearance can be allowed between the valve and the rotor, thus ensuring long and efficient working of the pump. In the variable-delivery type of pump the cam is rigidly attached to the pump casing, and in relation to it the cam is capable of being rotated 90 deg. to vary the relationship between the high and low points on the opposing cam faces. This movement changes the phase of reciprocation of each pair of pistons, and is used to vary the output of the pump from zero to maximum capacity. Teeth formed round a sector of the cam mesh with a rack on a piston in the cylinder. Hydraulic fluid from the pressure circuit is by-passed into the cylinder and presses the piston against a spring. To counteract the pressure of the hydraulic fluid on the piston, suitably graded springs are employed to hold the cam to the required pump output setting through the rack. With this means of control the pump delivers hydraulic fluid at a constant rate until the pressure in the circuit exceeds the initial control-spring setting. When this pressure in the circuit exceeds the pre-set limit, the pressure of the fluid forces the piston back against the spring load, and the rack rotates the cam to reduce the capacity of the pump. When the required pressure in the circuit is reached, the spring returns the piston to its position of balance and the pump continues to deliver just sufficient fluid to maintain the pressure. In the event of the pressure in the hydraulic system dropping, the spring overcomes the oil pressure and moves the rack to bring the cam into the maximum-delivery position until the pressure is restored.—*"The Engineer", Vol. CLXXXIV, No. 4,786, 17th October, 1947, p. 370.*

Threadless Pipe Fittings

Threadless malleable pipe fittings represent a new development for which it is claimed that it simplifies any piping layout and makes it possible to join steel or wrought-iron pipe without threads and without welding by a brazing method which any competent pipe fitter can use. The "Flagg-Flow" threadless fitting is a black malleable-iron socket-type fitting for brazing to steel or wrought iron. The cup of this fitting is reamed to accommodate the outside diameter of standard pipe and also to produce a shoulder or stop for the pipe when it is inserted. There is said to be materially less pressure loss due to friction and turbulence in a piping system using these fittings than in a similar system using threaded fittings. This reduced loss is particularly marked when handling viscous or semi-solid fluids, and the design of the fitting reduces the effects of turbulence in the pipe and fitting. Utilization of the full wall thickness is permitted, and therefore of the full strength of the pipe, since no metal is lost in threading. It is claimed that the fittings have proved the ability of the joint to withstand much higher rates of vibration than threaded joints and are therefore advantageous on lines subject to vibration, contraction or expansion. An oxy-acetylene torch is used to make the joint. No special equipment is required and normal silver-brazing techniques are employed.—*"Mechanical Engineering", Vol. 70, No. 2, February, 1948, pp. 148-149.*

Mechanical Reduction Gears

Discussing the manufacture of reduction gears, the authors lay emphasis upon the essential requirement that the quality of finish of the gear parts must be of the highest standards obtainable. Particularly does this apply to the journal, bearings and teeth. The journals of both the pinions and the gear wheels must be round and straight, within an upper limit of 0·0005in. The surfaces of the teeth as they leave the gear cutter are generally not sufficiently smooth to meet the requirements of a reduction gear for a main propulsion machine. The finish should be enhanced either by shaving or by the so-called "lapping" process. While the standard form of tooth with a flat bottom root has been in common use for many years, the practice of connecting the bases of adjoining teeth by a completed fillet results in a tooth much more resistant to fatigue than is the case with the older design where the corner radius is very small. Since shipowners are concerned with noise generation in the machinery, particularly in passenger ships, it is incumbent on the gear manufacturer to take all of the steps possible to keep the noise level of the gear to a minimum. Unfortunately, it is not easy to stipulate an upper tolerance with respect to noise. Merely to require that a gear operates with a sound level expressed in decibels below a certain limit overlooks the fact that gears with a relatively high decibel reading occasionally will emit noise that is by no means disturbing in view of the fact that the frequency is at a low level. It is not unusual to have a gear with a low decibel reading of, say, 90 decibels, but with a frequency that is particularly annoying to the human ear. With the exception of noise, the present principal difficulty facing gear engineers is the reduction of pitting. With the urge to reduce the size of reduction gears by increasing the unit loading of the teeth, it is doubtful whether pitting can be eliminated entirely. On the other hand, recent tests have proved conclusively that the smoother the tooth surface and the more accurate the involute curve on the flanks of the teeth, the less will be the amount of pitting. The abrasive action that occurs occasionally between gear teeth and is known under the general term of "galling" is now a relatively infrequent occurrence. It seldom if ever happens on the smaller teeth, and it is common practice among manufacturers to use what is known as "tip relief" on the larger teeth. From this, one can conclude with reasonable certainty that galling is produced by the fusion of the materials of the teeth due to the heat generated by the pressure and sliding at the point of contact when the quality or quantity of lubricant is insufficient. By reducing the size of the teeth and thus decreasing the rate at which sliding takes place, or by tip relieving the top edges of the flanks of the larger teeth, thus removing a portion of the surface where the sliding is greatest the tendency to this abrasive action can be eliminated. The calculation of the actual loading of the gear teeth is a straightforward procedure if it is assumed that the load is uniformly distributed over the contact lines of all the meshing teeth. In a spur gear the loads per inch of tooth length and per inch of face width are considered to be the same. In a helical gear where the loading extends over a diagonal line that covers only a small proportion of the length of the tooth, the bending stress cannot be determined readily. The authors show how a rational estimate can be made on the basis of test results. The effects of tooth cutting accuracy on gear performance are dealt with and a simple expression for the calculation of gear losses is also given. With regard to the lubrication of gear teeth the authors come to the conclusion that the spray method appears to be the simplest means for introducing oil to the teeth; also, this method results in minimum turbulence. The construction of gear wheels by welding is also discussed. —*J. A. Davies and H. W. Semar, The Society of Naval Architects and Marine Engineers, New York; Paper read at Annual Meeting 13th November, 1947.*

Tightness of Expanded Tube Joints

A simple theoretical evaluation of the conditions conducive to maximum tightness of a tube joint is presented. The residual pressure between tube and tube plate which can be considered as a measure of the tightness, possesses a maximum at certain tube dimensions. If tube and plate are of the same material, the tightness increases with increasing ratio of outside to inside diameter of the tube, up to a ratio of 1/4. If the tube is made from a metal sufficiently stronger than that of the tube plate, the residual pressure becomes larger, possessing a maximum at a ratio of 1·65 of the tube diameter.—*G. Sachs, "Journal of Applied Mechanics", Vol. 14, No. 4, December, 1947, p. A285-A286.*

The Creep Properties of Molybdenum, Chromium-molybdenum and Molybdenum-vanadium Steels

The author presents essential information regarding the working stress-temperature properties of molybdenum-vanadium type steel which has enhanced properties as compared with normal steels at present in use for high-temperature superheaters and steam pipes. Attention is drawn to the limitations of short-time tests, particularly when estimating the creep characteristics of a new type of steel. Extensive data are given regarding creep tests at different temperatures and stresses conducted on 0·5 per cent. molybdenum, 0·8 per cent. chromium—0·5 per cent. molybdenum and 0·5 per cent. molybdenum—0·25 per cent. vanadium steels. The effects of carbon, silicon, manganese and aluminium are discussed; as are also the effects of various heat treatments. Rupture tests of up to 58,000 hours duration were made and the mode of failure is discussed. By an extensive series of long-time creep tests the stress-temperature relationships for 0·1 per cent. and 0·2 per cent. deformation in 100,000 hours have been estimated for the molybdenum vanadium steel and suitable short-time tests for checking the quality of such steels are discussed.—*J. Glen, "Journal of The Iron and Steel Institute", Vol. 158, Part I, January, 1948, pp. 37-80.*

Resistance to Buckling of Light-alloy Plates

This paper gives an account of some experimental work which has been carried out on the buckling of light-alloy plates, and this work is related to existing experimental work for steel. Possible modes of failure of large stiffened sheets of plating in compression are considered. Some general conclusions are drawn wih regard to the application of the results to ship construction.—*W. Muckle, Paper read at a meeting of the North-East Coast Inst. of Engineers and Shipbuilders, 5th March, 1948.*

Gas Turbine Metallurgy

A report on the research activities carried out by the British Thomson-Houston Company, Ltd., in 1947 refers to the metallurgical problems attending the design of gas turbines. The company has a 1,200 h.p. gas turbine under construction for installation in the tanker "Auris", and it is stated that great care had to be exercised in the selection of suitable alloys for the various parts, since the disks and blades in the high-pressure rotor must have not only high-temperature creep strength, but also resistance to attack at high temperature from combustion gases of high sulphur content. Welding problems have also had to be met and overcome. In the steam-turbine field, creep and stress-relaxation properties of turbine bolt materials are being investigated, and for this purpose a stress-relaxation testing machine is being constructed. The material at present most widely used for high-temperature high-pressure casing flange bolts, namely, a chromium molybdenum steel, has certain disadvantages under modern stresses and temperatures. The results of ordinary creep tests indicate that a molybdenum-vanadium steel will be satisfactory, and it is planned to make a series of stress-relaxation tests on this class of steel. —*"Lloyd's List and Shipping Gazette", No. 41,557, 19th February, 1948, Shipbuilding and Engineering Section, p. 9.*

Ductility of Steels for Welded Structures

In the 1947 Campbell Memorial Lecture of the American Society of Metals, Dr. A. B. Kinzel explained that "the essence of the weldability problem is the ductility of the weldment". Unlike strength, which can be measured directly and expressed in numerical design values, the quality known as ductility can be defined in a variety of ways, and, when measured, its acceptance value is arbitrarily fixed on the basis of experience. After reviewing various testing methods the author expressed the opinion that all the factors which reduce ductility should be integrated in a test-piece in a manner similar to their integration in service, and specific recommendations are made. The opinion is expressed that the deleterious effect of restraint has by no means been overemphasized in recent literature, and the welding engineer has great responsibilities in specifying the proper cycle of operations to minimize the restraint imposed by the heat effects of the successive welds, and in insisting on proper pretreatment and final stress relieving when necessary.—*"The Engineer". Vol. 185, No. 4,805, 27th February, 1948, p. 208.*

Application and Use of Aluminium Alloys in Ship Construction

The purpose of this paper is to furnish the naval architect with information on the properties of various aluminium alloys and their application to ship design in place of steel. According to the author the primary justification at the moment for the use of aluminium in place of steel is the saving in weight that can be obtained. This in turn will be reflected in increased dead-weight carrying capacity, which is a point to be considered when evaluating the higher cost of aluminium alloys. Although the proportions of aluminium vessels in general will follow those of steel vessels, an increase in the depth to beam ratio and a decrease in the length to depth ratio are considered advisable. Every reasonable attempt must be made to keep the number of furnace heated plates and shapes to a minimum. If required to be heated, in order to be formed, they must subsequently be heat treated. Wherever possible, the design should be such that cold forming will be all that is necessary. For plates, shapes and extrusions, the 61S alloy is used almost exclusively in consideration of its high strength and good corrosion resistance; its composition is 0·8 - 1·2 per cent magnesium, 0·4 - 0·8 per cent silicon, 0·15 - 0·35 per cent chromium, 0·7 per cent iron, 0·15 - 0·4 per cent copper, 0·15 per cent titanium, 0·15 per cent max. manganese, 0·2 per cent max. zinc, other elements 0·15 per cent max., remainder aluminium. The tensile strength of plates is 42,000lb. per sq. in., yield strength is 35,000lb. per sq. in., and elongation in 2in. is 10 per cent. For shapes the tensile strength is 38,000lb. per sq. in., the yield strength is 35,000lb. per sq. in., and elongation in 2in. is 10 per cent. Based on the given properties and experience to date it is reasonable to assume a design stress of 15,000lb. per sq. in. An aluminium *versus* steel weight comparison shows a saving of approximately 44 per cent in favour of the final section in aluminium. This saving is made up as follows:—

	Saving per cent
Shell plating	46
Framing, longitudinal and transverse	32
Deck plating	50
Main structural bulkheads	41
Inner-bottom plating	45
Superstructures	50

Taking into consideration the other items included in the ship's weight, the total saving will approximate to 38 per cent, made up as follows:—

	Saving per cent
Cargo handling and rigging	33
Miscellaneous fittings	37
Hull piping	45
Electrical plant	18
Deck machinery and miscellaneous	12
Total for complete equipment and outfit	27
Machinery, total	24
Total weight saving, complete light ship	38

As riveted construction is employed for light alloy, consideration must be given to the deflexion of the ships as a whole and to the effect of this deflexion on the ability of the riveted joints to preserve the tightness of the structure. The amount of deflexion in an aluminium ship as compared with a steel ship is in inverse proportion to their respective moments of inertia multipled by the modulus of elasticity. The deflexion of an aluminium ship will therefore generally be found to be twice that of a comparable steel ship. The author states that he is not aware of any tests conducted on the tightness of riveted joints in either steel or aluminium structure loaded hydrostatically at the same time that it is subject to bending tests, but such data may become available shortly. While more deformation can be expected in the aluminium ship, it is not expected that difficulty will be experienced, due to the lower designed stresses. Experience has shown that in the heavier weights of material an increased amount of caulking is required in order to ensure tight joints. This is not necessary or desirable in the case of the joints of light alloy. A compound or tape can be applied to these faying surfaces if found necessary. Preliminary tests on the notch sensitivity of aluminium alloys under static fatigue loadings at room temperature indicate that no serious embrittlement will result, and that the material is not as notch sensitive as steel. An interesting point in the use of aluminium for hull construction is that this material will restore the balance between the weight and vertical centre of gravity of the machinery plant in relation to that of the hull. . The tendency towards reductions in the weight of propulsion plant has had the effect of raising the overall vertical centre of gravity. The use of aluminium for the hull and for all those parts for which it is suited in a normal cargo vessel of medium size, will lower the vertical centre of gravity by at least 6in. as compared with a similar vessel built of steel. The author does not, at the present time, recommend the welding of aluminium alloys by the usual means, as the efficiency of the joint is quite low in comparison with welded steel joints. However, the argon-gas tungsten-arc process shows great promise for the welding of aluminium. No flux is required and the weld can be made readily in any position. Valves and fittings of light alloy are not at present proposed for pressures exceeding 150lb. per sq. in. and for temperatures in excess of 200 deg. F. But aluminium condensers, boiler air casings, pumps, etc. are considered a distinct possibility.—*M. G. Forrest, The Society of Naval Architects and Marine Engineers, New York. Advance copy of Paper No. 8, Annual Meeting, 13th and 14th November, 1947.*

Alternating-current for Ships' Auxiliaries

The author examines the possible utilization of a three-phase a.c. system at a potential of 400 volts, while either a three-wire or four-wire distribution system may be installed, the four-wire system with a solidly earthed neutral is not considered suitable for marine applications. With the three-wire system power circuits should be supplied at the generator potential of 400 volts, heating and cooling circuit at 230 volts, and lighting circuits at 150 volts, the two lower voltages being obtained by the use of transformers of either the air-cooled or immersed types. If it is decided to install a four-wire system the 230-volt circuits for heating and cooling may be supplied from any one phase and the neutral, the 150 volts for lighting circuits being again obtained by the use of transformers. In order to obtain the maximum advantage from an a.c. installation it is essential that squirrel-cage motors should be fitted wherever possible in preference to the wound-motor or synchronous types. It has been found that the squirrel-cage motor with direct-on starting equipment is quite suitable for the vast majority of power drives on board ship. Where it is considered absolutely essential to have a variable speed range this can be obtained by the use of a.c. commutator or wound-rotor types of motor, the type depending on the rating and the speed range required. The commutator motor may have either a shunt or series characteristic. A method of speed control for special services such as refrigerating compressor motors, is given in the paper. The relative costs of d.c. and a.c. installations are examined.—*A. .N. Savage, North-East Coast Institution of Engineers and Shipbuilders. Paper read at Meeting of 6th February, 1948.*

Admiralty Gas Turbine

Under the auspices of the Admiralty a number of demonstration runs were made by H.M. motor gunboat No. 2009 from Portsmouth early last September. These runs were made to demonstrate the working of the 2,500 s.h.p. Metropolitan Vickers gas turbine driving one shaft through a reduction gear, with the other two propellers being driven by two 1,250-2,400 r.p.m. Packard petrol engines. Upon completion of the trials the gas turbine unit was removed and returned to the makers' works for inspection. The general condition of the blading of both the stator and the rotor of the air compressor was found to be very satisfactory. There were indications of a minute deposit of salt on the blading, but not the slightest sign of corrosion and no hard deposit that could not be easily washed off, and nothing which would impair the performance. The combustion chamber was in a very satisfactory condition. The carbon deposit was very light, and only minor distortion of the primary chamber had occurred, it is stated. The fuel sprayers were found to be in a perfectly satisfactory condition. This is ascribed largely to the provision of a sheath passed by cooling air. The rotor and stator blading of the power turbine which had been subjected to a temperature of approximately 1,500 deg. F. was discoloured by the heat, but showed no signs of failure or distortion.—*The Journal of Commerce and Shipping Telegraph", 29th January, 1948, p. 5.*

American Heavy Lift Vessel

The American Eastern Corporation, New York, which recently announced its intention to increase its ship operating activities, owns one of the few "heavy lift" vessels to fly the American flag. The ship, the motor vessel "Gadsden", was specially designed for the carriage of locomotives and tenders. She can carry eighteen of each at once, and has been engaged in transporting locomotives from the United States to France. The Gadsden was built during the war as a C_1-M-AV_1 type coastal freighter, and was bought by American Eastern in 1946 and converted to her present design by the Bethlehem Steel Company. A C_1-M-AV_1 type vessel was chosen as being the only type available in which the engines were aft. These vessels are 338ft. overall, with a normal load displacement of 6,390 tons, and have a single Diesel of 1,700 h.p., giving them a speed of 11½ knots. As converted, the Gadsden resembles to some extent the "Belships" of the Norwegian line which specializes in vessels designed solely for this type of work. The main feature of the conversion was the replacement of the three existing holds by two holds, served by a single 110-ton derrick. The two bulkheads were removed and replaced by a single one of heavy scantlings. The two new hatches are 65 and 91ft. long respectively, and the holds are without pillars. To give the necessary longitudinal strength, the hatch coamings have been extended downwards on each side to the full depth of the 'tween decks. Openings have been provided in these coamings so that the spaces behind them may be used for packaged cargo on return voyages. The heavy lift gear for a working load of 110 long tons consists of a tripod mast set on one side of the ship with the vertical leg near the centreline, allowing a single boom to swing through an arc of about 255 deg. The boom is thus able to load both hatches from either side of the ship. Two heavy duty winches, converted from towing machines, are sited in the 'tween decks below the tripod. One controls the topping lift and one the fall. The original steam drives have been replaced by 50 h.p. Westinghouse electric motors. The ship can be loaded with her full complement of locomotives and tenders in from four to five days.—*"The Shipping World", Vol. 118, 18th February, 1948, p. 225.*

ENGINEERING ABSTRACTS

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Combined Pressure Boiler and Gas Turbine Installation

The author reviews the reasons which have prompted this latest attempt to combine the advantages of the steam turbine with those of the gas turbine, and thus to raise overall thermal efficiency above the level attainable with the steam turbine alone. This attempt is stated to be due to the initiative and proposals of E. Mercier, who suggested the employment of a steam boiler with pressurized furnace from which the furnace gases under pressure are passed into a gas turbine, thus combining a closed steam cycle with an open gas turbine cycle. A first experimental plant of this type is in operation at the Arrighi power plant in Paris. An installation of this type requires the following component parts: (1) means for compressing the air to the required cycle pressure; (2) heat exchangers for recovering the waste heat and for preheating the compressed air; (3) pressure-fired boiler; and (4) prime mover plant consisting of gas turbine and steam turbine which are preferably coupled. There are several ways in which the cycle may be realized, according to the manner in which air compression is carried out:—(a) By means of air compressors driven by supercharged internal combustion engines, preferably of the free-piston type (Pescara type). (b) By means of air compressors driven by engines in which the working fluid is waste gases discharged from the boiler furnace; these engines are also preferably of the free piston type. (c) By means of rotary air compressors driven either directly or indirectly by the turbines. (d) By means of air compressors driven by steam engines, the steam supply being obtained from the pressure-fired boiler. The author confines his investigation to cases (a) and (b) because these offer the greatest promise from the aspect of cycle efficiency. Referring to case (a), the air is compressed from atmospheric pressure to the cycle pressure by means of three compressors arranged in series; these compressors—and also the scavenge air compressor—are each driven by an internal combustion engine. The inter-cooling of the air between the low and medium pressure stages, as well as between the medium and high pressure stages, is effected by intercoolers partly cooled by cold water and partly by condensate from the condenser of the steam turbine. The condensate leaves the intercoolers at approximately 80 deg. C. and is passed on to stage heaters supplied with bled steam from the turbine. It leaves the last heater stage at 150 deg. C. and 5 kg. per sq. cm. pressure and is then passed to the water jackets of the internal combustion engines, where it is partly evaporated. The steam-water mixture is then passed into a separator. From the latter the water is passed into a further feed heating stage, and thence to the boiler; while the steam is delivered into a heat exchanger which is passed by the exhaust gases of the internal combustion engines, hereby raising the steam temperature to 400 deg. C. This steam is subsequently passed into an appropriate pressure stage of the steam turbine. The compressed air delivered by the compressor at 80 kg. per sq. cm. pressure is heated to 525 deg. C. in the previously mentioned heat exchanger passed by the exhaust gases and then delivered to the liquid fuel burners of the pressure fired boiler. In the latter the products of combustion pass successively over an evaporating surface and a superheater surface, and finally into the gas turbine. The steam is passed at 80 kg. per sq. cm. pressure and 550 deg. C. to the steam turbine. The scavenging air is supplied at 3·5 kg. per sq. cm. abs. pressure. Upon passage through the heat exchanger the exhaust gases of the internal combustion engines are passed into an appopriate stage of the gas turbine at 3 kg. per sq. cm. pressure and approximately 320 deg. C. temperature. According to the author, this plant arrangement may be simplified in cases where very highest operating efficiency is not required, as, for instance, in ships and locomotives. For an installation of 30,000 kW. output operating at 80 kg. per sq. cm. steam pressure, the author estimates the cycle efficiency of the steam plant as 37·5 per cent., and that of the gas turbine plant as 42·4 per cent., yielding an overall plant efficiency of 39·7 per cent. Of the total power developed, 53 per cent. is furnished by the steam turbine and 47 per cent. by the gas turbine. Of this power 43 per cent. is required for driving the compressor plant.—*R. Papault, "Le Génie Civil" Vol. 124, 1st November, 1947, pp. 405-410.*

Seagoing Hopper Dredge "Comber"

The seagoing hopper dredge "Comber" is one of a class of four vessels completed at the Ingalls Shipbuilding Corporation yard in Pascagoula, Miss., for the Corps of Engineers, U.S. Army. These vessels are designed for deep-channel dredging the world over. The dredge is powered with a twin-screw turbo-electric plant developing 6,000 s.h.p. The provision of twin rudders ensures good manœuvrability at the low speeds associated with dredging. Main particulars are: length b.p. 340ft., beam moulded 60ft., depth moulded 30ft., design draught, 22ft. 2in., hopper capacity, 3,000 cu. yards, speed light, 15 knots, loaded 11·5 knots. The vessel is divided into thirteen watertight compartments. The hopper section occupies the midship third of the vessel with the pump room located at its forward end and on the boiler room bulkhead forming its after boundary. The hull is framed on the transverse system and all-welded construction is employed. The dredging is performed through two 30in. diameter suction lines pivoting at trunnions in the ship's sides. A ball joint located near the trunnion gives added flexibility, and when operating at an angle of 45 deg., dredging to a depth of 55ft. below the water's surface can be carried out. The two dredge pumps are of the centrifugal volute single-impeller type, each driven by a 1,150 h.p. direct current motor at 180 - 205 r.p.m. The propulsion plant consists of two Westinghouse turbo generators supplying direct current at 600 - 720 volts to two 3,000 s.h.p. shunt-wound separately excited motors. The latter are connected with 4-bladed manganese bronze propellers turning at 100 - 120 r.p.m. Steam is furnished at 450lb. per sq. in. and 750 deg. F. by two single-pass cross-drum boilers, each rated at 38,000lb. per hour, including desuperheated steam at the rate of 3,500lb. per hr. The boilers were manufactured by Combustion Engineering Company and are capable of operating continuously at a maximum rating 25 per cent above the designed normal evaporation. The boilers are oil-fired and have an efficiency of 87·5 per cent.—*"Marine Engineering and Shipping Review", Vol. 53, Janary, 1948, pp. 50-59.*

Single-screw Motorship "Pelayo"

The recently completed motor vessel "Pelayo" built by William Doxford and Sons, Ltd., for the MacAndrews Line is designed for the special requirements of the general cargo and fruit trade of the owners. Constructed to the 100 A1 class of Lloyd's Register, the "Pelayo" is of the single deck type with open shelter deck, and has a well raked stem and cruiser stern. Her dimensions are as follows:

Length, b.p. ...	330ft. 0in.
Breadth, extreme ...	50ft. 0in.
Depth, moulded ...	19ft. 4in.
Draught ...	19ft. 0in.
Gross tonnage ...	2,579
Deadweight tonnage ...	3,440
Net tonnage ...	1,002
Cargo capacity ...	206,500 cu. ft. (bales)

A special feature of the vessel is that the hold and 'tween deck spaces have been fitted with a special system of ventilation to ensure efficient circulation througout while carrying fruit cargoes.

The propelling machinery consists of a Doxford opposed-piston balanced oil engine of the latest design, having five cylinders of 600 mm. diameter and 2,000 mm. combined stroke with crank-driven scavenge pump. Rated output of the main engine is 4,100 b.h.p. at 122 r.p.m., which provides a speed in service of 15 knots. Fuel oil capacity is 360 tons. The auxiliary machinery is compactly arranged on each side of the main engine. Two G. and J. Weir electrically driven air compressors are arranged on the starboard side forward with two air storage tanks, the capacity of each compressor being 120 cu. ft. of free air per min. at 385 r.p.m. There is also a Weir emergency steam-driven compressor with an output of 20 cu. ft. per min. at 600lb. per sq. in. pressure. Drysdale and Co., Ltd. supplied two jacket water pumps, each with a capacity of 180 tons per hr., a 300-ton sea-water circulating water pump and a 250-ton ballast pump. Speed trials were carried out on the Newbiggin measured mile and an average speed of 16½ knots was obtained at the rated output of the engine.—*The Marine Engineer, Vol. 71, March 1948; pp. 121-124.*

Model Testing Basins

In a recent report to the National Research Council of Canada, Mr. E. S. Turner recalls that a model testing basin was constructed at the John Street Laboratory in 1930 for seaplane and flying-boat work. Owing to space limitations the size was limited to 350ft. long by 9ft. wide and 6ft. deep. Apparatus is available for measuring simultaneously the drag, pitching moment, trim, draft and speed of flying-boat and seaplane hulls, in addition to the towing resistance of ships' hulls. A larger towing basin, designed primarily for ship work, has since been constructed in the new building at Montreal Road. It has a section of 25ft. by 10ft. and a present length of 450ft.; provision has been made for extending the basin beyond this length. A short description is given of the equipment provided. The ship models are constructed of wood to a water-line length of approximately 10ft. This basin has been used for the investigation of a number of special problems. Tests carried out in it showed that a new design of balanced rudder had marked advantages over the conventional rudder. The torque required for operation was considerably reduced and the steering forces produced were increased. A number of designs for towing barges have been tested and suggestions made for improving towing stability. The steering effect in shallow water with two different rudder designs has been investigated. It is proposed in the near future to provide suitable equipment for testing screws in open water and when fitted behind hulls.—*E. S. Turner, National Research Council of Canada, Aeronautical Laboratories Report No. ME 1947(3), p. 1. Abstract No. 1,496, The British Shipbuilding Research Assoc. Journal, Vol. 3, No. 2, February, 1948.*

Trawler for Icelandic Government

The "Skuli Magnusson", the ninth of ten steam trawlers building at Beverley out of a total British order of 30 for the Icelandic Government, was launched from the shipbuilding yard of Messrs. Cook, Welton and Gemmell, Ltd., on 28th February. The vessel has a length b.p. of 180ft. 1in., breath moulded 30ft., and depth moulded 16ft., and will be of approximately 650 gross tons. The trawler embodies the builders' type of bow, comprising well-raked soft-nose stem associated with good flare, forecastle deck, cruiser stern and balanced rudder. The form adopted has been based on results of model tank tests carried out at the National Physical Laboratory, Teddington. Double bottomed tanks for fresh domestic and boiler feed water are situated under a large capacity fish room. A cross bunker divided into five tanks gives storage for 233 tons of oil fuel. Diesel oil tanks for 15½ tons are provided in the engine-room. Tanks for 5,000 gallons of cod liver oil are arranged under the after cabin flat. Accommodation is provided in the upper and lower forecastle, 'midships and aft, for a total complement of 38 men. Electric light and mechanical ventilation are provided, and two oil-fired domestic boilers supply the heat for the hot water system. The galley range is also oil-fired, and in addition to the normal provision stores, a refrigerated chamber is installed. A Triton trawl winch is being provided by Messrs. Charles D. Holmes and Co., Ltd., electric windlass by Messrs. Clarke, Chapman and Co., Ltd. Two 25ft. lifeboats will be carried under patent davits of Welin Maclachlan make. The propelling machinery, which will be supplied and installed by Messrs. Holmes, comprises a triple-expansion engine with cylinders 16½in., 28½in. and 47in., with a stroke of 30in. The single multi-tubular boiler is arranged for oil firing with Wallsend-Howden system of forced draught and superheat. For the auxiliaries, which are mainly electrically operated, two 80 kW. generators are provided, each driven by a six-cylinder Ruston and Hornsby oil engine. For emergency lighting, a 5 kW. Diesel generator is fitted, and this also drives a stand-by air compressor.—*The Journal of Commerce, Shipbuilding and Engineering Edition, No. 37,455, 11th March 1948, p. 8.*

Steamship "Silverbriar"

Trials were recently carried out off the North East Coast of the cargo passenger liner "Silverbriar", built to the order of the Silver Line, Ltd., London, by Joseph L. Thompson and Sons, Ltd., Sunderland. The "Silverbriar" is the second ship to be built for the owners to have steam turbine machinery, as all the others have been motorships. The principal particulars are:—

Length, b.p. ...	467ft. 9in.
Breadth, moulded ...	64ft. 9in.
Depth, moulded ...	41ft. 11in.
Draught ...	27ft. 7½in.
Gross tonnage ...	7,500
Deadweight tonnage ...	10,700
Cargo capacity (bale) ...	685,000 cu. ft.
Service speed ...	15½ knots

Shipbuilding and Shipping Record, Vol. 71, 26th February 1948; p. 253-255.

Miniature Tugs for African Use

In order to supplement African harbour facilities the American South African Line is using a special design of a small but powerful tug that can be hoisted on the davits of the Line's vessels. The davit spacing limits the length of the hull to 25ft. and proportionately the beam is 9ft. 4in. and the draft, 3ft. 6in. The hull is of welded construction using ⅜in. plate and 3in. by ⅜in. flat bar on 20in. centres for framing. The decks are made of ⅜in. checkered steel plate. Power is provided by a 165 h.p. General Motors Diesel turning at 1,400 r.p.m. connected with a Twin Disk reverse and reduction gear with a 2 to 1 ratio. Sufficient fuel is carried to permit operation for 24 hours without refuelling. On trial trips when running free the tugs have a 14 m.p.h. speed. The towing capacity is believed to be in excess of 400 tons in the form of cargo barges and log rafts.—*Motorship, New York, Vol. 33, January 1948; p. 27.*

Diesel-electric Ferry

The Diesel-electric ferry "Farringford", recently placed in service on the Lymington-Yarmouth route to the Isle of Wight, is a double-ended ferry propelled by independent paddles with bridge-controlled Diesel-electric drive and is fitted with power-operated hinged gangways at each end of the motor car (main) deck so that vehicles can be driven on at one end and off at the other without the necessity of turning. The principal particulars are:—

Length, overall	178ft. 0in.
Breadth, moulded	28ft. 0in.
Breadth, extreme	49ft. 6in.
Draught	6ft. 0in.
Gross tonnage	489
Speed	10½ knots

The vessel is provided with two rudders at each end, with electric steering gear and a clutch, so arranged that the pair at any one end are controlled simultaneously while the other pair are locked. The fact that the same speed can be maintained both ahead and astern and that the twin wheelhouses with duplicate controls and instruments are fitted allows the vessel to run with equal facility in either direction so obviating swinging at the terminals. The main engines are of the English Electric six-cylinder 10in. bore, 12in. stroke, single-acting four-stroke cycle type, developing 420 b.h.p. each at 650 r.p.m. under normal service conditions; but this power can be increased to 500 b.h.p. at 700 r.p.m. whenever necessary. These medium speed engines were chosen for several reasons, the most important being that their low height enables the car deck to run straight over the engine room, the only deck structure at this level being a narrow casing at each end for exhaust pipes, ventilators and the like. Each engine is fitted with an exhaust gas turbo-pressure charger, and in accordance with the maker's standard marine practice, fresh water cooling has been adopted, each engine being fitted with its own fresh water pump. Salt water is circulated through a tubular heat exchanger by a Drysdale motor-driven pump. Lubrication is effected by a mechanically driven gear-type pump drawing oil from the sump and delivering it through a strainer and an oil cooler to a main supply pipe inside the crankcase, the condition of the oil being maintained by Stream-Line filters through which a portion of the oil is continuously by-passed. The main generators each normally deliver 225 kW. at 650 r.p.m., but are capable of an output of 285 kW. at 700 r.p.m. The two generators and two motors are all arranged in one continuous series circuit so that both paddles can, if necessary, be driven by one engine. A novel feature of the engine-generator assembly, so far as main propulsion work is concerned, is the employment of a three-point support system. At full speed the paddles run at 40 r.p.m. and are driven through chain gearing and flexible couplings from independent electric motors with a rating of 275 b.h.p. each at 240 r.p.m. Control of the propelling motors is carried out on the Ward-Leonard system, each paddle being independently controllable, both as regards speed and direction of rotation, even when one engine is running.—*Shipbuilding and Shipping Record, Vol. 71, 11th March 1948; pp. 315-318.*

Cargo Ship Converted to Carry Liquefied Petroleum Gases

The conversion of a C1-A cargo vessel into a special tanker for the carriage of liquefied petroleum gases has recently been carried out in a Beaumont, Texas, shipyard. The vessel has been fitted with sixty-eight all-welded cylindrical tanks designed for a pressure of 250lb. per sq. in.; the storage tanks are installed in a vertical position, the size and capacity varying with the structure of the vessel. It is estimated that the total carrying capacity of the tanks will be approximately 1,300,000 gallons of propane, the ultimate capacity depending upon the maximum permitted filling density. The tanks are installed in all five cargo holds and in the way of the cargo hatches, arranged in groups of four athwartships, with the inboard pair extending through the top deck, and the outboard pair terminating below the top deck. For cargo handling the vessel will be equipped with six turbine driven, vertical process type, centrifugal pumps of 500 gal. per min. capacity, and two vapour compressors. The main compressor is a five-stage centrifugal type, while the stand-by compressor is a single-stage rotary type. Both compressors will be driven by steam turbines. In addition to the pumps and compressors, the cargo handling system will be fitted with a propane vapour condenser and a vapour scrubber used for condensing and cleaning the residual vapours to be discharged to shore tanks. When discharging liquid cargo to shore tanks, the ship's vapour compressor will draw from the vapour space of the shore tanks through a line connected at the vapour loading terminal. The vapours will be compressed and discharged into the ship's tanks, thus forcing the liquid out of the tanks to the liquid pumps, whence the liquid will be finally discharged to the shore tanks through the liquid line. To draw off the residual vapours in the ship's tanks after the liquid cargo has been unloaded, suction will be taken from the ship's tanks through the liquid line by the main vapour compressor until the pressure in the tanks is reduced to approximately 30lb. per sq. in. gauge. The vapours will be scrubbed, condensed, and discharged through a liquid pump to the shore tanks.—*Shipbuilding and Shipping Record, Vol. 71, 18th March 1948; p. 351.*

Experiment Work on Merchant Ship Models During the War

In this paper the authors relate results of model experiments with merchant-ship forms as were made during the war at the Ship Division of the National Physical Laboratory to the order of the Admiralty. The models referred to are in two groups of normal single-screw vessels comprising cargo vessels and coasters respectively, having ratios of length to breadth greater than 6·8. The results have been applied to illustrate an analysis of the factors affecting the smooth-water performance and in particular of the choice between "hollow" and "convex" box. The paper includes a chart in which the quasi-propulsive coefficients obtained are plotted to a base of revolutions per minute, converted to a 400ft. ship. This chart also includes graphic representation—in the form of a straight line—of the empirical formula for the quasi-propulsive coefficient given by one of the authors in an earlier paper. This empirical formula has been found to give a close approximation to the results obtained with a well-designed bronze propeller working at the designed speed on a model with a modern "streamlined" stern arrangement.—*Paper by A. Emerson and N. A. Witney, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders on the 19th March 1948.*

Irish Sea Motorship "Munster"

The "Munster", the first of two new motor vessels ordered by the British and Irish Steam Packet Co., has been delivered by the builders, Harland and Wolff, Ltd., Belfast, after successful sea trials. The ship has been built primarily for the Liverpool-Dublin passenger service, but is equipped also for the carriage of cattle and cargo. The "Munster" has been built to Lloyd's highest class and is designed on modern lines, with a well-raked rounded stem, cruiser stern, single low streamlined funnel, foremast and shortened mainmast for wireless aerials. Her principal dimensions are as follows:—

Length, overall	about	367ft.
Length, b.p.	„	345ft.
Breadth, moulded	„	50ft.
Depth, moulded	„	19ft.
Gross tonnage	„	4,000

There are two complete steel decks, with a lower deck forward and aft of the machinery space, poop, bridge and forecastle decks, promenade deck and sun deck. The hull is divided into ten watertight compartments by nine bulkheads, and there is a double bottom for fresh water, water ballast and lubricating oil fore and aft. The fore and after peaks are arranged for water ballast. Deep oil fuel tanks are situated forward of the auxiliary machinery space. There are three cargo holds, two forward and one aft of the machinery space, for the carriage of general cargo or motorcars. A total of 484 head of cattle can be carried. Of these 222 are carried on the main deck forward and 262 on the lower deck forward and aft. A feature of the cattle arrangements is the drainage. For the first time, the sludge, instead of being pumped overboard, is expelled by means of water ejectors. Each compartment has its own ejector, port and starboard, and the sludge is ejected directly overboard without passing through the pump. By this means, the cleaning of sludge cofferdams and liability of the pump to choke are obviated. Care has been given to the mechanical ventilation of the cattle spaces and all exhausts have been collected and led up into the main funnel of the ship. The propelling machinery consists of two trunk type, 10-cylinder, airless injection, Harland-B. and W. Diesel engines, working on the two-stroke cycle. They develop 5,600 s.h.p. and give a service peed of 18 knots. The cylinder covers, jacket and exhaust valves are cooled by fresh water, and the pistons are cooled by oil from the forced lubrication system. The lower part of the cylinder liner is cooled by the scavenge air supplied to each engine by rotary blowers fitted to and driven from the engine by gears. The exhausts from the main engines are led separately to a combined waste heat and oil-fired boiler of Clarkson type, made by Harland and Wolff. This boiler is suitable for using exhaust gas and oil fuel independently or simultaneously, and generates steam at a pressure of 80lb. per sq. in. The quantity of exhaust gas to the boilers can be regulated to suit requirements, the remainder of the gas being directed to the silencers, which, as well as those for the auxiliary engines, are situated in the funnel.—*The Shipping World, Vol. 118, 25th February 1948; p. 250-251.*

Motor Vessel for Sweden

The first of six single-screw motor-vessels has been launched by the Furness Shipbuilding Company, Ltd., Haverton Hill-on-Tees, for the Rederi A/B Scea, Stockholm. She is the "Bergsund", and is to carry 1,800 tons deadweight on a draft of 15ft. 3in., her dimensions being 284ft. in length overall, 39ft. in breadth and 22ft. 11in. in depth to shelter-deck. The vessel has two telescopic masts, designed for navigating the Manchester Ship Canal, and a single squat funnel. There are two holds, fore and aft of the machinery space, with four hatches, served by one ten-ton, two five-ton and six three-ton derricks. The main propelling machinery, to be installed by Richardsons, Westgarth and Company, Ltd., will consist of a Fiat motor, with six cylinders, 450 mm. in diameter by 740 mm. stroke, and developing 1,350 b.h.p. at 185 r.p.m. There will be three 40 kW. and one 15 kW. Diesel generator, and a Cochran boiler for heating. The navigational equipment will include a gyro-compass and echo-sounder.—*"Fairplay", Vol. CLXX, No. 3,379, 26th February 1948, p. 583.*

Tests of Hatch Corners

Tests were made of ten full-scale welded hatch corners to determine the effectiveness of various modifications used on Liberty ships. In addition three new designs were tested. A design similar to the hatch corners on early Liberty ships was used as basis of comparison. The simple expedient of extending the longitudinal coaming above deck for 30in. beyond the hatch opening was found to be very effective. The hatch corners used on later Liberty ships were found to be over 50 per cent stronger than the early corners on the basis of maximum nominal stress and ability to absorb more than sixteen times as much energy before major failure. Two of the new designs were unique in that they were the only ones which did not fail at the corner of the hatch and behaved in a ductile manner. One of these, involving the use of a hot-formed corner plate having radii in both the horizontal and vertical planes, gave an increase in maximum stress of 124 per cent and an increase in energy absorption of over 2,800 per cent.—*E. P. DeGarmo, The Welding Journal, New York, Vol. 27, February 1948; p. 50-s-68-s.*

Ship in "Splints"

A saving of labour amounting to one-third has just been effected by the use of tubular steel scaffolding in enabling engineers to fix special "breathing plates" to the hull of the American-built welded tanker "Tectarius", of 10,664 tons gross, owned by the Anglo-Saxon Petroleum Co., Ltd., London. The purpose of the "breathing plates" —which are of 1in. steel, 18in. deep—is to help the "Tectarius" to have the same "give" as a riveted vessel. Two further ships are to be similarly treated later.—*Fairplay, Vol. 170, 11th March 1948; p. 690.*

New Tanker "Lembulus"

Built on the combined transverse and longitudinal system with transverse framing on the ship's sides and at the ends of the ship, and longitudinals at the deck and bottom in conjunction with the two longitudinal bulkheads and a single deck for the range of the cargo tanks, the motor-tanker "Lembulus" has carried out her sea trials. She has been built by Swan, Hunter and Wigham Richardson, Ltd., of Wallsend, for the Anglo-Saxon Petroleum Co., Ltd., London, and to comply with the highest class of Lloyd's Register. Her principal dimensions are 425ft. in length b.p., by 54ft. 3in. in breadth moulded, by 31ft. in depth moulded; she is of 6,503 tons gross, and carries about 9,440 tons deadweight on a load draft of 25ft. 7¾in. The vessels propelling machinery, built by the Wallsend Slipway and Engineering Co., Ltd., is aft, and consists of a single-screw Diesel engine of the Wallsend Doxford opposed piston two-stroke cycle type, with lever-driven scavenge, cooling and lubricating oil pumps worked from the main engines. With three cylinders, each 600 mm. bore by 2,320 mm. combined stroke, the main engine was designed to develop a trial power of 2,800 b.h.p., when running at about 116/117 r.p.m., while her designed speed for loaded trials was 12 knots.—*Fairplay, Vol. 170, 4th March 1948; p. 630.*

Motor Vessel "Beyla"

In Canada, The Davie Shipbuilding and Repairing Co. are engaged in the construction of four 7,200 ton vessels for the Chargeurs Reunies of Paris. Two of these vessels, which are destined for the North African Trade, have been recently delivered to their owners. These vessels, the "Beyla" and the "Bilma", are built under special survey of Bureau Veritas and are fast, modern cargo ships. Following is a list of their principal characteristics:—

Length, b.p....	399ft. 7½in.
Breadth, moulded...	55ft. 7⅝in.
Depth to shelter deck ...	35ft. 2in.
Draft ...	24ft. 2⅜in.
Deadweight ...	7,200 tons
Gross register ...	4,513 „
Net register ...	2,529 „
Service speed ...	15 knots

The directly reversible Sulzer engines are of the single acting, two-stroke cycle crosshead type and develop 5,000 b.h.p. at 120 r.p.m. The eight cylinders have a bore of 28·3in. and a stroke of 49·3in. The line shaft bearings are of the SKF special roller type and are capable of compensating for deflexion caused by hull flexure. Eight bearings are used per ship. On trials a speed of over 16 knots was attained at practically full load draught.—*Motorship, New York, Vol. 33, January 1948; p. 24-26.*

Large Trawlers for Portugal

Three trawlers now under construction at Newburgh, New York, are among the largest ever built in the United States. These steel vessels which are 233ft. 3in., in overall length and will displace 2,400 tons, fully loaded, are being built by the Eureka Iron Works for Portuguese interests, and they will be used primarily off the Newfoundland Banks, where they will trawl for cod. It is anticipated that they will make two trips a year, being at sea for five months during each trip. These vessel are single deckers with a continuous main deck and a poop and forecastle. The principal characteristics are: length overall, 233ft. 3in.; length, b.p., 210ft. 6¼in., beam (maximum), 36ft. 2½in.; depth (least moulded for freeboard), 18ft. 8½in.; draft (loaded), 15ft. 5in.; draft (light), 9ft. 2in.; displacement (light), 1,000 tons; displacement (loaded), 2,400 tons; b.h.p., 1,000; range (nautical miles), 15,000; speed (loaded), 11 knots; fuel capacity, 380 tons; fresh water capacity, long tons, 238 tons. The two fish holds extend for about 50 per cent of the vessel's length amidships, their combined capacity being approximately 50,000 cu. ft. Each hold is served by two hatches. The vessels are being built to Lloyd's Register of Shipping classification "+ 100A1 Trawler Strengthened for Navigation in Ice; Part Electrically Welded". Except for a completely riveted shell, expressly stipulated by the owners, the remainder of the vessels' structure is entirely welded, great attention having been paid to ease of fabrication. It is felt by the designers of the vessels that the use of a riveted shell in combination with modern conventional toe welded angle construction will result in almost as great a weight saving over all-riveted construction as could be attained by welding the shell as well as the remainder of the hull structure. Each vessel will be powered by a Cooper-Bessemer Model LS-8 eight-cylinder four-cycle reversible Diesel developing 1,000 b.h.p. at 300 r.p.m. This engine has a 15½in. bore and a 22in. stroke. A 92in. diameter 53in. pitch propeller will be fitted. An electric stearing gear turning a balanced streamlined rudder will be provided. Service speed will be slightly in excess of 11 knots.—*Motorship (New York), Vol. 33, February 1948; pp. 39, 65.*

A New Anglo-Saxon Tanker

From the Govan shipyard of Harland and Wolff, Ltd., has been launched for the Anglo-Saxon Petroleum Co., Ltd., London, the single-screw motor-driven oil tanker "Liparus". Her principal dimensions are: 425ft. in length, b.p., by 54ft. 3in. in breadth, moulded, by 31ft. in depth, moulded to upper deck; and she will carry 9,000 tons deadweight on a draft of 25ft. 6in. The construction of the vessel is to Lloyd's Register's latest requirements for the carriage of petroleum in bulk, and on the combined transverse and longitudinal system of framing, with two longitudinal bulkheads. Longitudinal and transverse bulkheads divide the hull into twenty-four oil-carrying compartments. A Harland-B. and W. four-cycle crosshead type, Diesel engine with six cylinders, 650 mm. bore, and 1,400 mm. stroke, has been fitted. In addition to the oil-carrying compartments already mentioned, there are two cargo pump rooms, two cofferdams, a cargo hold forward, and below this hold a deep oil-fuel tank. A deep tank forward of the motor room and the double bottom under the motor room will also be used for carrying oil fuel. The centre cargo tanks are fitted with steam coils with sufficient heating surface in three sections for the carriage of bitumen. Special bitumen pumps are fitted in the after pump-room.—*Fairplay, Vol. 170, 18th March 1948; p. 760.*

Friction Losses in Pipe Bends

In a note in Amplification of the First Interim Report of the Panel on Losses in Pipe Bends and Elbows, Professor C. M. White points out that two or more bends placed near together give less loss than the sum of the individual losses. For example, 90 deg. deflexion made up by a 30 deg. turn followed by a 60 deg. turn, or by a 60 deg. one followed by a 30 deg. one, has even less resistance than a 60 deg. turn by itself. This is true of most pipe fittings and illustrates the advantage of grouping fittings as closely together as possible.—*Committee on Velocity Formulæ for Open Channels and Pipes, Panel on Losses in Pipe Bends and Elbows, Journal of The Institution of Civil Engineers, Vol. 29, February 1948; pp. 350-364.*

Modern Applications of Photo-elasticity

It has long been known that polarized light may be employed to analyse the stresses occurring in engineering parts. Recent modifications have simplified the apparatus required, so giving a wider scope to the application of photo-elasticity to engineering. The method of preparing transparent models for stress analysis is discussed, and the significance of the photo-elastic fringes is explained. Only the boundary stresses in the model are considered, and their importance is demonstrated by means of examples. Examples of the application of photo-elastic methods include the examination of a crankshaft design for stress and distortion. With the particular design investigated it was found that gas loading of the crankpin produced similar stresses to those caused by a simple torque applied to the crankshaft. However, the torque stresses were generally greater in value, so making it preferable to test under torque conditions. After freezing with a torque applied to the model distortion was clearly revealed, as shown in the accompanying illustrations,

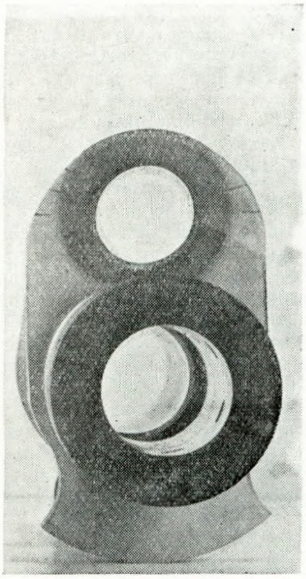


FIG. 34.

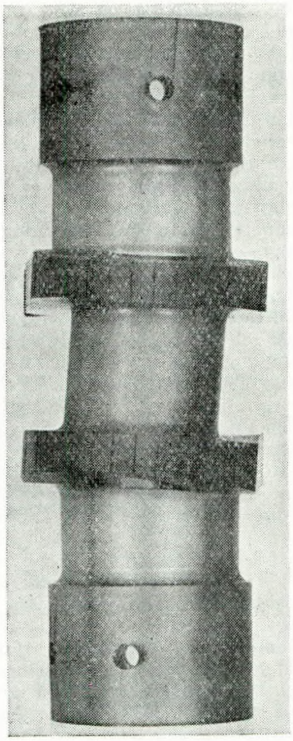


FIG. 35.

FIGS. 34 and 35.—*Model crankshaft distorted by torque.*

Figs. 34 and 35. Some of the fringes indicating the existing stresses in the crankshaft web are shown in Fig. 36, while the high stress concentrations prevailing in the crankpin fillet are evidenced by Fig. 37. The author believes that this method could be extended to the solution of quenching stresses in engineering parts. Because of the number of properties involved in quenching, he does not believe it likely that quantitative results can be ascertained, but a fairly accurate indication of the stress distribution should be possible.—*Paper read by R. B. Heywood at a meeting of the Institution of Mechanical Engineers, on 12th December 1947.*

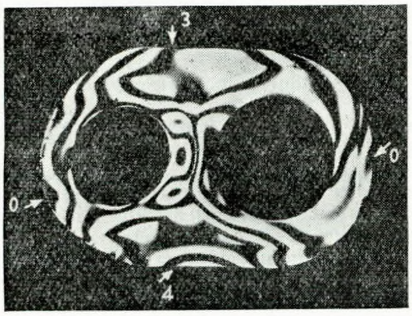


FIG. 36.—*Stresses revealed in crankshaft web*

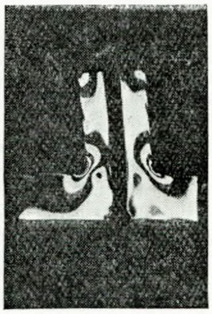


FIG. 37.—*High concentrations of stress in crankpin fillet*

Gridded Bearings

Prior to the development of the grid bearing, cast copper-lead bearings were considered the best combination to provide high strength and good imbedability. Heat conductivity was good and the lead, actually a filling in a matrix of copper, gave the material good surface properties, score resistance and imbedability. The chief difficulty encountered was the problem of casting the copper-lead alloys, which in the truest sense were not alloys but mechanical mixtures. This led to difficulty of manufacture and variation in the final product. The technique developed for the construction of gridded bearings has obviated this difficulty while retaining and, it is claimed, even adding to the advantages. Bronze backing proved to have some advantages over steel. Its high thermal conductivity quickly transmits heat and equalizes the temperature over the entire bearing to prevent local cracking. Shortly before the war, when steel tubing became available, the centrifugally cast lead-tin bronze bearing was developed. Its casting technique produces solidification from one direction only which eliminates the usual middle wall weakness of cast material caused by solidification from each surface towards the centre. This type of bearing has great fatigue strength and is proof against hydraulic pressure—a prime requisite for heavy-duty service. With a 0·002-in. lead-tin coating in the bore, it gave outstanding service during the war. But loads were increasing and these bearings were not the final answer. Gridding the centrifugally cast lead-tin bronze to combine its advantages with those of babbitt was the next logical step. Present applications of gridded bearings are for main and connecting rod bearings of heavily loaded Diesel engines and similar heavy duty service. They are now operating under loads of over 3,500lb. per sq. in. projected area with shafts as low as 160 Brinell hardness. Minimum area of babbitt is 40 per cent. The first step in making a gridded bearing is the application by either thermal bonding or electroplating of a layer of silver or copper onto a steel backing. Next, this surface is knurled, leaving impressions in the form of inverted pyramids. These are then filled with lead or lead alloys by electroplating or casting. The surface is then machined to remove the excess lead, leaving pockets of lead in the base metal. It is recommended that at least 40 per cent of the finished surface be lead and the percentage may be as high as 100 providing that the points of base metal are not more than 0·005in. below the surface. Considerable experimentation has shown that the exact proportion of lead to base metal is not critical to performance, nor is the depth or shape of the indentations. Satisfactory results are obtained with knurls of 20-50 pitch and 60-80 deg. angle, depending on the service required. The resulting surfaces have approximately 20-50 indentations per linear inch, varying in depth from 0·008in. to 0·024in. The superior performance of gridded bearings is illustrated by the fact that in a heavy duty 1,850 h.p. Diesel, the copper-grid main bearings were unaffected after 500 hours of operation under a load of 3,500lb. per sq. in. at a surface speed of 32ft. per sec. against a cast-iron shaft of 265-285 Brinell.—*Motorship, New York, Vol. 33, February 1948; p. 42-43.*

Analysis and Interpretation of Vibration Records

In this paper the author surveys the main features and limitations of the various procedures commonly used. The mathematical and numerical (ordinate) methods and their extensions by means of automatic devices are described. The treatment of the numerical method in the standard engineering textbooks is considered unsatisfactory insofar as it fails to emphasize inherent limitations and the dire results which may accrue from disregarding them. The author recommends that the same individuals who are responsible for producing the records should be entrusted with the task of analysing them. This will ensure that the records are taken in a manner best suited to analysis.—*Paper by R. G. Manley, read at a meeting of the N.-E. Coast Inst. of Engineers and Shipbuilders on the 20th February, 1948.*

Argonarc Welding

The argonarc welding process, which is to-day undergoing rapid development, employs a metallic arc as the heat source, which operates in an atmosphere of the inert gas argon. This shrouds and protects the molten metal during welding, thus preventing the chemical change of any elements in the base metal which would normally combine at fusion temperature with oxygen or nitrogen. The arc takes place between a tungsten electrode and the material to be welded, the electrode being mounted centrally in a nozzle-shaped hood or cup, through which the argon is passed to form a protective envelope around the electrode and the weld puddle beneath it. For supplying power to the arc, a standard welding machine may be employed. Either a.c. or d.c. power can be used, although a.c. is preferred. When a.c. power is used with uncoated electrodes in inert gases, difficulty is experienced in striking an arc unless high voltages are used. Some method to facilitate striking of the arc must therefore be employed. A high frequency oscillator, which, when coupled with the main welding circuit, enables the arc to be struck without the necessity of making contact between the electrode and work, is in common use in argonarc welding sets at present. In present-day application, argonarc welding covers three main categories; the first is the light sheet and tube welding field with welding currents not exceeding 150 amp.; the second field is concerned with heavier gauge materials requiring currents of the order of 300 amp. Both these fields lie within the orbit of manual welding. The third category covers automatic welding with currents up to 450 amp. or higher. In the latter category, which has been little developed in Britain to date, it will be possible to provide simpler torch designs than those used in the manual field. Current-carrying capacity, insulation and water-cooling are important factors in this respect. The high frequency equipment will also have to be modified. and the spark-oscillator equipment may give way to electronic continuous wave units. *—R. R. Sillifant, "Welding", Vol. 16, February, 1948, pp. 53-60.*

Copper Alloy Stud Welding

While the process of copper alloy stud welding has been mainly used on steel studs for shipbuilding and similar purposes, it has also been applied to secure brass studs on to steel plates and angles. Probably only the brass fuses in this instance, but the joint is of great strength, states the Copper Development Association bulletin. One application of this process which may be mentioned is for the attachment of brass studs securing window frames. There is no apparent reason why brass studs should not be secured to brass sheet by this method, nor why the process should not be extended to other copper alloys. It has the advantage over projection welding of studs that it can be used to fix studs in awkward corners and on members too large to be brought within the jaws of a projection welding machine. High production rates can be attained.*—The Journal of Commerce, Shipbuilding and Engineering Edition, No. 37,449, 4th March 1948; p. 7.*

Corrugated Bulkhead Press

A well-known firm of shipbuilding machine tool builders in Glasgow has developed and put into production a corrugated bulkhead-section press capable of corrugating lengths up to 40ft. The press is hydraulically operated and consists essentially of two massive beams, the lower one fixed and the upper one moving down on the plate to be flanged. Steel dies are bolted to the beams and are designed to flange mild steel plate to any angle from 180 deg. down to 90 deg. and at a bevel if required. The approach of the top die to the plate is speedily effected by auxiliary hydraulic cylinders. The machine is available in powers of 600, 800 and 1,200 tons and for sections in lengths from 30 to 40ft.*—The Shipping World, Vol. 118, 24th March 1948; p. 334.*

Welding of Nickel Alloys

The welding of nickel alloys is not difficult provided the correct technique is employed; nickel itself may also be welded with the same facility. Typical nickel alloys are Monel and Inconel. The former metal is a silvery-white nickel-copper alloy containing about two-thirds nickel. It is rustless, stronger and tougher than mild steel and is highly resistant to corrosion. Inconel is a nickel-chromium-iron alloy, containing approximately 80 per cent nickel, 13 per cent chromium, the remainder being chiefly iron. It is characterized by its high resistance to corrosion and oxidation at high temperatures. Monel, Inconel, nickel and nickel-clad steel may all be welded by the usual methods employing either oxy-acetylene, metallic arc, or carbon-arc processes. With the exception of nickel-clad steel, these metals may also be welded by electric spot, seam and flash welding. In oxy-acetylene welding the flame should be just on the reducing side of neutral and an even gas pressure is essential. The size of burner should generally be one size larger than that recommended for the welding of mild steel of the same thickness. In order to secure complete control of the oxygen pressure it is desirable to regulate the pressure both at the cylinder and at the torch, so that it bears a reasonable relation to the thickness of the metal being welded. For example, the pressure should be reduced to 8lb. per sq. in. for 16 S.W.G. sheet and to as little as 5lb. for 26 S.W.G.; for heavier gauges it may be increased up to about 20 or 25lb. per sq. in. The most satisfactory flux for Monel is ordinary powdered boric acid, applied by sprinkling on to the part to be welded or, in the form of an alcoholic solution, by means of a soft brush. Nickel itself needs no flux. For Inconel the flux used is generally that supplied by the makers of the metal. For flat butt welds on sheets thinner than 18 S.W.G. the weld is made simply by flanging up the edges of the sheet to a height about $\frac{3}{32}$in., and butting the flanges together. The operation should be done carefully and the flanges left so that they are slightly inclined to each other. The two flanges are then fused down into the body of the sheet by the application of the torch. On sheets of this thickness the ridge left after welding should be hammered down flat; no filler rod is required. For sheets thicker than 18 S.W.G. the edges should be chamfered at an angle of 45 deg. Filler rod, coated by dipping it into a saturated solution of boric acid in alcohol, should be applied. The diameter of the filler rod should be the same as the thickness of the sheet. For corner welds on sheets thinner than 18 S.W.G. the edges should be flanged up to 45 deg. and the flanged parts butted together, afterwards being fused down in the same manner as for flat butt welds. For heavier sheets than 18 S.W.G. the sheets are butted together at right-angles and the 90 deg. crevice thus formed filled by fusing in the filler rod. The oxy-acetylene method of welding may be applied to nickel-clad steel and the bevelled butt joint is the best type for general use, but other types common to steel plate-welding may be expected to give good results. Usually the steel weld is made first and then the nickel weld. For the steel side the usual practice in welding solid steel-plate is adopted. For the nickel side it is important to employ a slightly reducing flame, the burner having a tip one size larger than that used for steel welding. No flux is required. On these metals carbon-arc welding works similarly to oxy-acetylene. Straight polarity, i.e. carbon negative, should be used, and the carbon pencils—diameter $\frac{3}{16}$ to $\frac{3}{8}$in., according to the thickness of the welding electrode—should be tapered to a pencil point for about 2 in. In arc welding the work should be negative and the electrode positive. Direct current is preferable to alternating current, and a wide range of work can be covered with most generators of the drooping voltage type set at an open circuit voltage of 60 to 70. The welding machine should give a constant current. The use of a suitable flux-coated electrode is important. For butt welds on material of 14 S.W.G. to $\frac{3}{16}$in. inclusive, no bevelling is necessary, the plates being set as an open square butt with a gap equal to half the thickness. For heavier material the edges should be bevelled to an inclusive angle of 75 deg. to form a single V butt without gap. Before welding, the material should be in the softest possible condition.*—A. E. Williams, Engineering and Boiler House Review, Vol. 63, March 1948; p. 77-79.*

Cast Iron Research

The twenty-sixth annual report of the British Cast Iron Research Association covering the year ending 30th June 1947, has recently been published. It reveals that, among other things, considerable attention has been given to the mechanism of graphite formation, and a process has been developed whereby nodular graphite structures can be obtained in as-cast grey cast iron without heat treatment. The results indicate that there is the possibility of producing grey irons possessing mechanical properties considerably higher than those of the high-duty cast irons. Work has been continued to determine the formation of graphite during the production of malleable iron, and valuable information has been obtained upon the influence of manganese and sulphur during annealing. The investigation on gaseous decarburization has been continued and attention has been paid to the annealing of white and grey cast irons in hydrogen and also in hydrogen and water vapour.*—Shipbuilding and Shipping Record, Vol. 71, 19th February 1948; p. 219.*

Electricity in Research

An outstanding feature of modern ship and engineering research work is the increasing use of the latest types of electrical and even electronic devices to obtain accurate results. One of the most useful instruments in this category is the oscillograph, or radar-type screen, in its application to the visual or photographic representation of any phenomena involving oscillation or vibratory movement. An example of the former is the movement of a towed model under varying conditions of wave period and height, whilst the natural and fundamental frequencies which exist in, say, a propeller blade can be traced with accuracy and precision. This is in marked contrast to the tuning fork and fine sanded surface method generally used before the development of modern instruments. Another electrical application of interest in research work is the use of a variable condenser to measure torsion. As an example of this, if a casting carrying one-half of the condenser vanes is rigidly secured to a rudder head, and a second, insulated, casting carrying the other half of the condenser vanes is secured at a definite distance from the first casting, any variation of the measured capacity at rest will represent an accurate indication of the torque required to be exerted on the rudder head under varying conditions of helm and sea. This is a line of investigation upon which, until recent times, but little special work had been done.—*The Journal of Commerce, Shipbuilding and Engineering Edition, No. 37,443, 26th February 1948; p. 6.*

Correlation of Laboratory Tests with Full Scale Ship Plate Fracture Tests

In this report the authors discuss notch impact tests conducted on merchant vessel quality ship plate. Tests were conducted so as to establish the energy absorption-temperature curves for selected steels having widely separated temperatures of transition from ductile to brittle failure. The authors show that the results of standard impact testing are not suitable to allow prediction of the behaviour of a given quality steel in a ship's structure, based on the correlation of the impact test results with 72in. plate tension test results. Additional impact tests were conducted to show the effects of (a) strain; (b) strain aging; (c) variations from plate to plate; (d) final plate thickness and (e) grain size on the transition range from ductile to brittle failure on selected project steels. In an attempt to develop a testing procedure whereby satisfactory prediction of the 72in. plate test behaviour is obtained, the rate of bend testing of notched bars was decreased, while the size of the specimen was increased. The specimen developed in this proved adequate for specifying the large plate behaviour of the steels with certain exceptions which are discussed. Subsequently, this type specimen was replaced by a type developed by Schnadt in Holland, in which the compression zone opposite the notch in the test bar is drilled out and replaced with a hardened steel pin. This type of specimen will break completely both for brittle and ductile fracture and will allow examination of the fracture surface. It is shown by the authors that load deflexion diagrams, obtained for the slow bend test, are not in all instances suitable for energy absorption measurements to reveal the temperature of transition from brittle to ductile failure. Frequently such measurements indicate the brittle failure as absorbing as much energy as does the ductile failure. This for the most part is due to energy absorption resulting from penetration of the specimen by the specimens supports and tup. However, according to the authors, for some of the steels tested appreciable ductility may be observed before brittle failure of the specimen.—*E. P. Klier, F. C. Wagner, and M. Gensamer, The Welding Journal, New York, Vol. 27, February 1948; p. 71-s-96-s.*

"Cargocaire" Installation

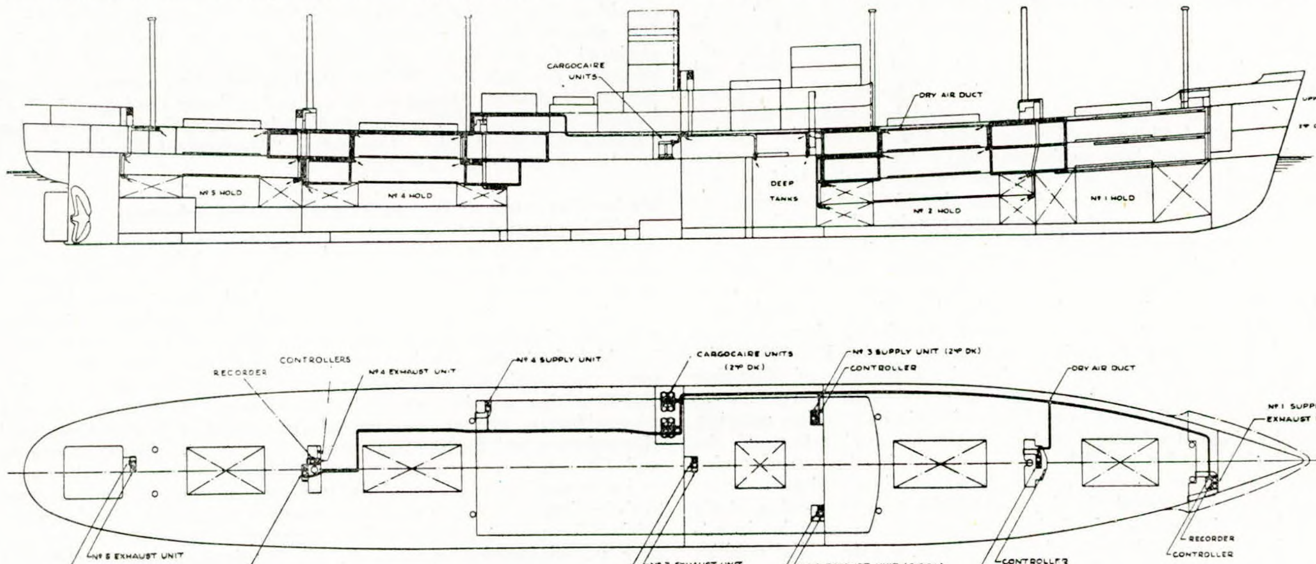
The "Pacific Fortune", which recently completed successful trials, is the first British ship to be equipped with the "Cargocaire" system throughout the entire cargo-carying space, including the deep tanks and the refrigerated chambers. Built by the Blythswood Shipbuilding Co., Ltd., Scotstoun, for the Norfolk and North American Steam Shipping Co., Ltd., this vessel carries about 11,400 tons of general and refrigerated cargo and edible oil. The "Cargocaire" system is installed to permit adequate ventilation of the cargo compartments at all times, irrespective of the weather, and is designed to ensure that the holds are kept free from condensation. The deep tanks can be quickly dried after cleaning, and the cold chambers dried when necessary after the discharge of refrigerated cargo. This installation comprises two "Cargocaire" units coupled together to supply 3,000 cu. ft. of dry air per min. continuously and automatically whenever atmospheric conditions make this necessary, that is, whenever the dewpoint of the atmosphere is high, or cold weather sets in; or again when dry air is required for such purposes as drying out a deep tank. These drying units are arranged side by side in the engine room to take the air to be dried from the casing top, and deliver it after drying, in a fresh warm and dry state, into a common duct. Connexions leading from this duct provide for its distributing the air throughout the ship or to any part of the ship, as required. The drying medium is silica gel, an inert and indestructible material capable of repeated regeneration without deterioration in its effectiveness as a drying agent, by the simple action of heat. Regeneration is automatic and duplicate silica gel beds allow a continuous supply of dry air to be maintained.—*The Shipping World, Vol. 118, 17th March 1948; p. 314.*

Design of Marine Heating and Ventilating Systems in Habitable Accommodation

In this paper the author deals with an aspect which is not so apparent as the familiar procedure employing standard rates of air change imposed by climatic conditions. The paper is concerned with an examination of the matter from a more technical aspect which takes into account the more involved considerations of (1) the physical properties of ship construction, (2) the thermo-dynamics of heat transfer, (3) the physiological importance of allowable temperature rise, temperature reduction, and temperature limitation, together with considerations of relative humidity, in the respective processes of heating, air conditioning, and mechanical supply ventilation, (4) the potentialities of thermal insulation, (6) the mechanics of air motion. The author points out that the problem of accommodating the equipment required is also a matter of present concern to those responsible for its design and installation, and while it is realized that any proposition which tends to increase the problem may be unpopular, it is felt, nevertheless, that this practical difficulty will be overcome in due course by the appreciation of the importance attached to the development of marine heating and ventilation.—*R. McDonald, North-East Coast Inst. of Engineers and Shipbuilders. Paper read at meeting on 20th February, 1948.*

Empire Refrigerated Produce Service

The acceptance trials of the Blue Star Line's new 13,200 ton refrigerated motor vessel "Imperial Star" were carried out recently. This vessel, built by Harland and Wolff, Ltd., Belfast, is fitted with two Harland and Wolff eight-cylinder two-stroke cycle double-acting B. and W. Diesels of some 15,000 b.h.p. The refrigerated space amounts to 415,120 cu. ft with provision for the insulation of additional lockers for chilled commodity carriage at a later date. There are twenty-one separate cork-insulated spaces composed of 321,160 cu. ft. air-cooled, 92,460 cu. ft. gas tight capacity for "chilled" carriage, and 1,500 cu. ft. pipe-cooled low temperature space. The



Plan and profile of the Cargocaire system in the "Pacific Fortune" refrigerating plant, which is centrally located in the ship, directly above the main electrical generators, comprises three horizontal, enclosed, twin CO_2 compressors, each direct coupled to a variable speed electric motor of 170 b.h.p. There are two sea-water and seven brine pumps of the vertical spindle, centrifugal type with variable speed motors. Brine circulation is on the closed system. An electrical distance therometer installation for measuring the temperature of the spaces and for indicating the air temperature at the delivery and return from the coolers is provided. The aforementioned low temperature space is insulated with 11½in. of cork and is installed for use in connexion with the new packaged, quick-frozen food trade. A temperature as low as − 25 deg. F. can be carried if required. This chamber is cooled by a two-cylinder methyl chloride plant driven by a 7 b.h.p. electric motor.—*Modern Refrigeration, Vol. 51, March 1948; p. 66-67.*

Corrosion in Tankers

In a paper entitled "Metallurgical Methods for Combating Corrosion and Abrasion in the Petroleum Industry" the author makes reference to the continuous corrosion encountered in ocean-going tankers. Although a great deal of study has gone into the possible protection of the tanks, to date no satisfactory and at the same time economical method has been evolved. The most severe corrosion is in those tanks in which gasoline and light products are transported. This is due to the fact that these products leach the walls and so lay them bare to the corrosion that will occur when the tank is emptied, or when ballast is carried. The system of washing down the tanks with hot salt water is considered as a contributing factor to the corrosion. The ballasting of the tanker by taking on a salt-water cargo also contributes appreciably to the corrosion. Some time ago the Development and Research Division of the International Nickel Co., in co-operation with several groups in the oil companies, began a series of tests to ascertain if an alloy steel could be found that would increase the life of the tankers without uneconomically increasing the cost. As the first step to this investigation, sample test spools were installed in the top and bottom of cargo tanks. Corrosion is most severe at the top, as has been generally considered. Alternative cargoes of gasoline and sea-water appeared to be more corrosive than gasoline alone. This combination has long been suspect. The effects of gasoline cargoes compared with crude cargoes were also noted. The corrosion is least in "black oil" service. From a general study of many steels, the most resistant, from the standpoint of corrosion, was the 5 per cent nickel steel. This steel was considered to be too difficult to work and too expensive for practical application. As a result of the study of small specimens, a thought occurred that possibly the more vigorously attacked parts of the tank, usually the roof and possibly the bottom, could be made of some steel slightly noble to the tanker steel ordinarily used. By applying a more noble steel to the roof and bottom, the attack during the period that ballast was being carried would be directed against the carbon steel bulkheads and the sides which normally do not deteriorate at the rate of the top and bottom. This method of galvanic protection, while somewhat bizarre, attracted some attention, with the result that very elaborate installations of samples were made in the top, on the forward bulkhead, and on the bottom of a tank of an ocean-going tanker. About 2 tons of metal were involved and the specimens were insulated from the ship. The object of the test was to ascertain what galvanic protection could be expected and also the manner in which this would vary with the changes in relative areas of the noble and less noble material. Unfortunately, by the time these specimens were ready to be removed, the tanker was lost as an act of war. Prior to this some thought had been given to installing rivets of a material slightly more noble than tanker steel in order to protect the rivet heads on the sea side at a slight expense of increased corrosion of the surrounding tanker steel. A number of rivets were installed and to date have been reported upon favourably. However, interest in riveting has almost entirely disappeared. The test rivets were of a steel containing about 1 to 1¼ per cent nickel, 0·10 to 0·20 carbon, designated as S.A.E. 2115. The material has been accepted by the American Bureau of Shipping and Lloyd's Register as a rivet material as a preliminary step to having test rivets installed. The problem of tanker corrosion remains, and work is about to be undertaken again by exploration of the various materials under conditions encountered in the cargo tanks. At the present time several nickel-plated specimens have shown unusual resistance to attack in the top of the tankers, and a study along the lines of the use of plating may get under way by installing some deck plate, nickel plated on the bottom face. The nobility of the plating compared with the other parts of the structure will have to be considered with care.—*B. B. Morton, Journal of the Institute of Petroleum, Vol. 34, January 1948; p. 1-59.*

The Corrosion of Heating Surfaces in Boiler Plates: Further Studies in Deposit Formation

This paper compares the behaviour of cast iron and steel under the corrosive attack of the sulphur acids occurring in boiler gases. Preliminary laboratory tests show a pronounced difference in behaviour of the two metals. Further investigation shows that cast iron has inherent properties which increase its resistance to corrosion over a wide range of conditions. These properties are shown to be linked with the silicon content of cast iron. Consideration is given to the influence of corrosion products, and of sulphurous acid. An explanation is offered of a number of observed phenomena in practice, including the puzzling "band corrosion" in air-heaters. This is shown to be a temperature and acid-concentration phenomenon. The paper ends with some comments on the modern practice of cleaning economizers and air-heaters by washing, and makes suggestions for the future guidance of designers.—*Paper read by J. R. Rylands and J. R. Jenkinson at a Joint Meeting of The Institution of Mechanical Engineers and The Institution of Electrical Engineers, on 20th February, 1948.*

A Subsaturation Reheat Cycle

High-pressure is recognized as a prerequisite to maximum economy in steam-power production, but the resulting moisture increase reduces efficiency in the wet stages and aggravates water cutting of the exhaust blades. Increasing initial steam temperature or reheating the steam during expansion is the usual compensating means for reducing the excess moisture which causes exhaust-blade deterioration. About 12 per cent of moisture in the exhaust stages is generally considered as the economic limit in the design of steam turbines. A reduction of exhaust moisture is desirable because it increases efficiency and reduces maintenance. While an increase of initial steam temperature will reduce exhaust moisture, some form of reheat is more practical. Since moisture conditions ordinarily occur below the 100lb. stage, this paper proposes a reheat method which uses low-pressure bleed steam in combination with hollow stationary blades or nozzle partitions currently being provided in some turbines to improve strength performance and methods of fabrication. Steam bled from the higher stage enters the top of the diaphragm passage, flows through the hollow blades to the centre segment, then into the lower half of the diaphragm and on down through the lower blades to the bottom drains. It is not intended to superheat the steam but to evaporate excess moisture as it is formed. The surfaces in the low-pressure stages are adequate and the required temperature differences can be obtained with moderate pressure differences. The engineering problem involved in introducing low-pressure steam into hollow stationary blades is a simple one. The number of stages to be heated by this method can be determined on the basis of economics but addition of heated stages upstream until the dew-point is reached will increase efficiency. Evaporative reheating releases the choice in initial steam pressure from the limitation imposed by initial temperature and exhaust moisture conditions. It offers more effective moisture control than by increasing initial steam temperature. It permits building a simple two-bearing condensing turbine in a single unit for any initial pressure up to the critical with an initial temperature of 950 deg. F. or less with over-all economy excelling that of turbines now available. The need for super alloys for abnormally high temperatures and for resisting cutting is obviated since initial steam temperature can be reduced with maintaining a dry exhaust. This method of reheating requires no regulation and operating simplicity is assured.—*Paper read by W. E. Caldwell at 1947 Annual Meeting of the American Society of Mechanical Engineers, New York. Abstract in "Mechanical Engineering", Vol. 70, March 1948; pp. 256-257.*

Marine Exposures of Cementiferous Painting Schemes

This paper describes tests on painted steel specimens which were attached to rafts at Millport, and subject to total and partial immersion in the sea for periods of up to two years. Three schemes based on cementiferous paints have been studied, these paints being based on mixtures of zinc dust and certain chloride solutions which produce a matrix of oxychloride cement by the action on the zinc: (1) schemes in which both the priming and the anti-fouling coats were cementiferous compositions and were not satisfactory, owing to the gradual disintegration of the cementiferous matrix, (2) schemes in which a cementiferous primer was sealed (to retard disintegration) with an oleoresinous anti-fouling coat, were effective only for a limited period, and (3) schemes in which a cementiferous primer carried an oleoresinous sealing coat, which in turn was covered by an oleoresinous anti-fouling coat, gave excellent results; they were particularly promising for use at the water-line, where the conventional combinations give unsatisfactory results.—*K. A. Pyefinch, Paper MG/BC/43/47 of the Marine Corrosion Subcommittee of the Metallurgy (General) Division of the British Iron and Steel Research Association. "Journal of the Iron and Steel Institute", Vol. 158, February, 1948, pp. 229-235.*

ENGINEERING ABSTRACTS

Section 3. Shipbuilding and Marine Engineering

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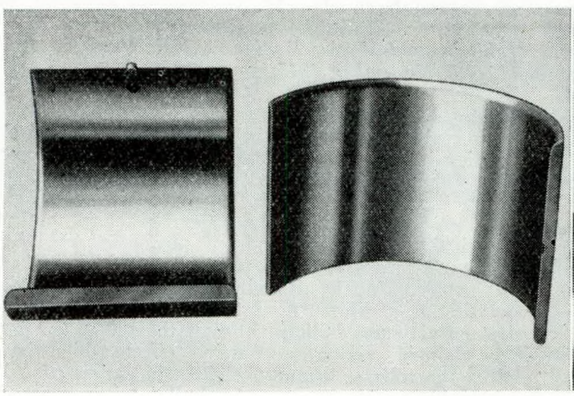
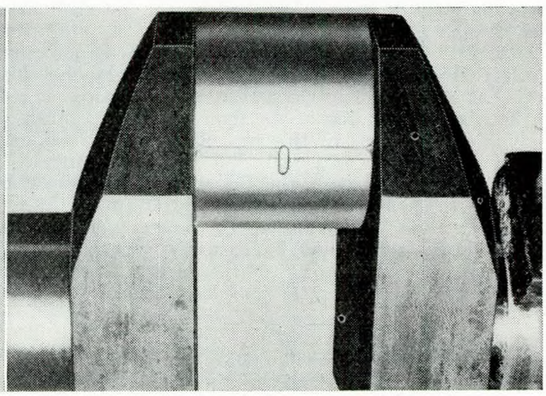
New Crankshaft Repair Method

The repair of crankshafts by the Bingham sleeving process consists in the welding of a specially prepared steel sleeve to the worn pin or journal; but in welding the sleeve in place there is no welded bond between the journal and sleeve. The journal diameter and the inside diameter of the sleeve are fitted to such precision that the edges of the split sleeve exactly meet. The process is a method of applying the weld so that there is no bond with the shaft. Incipient heat fractures in the base metal are thus avoided. As the weld cools on an applied sleeve, shrinkage causes the two halves of the new sleeve maximum depth beyond which most manufacturers recommend condemnation. The shaft under repair is first ground to a sufficient diameter to remove all imperfections, which usually is considerably less than the allowable maximum. The fillet is retained and later a small keyway is cut midway to the allowable maximum. The fillet is retained for the same reason that it was originally used; the remaining metal must do the work of the original shaft and the fillet helps to avoid stress concentrations which might occur if a sharp corner were used. Because of this tight mechanical fit and the precision with which the mating surfaces are prepared, it is



The two halves of the specially prepared sleeve



The special sleeve surrounding a crankpin

to grip the journal tightly. A specially prepared steel sleeve is provided, the inside diameter of which is ground to the exact size of the journal on which it is to be applied. It is then cut into halves and the edges bevelled, one edge being keyed to fit the shaft keyway. A special clamp holds the halves during the welding operation. The first step of a typical repair is the preparation of the crankshaft. The process is particularly applicable to journals that are scored, pitted, or have some other form of surface damage. The damage may extend to a depth of ⅛in., cr ¼in. on the diameter. This is the claimed that the subsequent loads are transmitted to the original journal over its entire area, and the heat transfer characteristics are not impaired. The final step in preparing the crankshaft for useful life consists of grinding the outside diameter of the new journal sleeve to the manufacturer's original specifications. This has the advantage of permitting the use of standard bearing inserts. The final finish is comparable to that of a new shaft and the hardness of the sleeve, unaffected by the welding process, insures long life.—*Gas and Oil Power, Vol. 43, March 1948; p. 67-68.*

Machining Shafts in Place

A recent article in an American journal, The Nautical Gazette, describes the machining of the journals of the main gear-wheel shaft in place in the hull of a ship, which resulted in a saving of some $50,000 (say £12,500). An examination of the bearings of the main gear-wheel on a C-3 class cargo vessel while undergoing extensive repairs, revealed that the shaft journals were badly scored. Apart from the fact that the vessel was in dry dock at the time for major hull repairs, the removal of the 22-ton gear-wheel and shaft to a machine shop ashore would have involved the dismantling of numerous pipes, gratings, ladders and sundry equipment, added to which, it would have meant floating the ship under a suitable crane thereby delaying other work to the hull and machinery of the vessel. It was, therefore, decided to machine the damaged shaft journals in place, for which purpose a special jig was designed to support the gear-wheel and shaft while it was being turned at machining speed by a large electric motor. The jig was fabricated from 2-inch welded steel plates and took a fortnight to construct. The machining process took a week to complete with two shifts of operators working round the clock, but the work was carried out with a high degree of accuracy, the position of the shaft with reference to the pitch line being unchanged and a zero tolerance maintained. At the same time four new bearings for the main gear-wheel shaft had to be manufactured.—*Shipbuilding and Shipping Record, Vol. 71, 11th March 1948; p. 307.*

Large-scale Torsional Fatigue Testing of Marine Shafting

This paper describes the design and construction of a new type of torsional fatigue testing machine of the resonance type capable of generating a reversed harmonic torque of up to $\pm 3 \times 10^6$lb.-in. in a stationary test shaft, at a frequency of approximately 2,500 vibrations per minute. Reference is made to a specially developed electronic method of speed control capable of regulating the nominal stress in the specimen to within one per cent. The paper includes the results of a number of fatigue tests carried out on 9⅝-inch diameter mild steel shafts, and also on "Meehanite" cast-iron specimens of 6-inch diameter, and concludes with some remarks on scale effect, based on results from ½-inch diameter specimens subjected to reversed torsional fatigue tests carried out on a combined-stress fatigue testing machine at the National Physical Laboratory.—*Paper read by S. F. Dorey at an Extra General Meeting of The Institution of Mechanical Engineers on 13th February 1948.*

Reversible Propellers for Fast Cargo Liners

The motor-ship "Los Angeles" for the Swedish Johnson Line recently launched from the yard of Kockums Mek. Verkstad at Malmo is being fitted with the largest reversible propeller so far designed anywhere. The principal dimensions of the "Los Angeles", which is designed for a service speed of 19½ knots, are 502 feet overall length, 465 feet length b.p., 64 feet beam, and 39ft. 10in. depth moulded to shelter deck, 9,100 tons dead weight. The propellers, which will be driven by two double-acting oil engines of 7,000 s.h.p. each, are of the KaMeVa type, designed and manufactured by the Swedish firm of Karlstads Mek. Verkstad. They are made of stainless steel and measure 17 feet in diameter. The pitch of the blades can be adjusted to any position direct from the navigating bridge, whereby the ship can be made to go forward, stop, or go astern at any desired speed without interference with the running of the main engines. Improved manœuvrability obtained by means of this propeller system is expected to be of special importance to vessels like the "Los Angeles", which are designed for traffic through the Panama Canal and other routes where they have to go at low speed for long distances. Moreover, previous experience has shown that the amount of towing necessary in restricted waterways and harbours is reduced by the use of reversible propellers.—*The Journal of Commerce, Shipbuilding and Engineering Edition, No. 37,455, 11th March 1948; p. 2.*

Controllable and Reversible Pitch Propeller Development

At the David W. Taylor Model Basin of the U.S. Navy Department, Washington, D.C., model tests are being carried out to study the effect of blade design upon the propulsive performance of controllable and reversible pitch propellers. These tests are integrated with full scale trials made under the direction of the United States Bureau of Ships. It is reported that three Taylor Model Basin blade designs and one design of the S. Morgan Smith Company are being investigated, while others are contemplated. Standard open water tests of the aforementioned designs have been made at positive slips with both ahead and astern; while tests at negative slip and at more than 100 per cent slip will be made. Self-propelled tests were made with a tug boat model under towing conditions. Additional tests will be made under manœuvring conditions. Two types of apparatus for measuring the blade spindle torque are being developed. With the first type the spindle torque on one blade may be measured during tests in the variable-pressure water tunnel, with the pitch fixed at any desired setting. The second type will permit continuous measurement of the spindle torques during pitch-changing operations. —*Bulletin No. 1-1, Current Hydromechanics Research in the United States related to Naval Architecture and Marine Engineering, Prepared by the Hydromechanics Sub-Committee of the Technical and Research Committee of The Society of Naval Architects and Marine Engineers, New York, November 1947, pp. 12-13.*

New Forms of Hulls and Propellers

The author outlines the principles and advantages of model experiments for determining the resistance and seagoing properties of ships. Dealing with improvements in ships' forms, he describes in some detail the three most important developments, namely, the Maier-form, Isherwood and Yourkevitch forms. He believes that all these forms have proved their worth in decreasing resistance, and should be well suited to speeds appropriate to them. In conclusion the author enumerates the principal requirements for a good form of hull and propeller, and shows the power diagram for a 31,000-ton liner to illustrate the progress made during the last few years in hull form. From this it can be seen that, while a liner of 1930 required 42,000 e.h.p. for a speed of 25 knots, a modern form, with the same displacement and length, needs only 25,000 e.h.p. Only ten years ago it was considered that the economical speed of cargo ships should not exceed 10-11 knots, whereas at present their speeds exceed 16 and even 18 knots; in addition, the low consumption of crude oil makes it possible to increase the power and speed in order to economize in time and labour.—*V. I. Yourkevitch, "Marine News", New York, 34 (1947), pp. 44 (Nov.). Abstract No. 1,498, "Journal of the British Shipbuilding Research Association", Vol. 3, No. 2, February 1948.*

Propeller Tunnel Notes

This paper describes the procedure for cavitation tests as followed at the Massachusetts Institute of Technology and relates some actual test data. The author discusses the influence of the presence of dissolved air in the water upon the phenomenon of cavitation and points out that this effect is only imperfectly understood, and much additional research, both model and full-scale is required. It is believed that in general ships' propellers cavitate more readily than indicated by model tests where the law of similitude for constancy of the cavitation index is applied. It is considered desirable to have a law of comparison with respect to air content connecting the model and ship phenomena, but no such law has yet been formulated. The author proposes a tentative hypothesis based on certain simplified assumptions. This hypothesis neglects any time factor or the effect of dissolved salts or dust particles in the formation of cavitation bubbles. While it is thus uncertain if the proposed hypothesis is sufficient, or even entirely correct, it at least indicates that model tests should be made with the highest practical air content in the tunnel water.—*F. M. Lewis, Paper read before The Society of Naval Architects and Marine Engineers, New York, at Annual Meeting, 13th and 14th November 1947.*

Cleaning Condenser Tubes

In order to maintain the condensers on board ship in an efficient condition it is essential that the interior surface or water-side of the tubes should be kept clean, since even the thinnest deposit of scale or slime forms a non-conducting film which greatly impedes the transfer of heat through the tube wall. The usual method of cleaning the tubes is by means of hand- or power-operated brushes carried on long rods; but with large condensers this is rather a slow process. This problem can be solved by the use of the hydraulic gun which, operating at a pressure of 60lb. per sq. in., is used to "fire" brass wire spiral brush bullets through the tubes, the form of the bullet, it is claimed, giving a scouring effect while the following water sluices the tubes. Water pressures in excess of 60lb. per sq. in. are undesirable as they cause the bullet to emerge with such a force that it strikes the rear water box door and is bent and thereby rendered useless for further service. This method of condenser tube cleaning is said to be thorough, rapid and cheap, but the work involved is unpleasant and necessitates the wearing of protective water-proof clothing by the cleaners in the water box. Moreover, the bullet sometimes sticks in the tube and has to be driven out by suitable rods. Various other forms of tube cleaning bullets have been developed, all of which can be fired from the same type of gun.—*Shipbuilding and Shipping Record, Vol. 71, 18th March 1948; p. 335.*

Harland and Wolff Engine Governor

In Fig. 2 is illustrated a centrifugal speed governor. A series of four metal balls (A), radially movable in a rotatable cage, co-act with the internal surface of a conical member (B) carried at the lower end of a plunger (C), loaded by an adjustable spring device (T_3). The plunger is movable with respect to a sleeve (D) which works within the governor casing (E). The casing is formed with a cavity to receive a piston (J) carried by the sleeve (D) and raised by a spring. The space beneath the piston (J) communicates, by way of an oil pipe, with a fuel regulating device, comprising a piston (K). The piston bears on the end of a fuel regulating rod (L), returned in place by a spring (M). The rod (L) is connected to the engine fuel pumps and an outward movement of the rod will effect an increase in the fuel supply. A passage (Q) opening out from the governor casing (E) is connected to a relief pipe. This ensures that the pistons (J,K) will always take up the correct relative positions when the governor is at rest. A reservoir (O) is connected by a pipe to a stop cock (N). The pipe (F) is supplied with oil under pressure from the lubricating oil system of the engine. This oil, when admitted through the chamber (G) to the space (H), acts on the piston (J) causing the sleeve (D) to follow the motion of the plunger (C), so that the travel of the sleeve is effected by the operating force of the oil and is not direcely dependent on the centrifugal force exerted by the governor balls (A). Movement of the piston (J) will, through the medium of the column of oil in the pipe (H^3), operate the piston (K) and thus control the fuel regulating rod (L). To stop the engine, the cock (N) is opened, in which case the oil in the cylinder (K^1) is released and the spring (M) acting on the piston (K) will discharge this oil to the tank (O). When the governor is at rest, the spring lifts the piston (J) to a position in which it uncovers the oil relief passage (Q), when the whole of the oil system is filled through the various pipes and passages and the open cock (N). This cock is closed before the engine is started. Failure of oil pressure in the system will release the downward pressure on the piston (J),

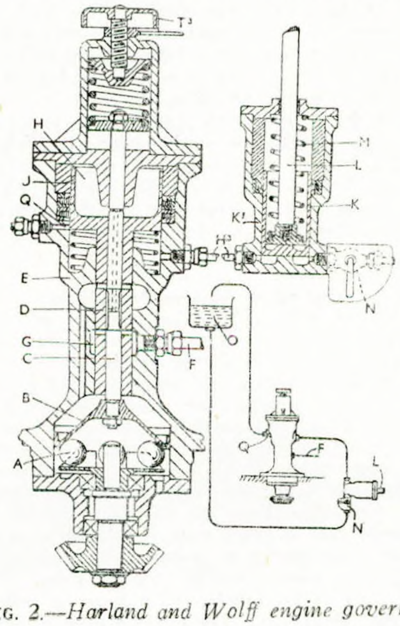
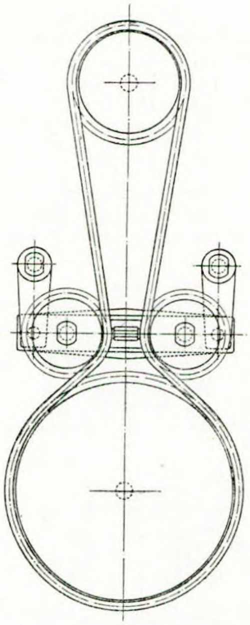


FIG. 2.—*Harland and Wolff engine governor*

permitting its spring and the spring (M), through the piston (K), to lift the piston (J) until it uncovers the passage (Q). The spring (M) returns the regulating rod (L) to a position in which the fuel supply is cut off and the engine stops. Adjustment of the load on the spring, by means of the hand wheel (T^3), enables the speed control to be varied, so that the governor will operate within a specific speed-variation limit.—(Patent No. 595,654. F. Moller and Sir F. E. Rebbeck, Harland and Wolff, Belfast).—*The Oil Engine and Gas Turbine, Vol. 15, March 1948; p. 393.*

A Chain Phase Adjuster

For the purpose of obtaining angular displacement between the crankshaft and camshaft of an oil engine, with any desired setting between designed limits, the Renold and Coventry Chain Co., Ltd., have developed a method using two coupled jockey wheels applied to a two-wheel drive in which there is only one driven wheel, namely, the camshaft wheel. The jockey wheels are mounted on a common bracket moved by a pair of parallel cranks operated by hand screw



A chain phase adjuster

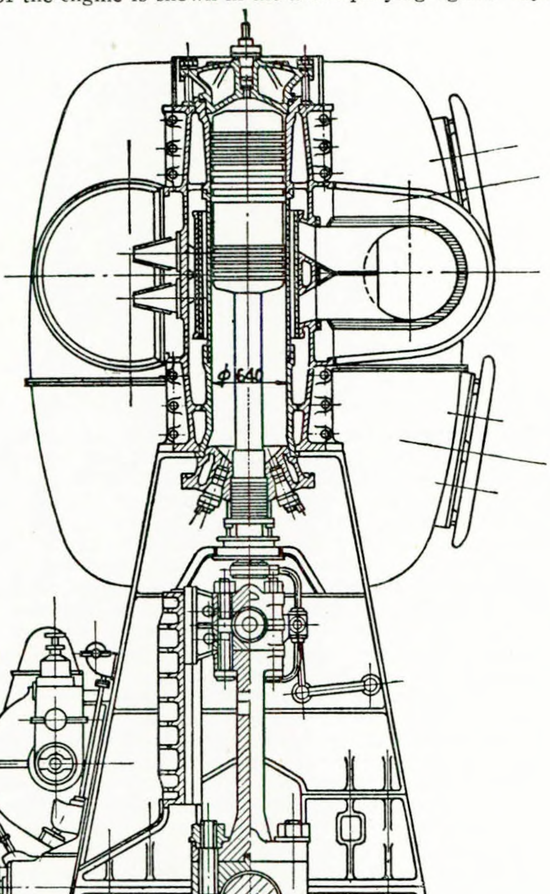
gear. The complete mounting is set centrally about the line of centre distance between the crankshaft and camshaft and arranged so that throughout the movement of the bracket the centre line between the pair of jockey wheels is always at right-angles to the centre line between the crankshaft and camshaft. The bracket also contains an adjusting screw connecting the bearings of the two jockey wheels and has a right-hand and a left-hand thread, one on each end. In operation the screw of the bracket is used solely for adjusting the initial chain tension as by turning the screw, the jockey wheels approach or recede simultaneously and equally with respect to the centre line of the drive. This operation therefore does not cause any relative displacement of the crankshaft and camshaft wheels, i.e., the timing is undisturbed. When the screw gear, which moves the bracket bodily on its mounting, is operated the pair of jockey wheels is displaced to one side; in so doing the chain lap on one jockey is increased and on the other decreased. At the same time the camshaft wheel is displaced angularly with respect to the crankshaft pinion, the chain tension being entirely unaffected. When the pair of jockeys is symmetrically disposed about the drive centre line, i.e., each is equidistant from the centre line, what may be described as the basic setting position is obtained. Movement of the pair of jockeys, i.e., phase adjuster, to either side of this position will therefore provide either advance or retard of the camshaft wheel in respect to the crankshaft pinion.—*The Motor Ship, Vol. 28, March 1948; p. 493.*

Explosions in Compressed Air Lines of Diesel Engines

Explosions in the compressed-air lines of Diesel engines are caused usually by heat in contact with an explosive gas mixture. The heat can be produced by the compression of the air, while the explosive gas can be supplied from improper or excess lubricating oil used in the Diesel engine or compressor. The design of the compressed air piping also may affect the matter. If there are certain pockets where the heated gas may collect, this will contribute to explosive possibilities. In any case the lubricant should be such that it does not gasify or disintegrate at the temperatures encountered. Hence, blended lubricating oils may be undesirable because some parts may gasify at the working temperature encountered. A minimum of special high-grade oil suitable for the temperature should be used. The danger of explosion is more likely from using too much improper oil than from an adequate supply of suitable oil. The likelihood of compressed-air explosions is increased by erratic operation, such as repeated stopping and starting, under which conditions an undesirable amount of lubricating oil may get into the system. An oil residue also may be deposited in the piping, which, when subjected to an unusually high temperature, may gasify and cause an explosion.—*H. C. Dinger, Marine Engineering and Shipping Review, Vol. 53, February 1948; pp. 86-88.*

Fiat Diesels for 9,000 ton Vessels

The M.V. "U. Vivaldi" the sea trials of which took place last year was built by the Cantieri Navali Ansaldo for the Soc. di Navigazione "Italia". The vessel is the first of a series of eleven modern motor vessels of the combined cargo and passenger type for the Soc. di Navigazione "Italia" and the "Lloyd Triestino" to be built by the Cantieri Navali Ansaldo and the Cantieri Riuniti dell'Adriatico respectively. The principal particulars of the "U. Vivaldi" are: length b.p., 138·68 metres; breadth, 18·92 metres; draught fully loaded, 7·9 metres; 15,070 tons displacement; 8,914 tons gross; 5,208 tons net; service speed, 16 knots. The main engine is a two stroke double acting nine-cylinder Fiat Diesel developing normally 7,500 b.h.p. at 125 r.p.m. During trials the engine developed 11,000 b.h.p. for eight consecutive hours, giving the vessel a speed of 18 knots. A sectional elevation of the engine is shown in the accompanying figure. Cylinder



Sectional Elevation of 7,500 h.p. Diesel

diameter is 640 mm. and the stroke is 1160 mm. The engine is operated normally on boiler fuel, the necessary equipment for heating and cleaning the fuel being provided. Specific fuel consumption approximates to 170 grams per h.p.-hr. All auxiliaries are electrically driven, three Diesel-generator sets of 225 kW. each being provided for this purpose. There is also an exhaust boiler arranged in the funnel and equipped for alternative oil firing.—*A. Gregoretti, Bolletino Tecnico Fiat Stabilimenti Grandi Motori, No. 1, 1948, pp. 15-20.*

The Burning of Boiler Fuels in Marine Diesel Engines

This paper gives a detailed account of the experimental investigations made by the author into the burning of heavy boiler fuels in marine Diesel engines. Instead of constructing a miniature of the 4,000 i.h.p. Werkspoor four-stroke Diesel in the adaptation of which to boiler fuel the author was chiefly interested, an exact duplicate of one engine cylinder in the shape of a specially built single-cylinder unit was constructed for the purpose of the tests. Most boiler fuels are composed of a mixture of residual and distilled oils, and it is the residual portion in which matter objectionable in Diesel engine fuels is to be found. With the exception of water, earthy matter and inorganic ash, however, every particle of residual oil is combustible. The removal of water and earthy matter is a simple matter with everyday equipment and the only objectionable constituent of boiler fuels for Diesel engine use is the ash content which is composed of silica, iron oxide, vanadium oxide and other abrasive matter. It was found that by raising the temperature of the fuel to 180 deg. F. and by passing it first through a centrifugal separator of ordinary construction serving as "purifier" and subsequently through another centrifugal separator serving as "clarifier" the desired result was achieved. The second stage of the experiment was carried out by converting the 4,000 i.h.p. Hawthorn-Werkspoor main engine of the 12,500 tons deadweight 12-knot tanker "Auricula" to running on boiler fuel. A full account of the service results is given and it is stated that they were what the author had been led to expect by the results obtained with the experimental engine. Reviewing results so far obtained the position was that it had been proved conclusively that with practically no alterations a standard four-cycle Diesel would operate indefinitely under normal sea conditions on boiler fuel up to 1,500 seconds viscosity if treated in the manner described. The conditions set up by heavy weather involving constant and wide variation in engine speed had no detrimental effect upon any part of the engine when operating on heavy fuel. The engine would start satisfactorily on heavy fuel provided the inoperative period prior to starting did not exceed three to four minutes. The specific fuel consumption as ascertained from a number of one hour tests was 0·295lb. per i.h.p. hour with Diesel fuel and 0·308lb. per i.h.p. hour with heavy fuel. On a cost basis a saving of over £200 would accrue for each Atlantic crossing with a 4,000 i.h.p. engine. The cost to convert existing ships will vary according to the arrangement of the fuel storage and service tanks, but if the arrangement follows general practice, the cost is estimated not to exceed £5,000, which approximates the saving effected during one year's operation of a 4,000 i.h.p. engine converted from Diesel fuel to heavy fuel. The cost of conversion will not be materially affected by the power of the installation, so that for an 8,000 i.h.p. installation the outlay will be recovered after six months' service.—*J. Lamb, Transactions of the Institute of Marine Engineers, Vol. 60, No. 1, February 1948; pp. 1-25.*

The Gas Turbine as Applied to Marine Propulsion

The paper begins with a historical survey of gas-turbine development, and deals briefly with the constant-volume and constant-pressure principles. Under the latter are included the open, closed, and semi-closed cycles. Notes are added on air heaters and heat exchangers, materials required for gas-turbine components, and systems of control. The latter portion of the paper covers the application to marine purposes, and describes some current marine-turbine installations. In view of the small number of the moving parts, gas turbines should eventually prove as reliable as older forms of propulsion machinery. Life should not be less than 100,000 hours at full load and temperature, but, as creep tests of this duration are impracticable, the designer must at present base his calculation on rather meagre data. Up-keep costs should, once the initial difficulties have been overcome, compare favourably with those of other forms. A gas turbine of 5,000-10,000 s.h.p. per shaft can be constructed to give a fuel consumption of 0·44-0·46lb. per s.h.p.-hr. (giving a thermal efficiency of more than 30 per cent on the gross calorific value of the fuel), and the figure should improve to 0·38lb. (comparable with the Diesel consumption) when metallurgical developments allow the initial air temperature to be raised by 150 deg. F. It should be able to burn the cheaper grades of boiler oil. The gas turbine is lighter in weight and occupies less space than the corresponding steam-turbine or Diesel installation. The author concludes that it will earn a fundamental place in marine propulsion during the course of the next few years.—*T. A. Crowe, The Twentieth Thomas Lowe Gray Lecture, read before The Institution of Mechanical Engineers on 23rd January 1948.*

Forced Circulation Boilers

Two twin-screw passenger and cargo liners now under construction in this country for French owners will be equipped with two La Mont boilers each. Each boiler has a normal output of steam of 55,000lb. per hour at a pressure of 500lb. per sq. in. superheated to 734 deg. F., the overload capacity being 80,000lb. per hr. The water capacity of each boiler is 4½ tons and the weight (empty) including the economizer is 25½ tons. Each boiler is provided with a circulating pump driven at constant speed by a turbine taking its steam direct from the main steam outlet pipe of the superheater header, the consumption of the turbine being, it is stated, less than 0·75 per cent of the boiler output. The pump is of the simple centrifugal type operating under a constant pressure differential of 35 lb. per sq. in. The main steam drum is 3ft. 6in. internal diameter and 1¼-inch thick, the seams being fusion welded, while all the tubes in the evaporator banks, the superheater and the economizer are of solid drawn mild steel 1in. outside diameter. The various safety devices include an automatic feed regulator, a high-and low-level alarm and a differential pressure alarm on the discharge side of the circulating pump.—*Shipbuilding and Shipping Record, Vol. 71, 11th March 1948; p. 307.*

Thermal Computation of Boiler Furnaces

According to the author, the heat absorption in a boiler furnace can be reliably determined by computing the heat balance of the individual exposed surfaces in the furnace on the basis of the Stefan-Boltzmann law. It is claimed that the new method developed by the author permits the computation of the temperature in the furnace within ± 25 deg. C.; but in order to extend the applicability of the method, additional experimental data on the black body coefficient of the flames of different fuels are called for. The method is said to be capable of further simplification and the establishment of reference data in tabular form is suggested.—*S. P. Siromyatnikov, Izvestya Akademii Nauk, U.S.S.R., No. 12, 1947; p. 1,615-1,627.*

Technical and Economic Aspects of Water Purification for Ships

The Kleinschmidt vapour-compression distilling unit was developed for the Marine Corps as a simple and economical means of producing potable water for landing operations. The unit has five major parts, a source of mechanical power, a steam compressor, an evaporator, a heat exchanger and a source of heat for starting the unit. This paper compares the Kleinschmidt method of distilling water with the conventional steam-heated evaporator in respect to fuel efficiency, purity of distillate, capacity, simplicity of control, ease of cleaning, and finally over-all cost. Cost of water produced by the unit is of the order of from one to five cents per day per person aboard. Six specific applications of the unit are discussed.—*Paper read by R. V. Kleinschmidt at the 1947 A.S.M.E. Annual Meeting, Mechanical Engineering, Vol. 70, March 1948; p. 251.*

Low-pressure Steam-heated Distilling Plants

This paper refers to the fact that the present-day employment of relatively high steam pressures in marine power plants superimposes on the old problem of supplying general-purpose fresh water the need of extremely pure water for boiler feed. Use of the low-pressure steam-heated distillation plant for supplying water for both purposes offers many advantages from an economic and engineering standpoint. The advantages are discussed with reference to the "package-type" distilling plant recently made available in normal-rating capacities from 9,320 to 60,000 gal. per day. Recent studies show that installation costs can be justified on some vessels because the plants make available additional cubic capacity and reduce dead weight by eliminating fresh-water storage tanks. Substantial profits can be realized on distilling plants in investment on larger ships, but on smaller cargo vessels economic justification can be dubious. On the Venore class, service experience showed that while at sea, a well-designed plant could produce regularly a distillate having a sea-salt content of 0·1 grain per gallon. Potable water could be produced regardless of the temperature of evaporation providing no priming occurred. Plants equipped with an automatic device to discharge distillate overboard when sea-salt content exceeds 0·25 grain per gallon have been approved by the U.S. Public Health Service. Scale formation is not a serious problem because of the low-heat steam and low boiling temperature. "Cold shocking" once daily is customary. Use of a Navy compound-cornstarch feed treatment is claimed practically to eliminate scale. Engineering considerations of a typical low-pressure steam-heated plant are discussed and control devices which simplify operation and provide a considerable measure of automatic control are listed. Fuel-economy data for single- and double-effect plants are given, also a heat-flow diagram for a 6,000-gallon per day (bleeder operation) single-effect plant. The distilling plant is a vital piece of equipment on the modern ship. It should be constructed to outlast the life of the ship. Non-ferrous materials such as cast bronze and 70-30 copper-nickel alloy are generally specified.—*Paper read by A. M. Impagliazzo, and R. M. Bent at the 1947 A.S.M.E. Annual Meeting. Mechanical Engineering, Vol. 70, March 1948; p. 250.*

Oil Engines and Steam Engines for Marine Propulsion

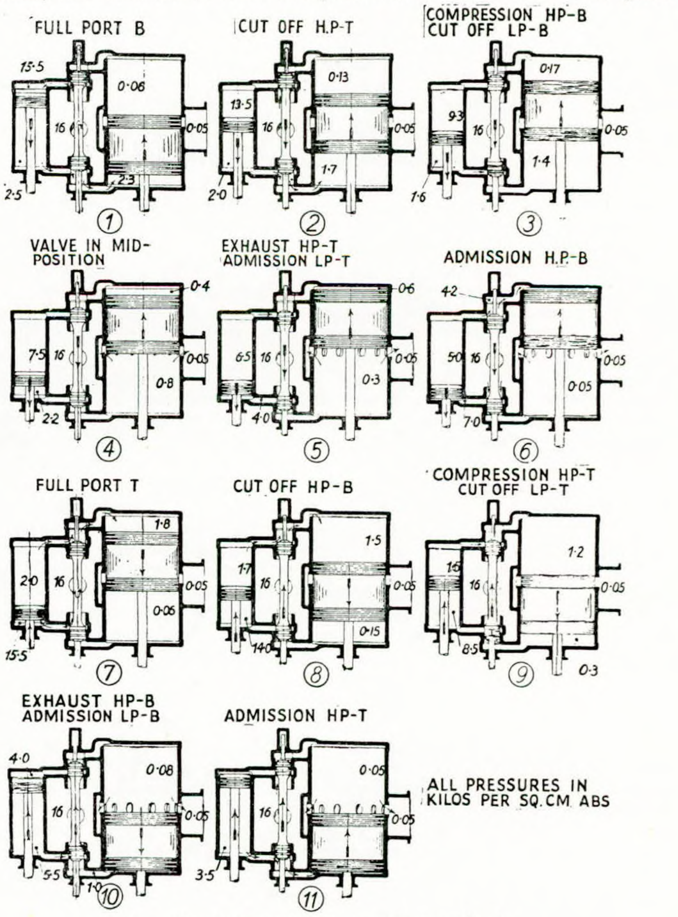
In marine engineering, as in all other activities, the aftermath of the war still has very important effects. Many shipowners are accepting machinery types today which are not necessarily those they would have chosen in more normal circumstances. Owing to full order-books and limited capacity of the marine engineering industry in this country, owners are often largely influenced by what they can get comparatively quickly, so as to be able to take advantage of the favourable freights which can be expected for at least a short time to come. It is probable, therefore, that when things become more normal marine engineering practice will be appreciably different from that ruling today. Nevertheless certain tendencies are discernible, and the author gives a brief résumé of the present position regarding oil engines and steam engines for ship propulsion, together with an estimate of the trend in the near future.—*P. L. Jones, Centenary Lecture, given 10th June 1947 before The Institution of Mechanical Engineers, London, Proceedings 1947, Vol. 157, pp. 171-174.*

Warming-up a Geared-turbine Unit

This article deals in detail with the procedure to be followed in warming-up a geared turbine unit. The following main items are listed and discussed: measurement of cold turbine radial and axial clearances; inspection and placing of lubricating-oil systems in operation; inspection of stern-tube glands; draining of steam lines and turbine; engaging and starting turning gear; freeing of throttle and nozzle valves; inspection of turbine sliding feet; placing condenser in operation; placing gland-sealing system in operation; starting second-stage air ejector; warming up steam line; obtaining permission to spin turbines · disengaging turning gear; starting turbine warm-up; checking operation of self-closing valves; checking lubricating-oil temperature; closing steam-line-heating by-pass; measuring warmed-up turbine axial clearances.—*Marine Engineering and Shipping Review, Vol. 53, March 1948, pp. 78-80; 102.*

The Fredriksstad Steam Motor

The s.s. "Viktun" of 4,570 tons gross, built by John Readhead and Sons, Ltd., South Shields, for the Tanker Corporation of Panama, will be the first to be completed of three vessels in this yard



The Frederiksstad Steam Motor Cycle

which are to be powered by the Fredriksstad Steam Motor. The three engines, either constructed or under construction at Readhead's engine works, are the first of this type to be put into service in Great Britain since the end of the war. The Fredricksstad Steam Motor is a double compound marine engine, built to operate on the Wolf principle and with the four cylinders working on separate cranks. The diameter of each of the two high-pressure cylinders is 450 mm. and of the low-pressure cylinders 1,080 mm., with a stroke of 985 mm. They are designed for developing at normal cut-off 2,200 i.h.p. at 102 r.p.m. and at maximum cut off 3,200 i.h.p. at 115 r.p.m. The engine—which weighs about 90 tons—operates with superheated steam at 220lb. per sq. in. and at 600 deg. F. The engine consists of two equal halves, each half composed of one h.p. and one l.p. cylinder with only one common piston valve, which serves to regulate the admission and discharge of the h.p. cylinder and is—as with any h.p. valve—of small dimensions. When the valve opens for h.p. discharge the steam passes directly into the l.p. cylinder and expands further in both cylinders simultaneously. This is made possible by the cranks being placed opposite. The crankshafts of the two engine halves are placed at 90 deg. in relation to each other, thus securing a very even turning moment. The exhaust from the l.p. cylinder is controlled by the l.p. piston itself, thus: at the end of the stroke (in the middle of the cylinder) exhaust ports are arranged in the cylinder wall (uniflow principle). The design of these ports has ensured that no measurable pressure drop occurs between the cylinder and the condenser—unlike some engines with slide or poppet exhaust valves, where the pressure drop may be quite considerable. The indicator cards, in fact, have shown that even at top speed the high vacuum in the condenser acts unreduced on the l.p. piston. . The Steam Motor is thus designed to utilize a vacuum which is unusually high for reciprocators, about 95 per cent. The high vacuum is attained by a regenerative condenser. No pumps are attached to the main engine. The pumps and fan engine work on superheated steam with full boiler pressure and about 30lb. back pressure, the exhaust being utilized for heating the feed water. The steam consumption figures are about 9·25lb. per i.h.p.-hr. for the steam motor alone, or about 9·8 including the consumption of the air ejector, condensate, feed and circulating pumps as well as the fan engine. The steam consumption per i.h.p. has been proved to be practically independent of the cut-off. This means that the cut-off may be increased from say the normal 40 per cent to the maximum 55 per cent, corresponding to an increase in output of over 40 per cent—without using more steam per horse power.—*The Shipping World, Vol. 118, 21st April 1948, pp. 417-418.*

The Gas Turbine and Heat Engines of High Efficiency

In this paper the author reviews the problems involved in the development of heat engines to combine high thermal efficiency with a minimum capital expenditure. Today the steam turbine has practically reached the highest thermal efficiency that can possibly be attained with this type of prime mover in practice, namely some 35 per cent as compared with a theoretical figure of 45 per cent. Further progress can therefore be attained only in the field of the internal combustion engine. With simple gas turbines operating on the adiabatic compression-combustion-adiabatic expansion principle only mediocre thermal efficiencies of 20-25 per cent can be reached. Higher efficiencies are possible with the employment of heat exchangers, but these are very high in first cost and other losses caused by them may considerably reduce actual efficiency. The author therefore believes that there exist definite limitations to gas turbine progress and that piston engines offer better promise, particularly as they are not subject to limitations of combustion temperature. A supercharged Diesel permits the attainment of some 40 per cent of thermal efficiency, but this figure may ultimately also be reached with gas turbines by resorting to higher combustion temperatures. In view of the much higher first cost of the supercharged Diesel as compared with the gas turbine, the economic advantages of the Diesel over the gas turbine are therefore highly doubtful. There exists, however, another way to increase piston engine efficiency, which is the adoption of the total injection system as proposed by the author. In this system the pre-compressed combustion air is preheated in a heat exchanger by the exhaust gases. The combustion pressure of a total injection engine will rapidly increase with the richness of the mixture. In the case of an engine burning a low grade fuel with 130 per cent excess air the combustion pressure will be only 22·5 kg, per sq. cm., but the effective efficiency will be 51 per cent. By increasing the combustion pressure to 68 kg. per sq. cm. with 80 per cent excess air, an efficiency of 55 per cent will be reached. These figures are based on an isothermal compression efficiency of 70 per cent, and by employing compressors with water injection it should be possible to reach overall engine efficiencies of 60 per cent. The indicator diagram of the total injection engine should be superior to that of an ordinary Diesel as a much more favourable ratio of m.e.p. to maximum pressure can be achieved. Also, the speed of a total injection engine may be three times that of the ordinary Diesel without causing heavier stresses in the reciprocating mechanism. An exhaust turbine may be added to supply air to the compressor at 3-4 kg. per sq. cm. pressure, and this will lead to a considerable reduction in the dimensions of the compressor.—*Paper by G. Brun, read before the Société des Ingenieurs Civils de France at a meeting on the 23rd January 1948; Bulletin No. 2-4, pp. 31-35.*

Chromium Plating for Cylinder Bores

The "Honeychrome" process consists in the deposition of a smooth, regular, non-flaking surface of "dense" chromium, of the required thickness, on the bore; this is followed by a patented method of making depressions in the chromium layer. This results in a hard chromium surface patterned with matt-finish cellular depressions which constitute oil reservoirs for the provision of constant lubrication. The outstanding feature is that the oil reservoirs are accurately controlled in regard to pattern, size, pitch and depth, and that each of these factors can be varied to suit the particular requirements of any type of piston and ring arrangement. This degree of control of the oil cells is designed to preclude any possibility of "blow-by" or of oil being pumped past the rings, whilst at the same time providing adequate lubrication; together with the low coefficient of friction of the chromium surface, the design reduces ring friction and the possibility of scuffing troubles. Although carbon may be deposited in the cells during the engine running, it is of a spongy formation and has no adverse effect on the oil-storage properties of the depressions.—*The Oil Engine and Gas Turbine, Vol. 15, April 1948, p. 426.*

Optimum Power Cycle for Turbine Power Plants

The authors of this paper announce the discovery of a new realizable thermodynamic cycle, the "Hexagon", intermediate between those of Brayton and Ericsson, which avoids the many reheater and cooler components of the latter, and in addition has a thermal efficiency superior to both the Brayton and Ericsson types as shown below:—

Brayton, per cent	Ericsson, per cent	Hexagon, per cent
21·1	21·5	25·6
24·3	31·2	34·0

—*Preprint of paper by J. Kreitner and F. Nettel, read before a meeting of the American Society of Mechanical Engineers, New York, December 1947.*

Port Arrangement for Sulzer Two-stroke Machinery

A special arrangement of ports suitably designed for a two-stroke engine with exhaust gas turbo-charging is illustrated in Fig. 4. The

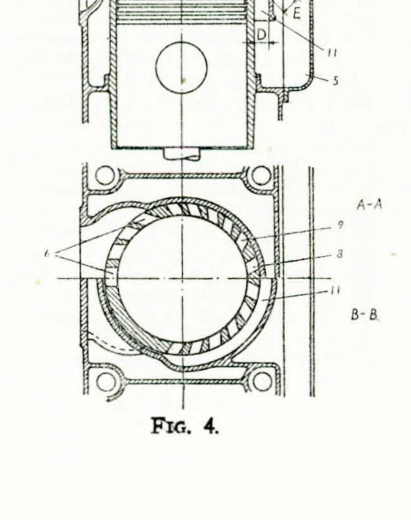


FIG. 4.

scavenge ports (8, 9) are directed obliquely upwards, and there is an annular supply passage (11) inside the scavenging air truck (5). The radial width (D) is approximately equal to the height (E) of the ports (8) measured at right-angles to the inclined surfaces. The length of the annular space (11) is such that the exhaust gases, which may tend to blow back towards the scavenging conduit, cannot reach the interior of the scavenging trunk (5). This length depends on the piston speed of the engine and the dimensions of the ports. The measurement is arranged to be not less than one-third of the piston stroke. Exhaust ports (6) are provided on the opposite side of the cylinder liner to the scavenging air ports. It is claimed that this arrangement offers special advantages in the case of engines supercharged by an exhaust gas turbine.—*The Oil Engine and Gas Turbine, Vol. 15, April 1948, p. 428.*

Stork Supercharged Two-stroke Engine

British Patent No. 595,236, recently granted to Gebr. Stork N.V., Hengelo, Holland, covers a supercharged two-stroke engine. Mounted in the cylinder head (2) of the engine partly shown in Fig. 1 is an exhaust valve (5) for the combustion gas and an inlet valve (6) for the admission of supercharging air. The engine is of the two-stroke type with scavenging air ports uncovered by the piston (3). The

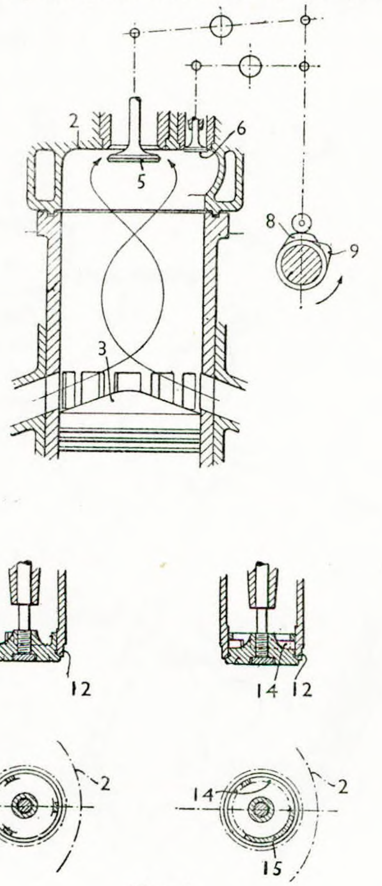


FIG. 1.

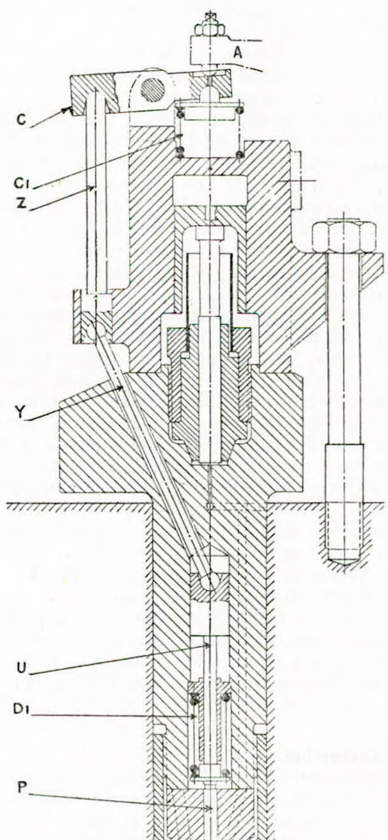
exhaust valve and the supercharging valve are lifted by means of cams (8, 9) respectively. The arrangement has the advantage that the exhaust valve and its casing are cooled by air directly supplied by the supercharging valve, and the amount of air is regulated by adjusting the timing of the valves relative to one another. Two forms of supercharging valve are shown in the diagrams. On the left the valve is of the piston type for part of its length. It opens only when it has been lifted off its seat (12) and has attained an appreciable speed. The valve on the right is provided with two ports (14). The part (15) of its wall serves as a baffle for tangentially deflecting the inflowing air, thus intimately mixing the air with the fuel spray as it enters the combustion chamber.—*The Motor Ship, Vol. 29, April 1948, p. 40.*

Piston Ring Movement During Blow-by in High-speed Petrol Engines

This paper deals with electrical recording of the axial and radial movement of a piston ring, relative to its groove, in a petrol engine running under conditions of heavy blow-by. The engine was delivering power and records were made at speeds up to 5,500 r.p.m. The records show that the excessive blow-by often experienced at high engine speeds is not due, as generally supposed, to a vibratory piston ring radial "flutter" of frequency associated with the natural frequency of the piston ring. The records show instead that, at high engine speeds, the piston rings collapse radially inwards some 25 deg. before the end of the compression stroke and remain steadily collapsed until some 60 deg. after the start of the firing stroke. It is this steady collapse which causes the heavy blow-by. An explanation, supported by experimental results, is given of this radial collapse of piston rings. A description is given of two designs of piston ring and groove which were evolved as a result of this investigation. These two designs have not yet been thoroughly tested, but preliminary trials are very promising and suggest that with such designs blow-by should not become excessive at any practicable engine speed. —*Paper presented by P. de K. Dykes at a General Meeting of the Automobile Division, jointly with the Internal Combustion Engine Group of the Institution of Mechanical Engineers, London, 6th April, 1948.*

Injection Conversion Timing

A new improvement of the Wilson and Kyle Kockum system for the conversion of old air-injection engines to airless-injection consists in the incorporation of a timing device. This addition enables accurate timing of the point of injection to be made by means of an adjusting screw in the fuel valve rocking lever. and the adjustment can be carried out without stopping the engine. Referring to the accompanying drawing, the nozzle needle P is held in a closed position by helical springs C1 and D1: the pressure of the former is transmitted through the short fulcrum lever C and the push rods Z, Y, and U. At the point of injection the engine cam operates the fuel valve rocker lever A, which in turn depresses lever C, compresses the spring C1, and allows fuel oil to lift the nozzle needle against the pressure of spring D1 only. Fine adjustment of the timing is obtained by adjusting the screw in the rocker arm A. By screwing this down



Section through the combined fuel pump and valve the point of fuel injection is advanced and the maximum firing pressure increased; the opposite effect is obtained by screwing back. The whole combined fuel pump and valve with the timing device is studded to the cylinder head.—*The Marine Engineer, Vol. 71, April 1948, p. 180.*

Navy Diesel-engine Research

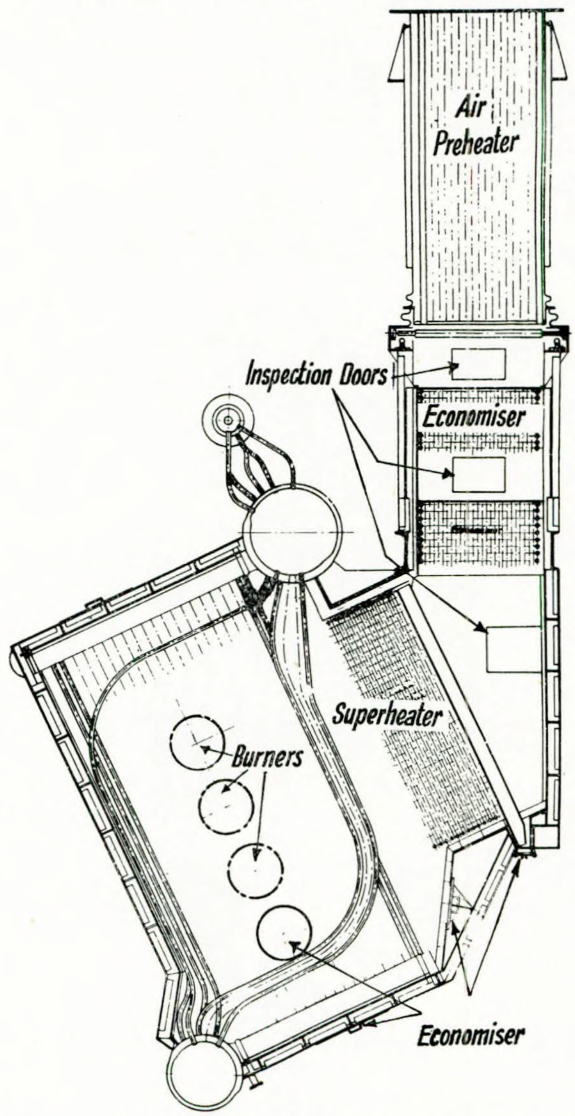
A review is given of the outstanding projects investigated at the Engineering Experimental Station at Annapolis, Maryland, which is responsible for the research and development work on internal combustion engines for the United States Navy. At this station life tests of 2,000 hours or more, under conditions simulating normal operation in the fleet, are carried out on submarine-type Diesel engines. A brief description is given of a small, light weight unit designed for high specific power transmission, which has been adapted for use in many installations including the engines of the PT boats. Approximately 120 different filters have been tested, and two Diesel-fuel and eight lubricating-oil filters have been standardized from the data so far obtained on filter efficiency. Five different submarine Diesel engines, representing two distinct types, were used for extensive tests on types of lubricating oil, cylinder liners, main and connecting-rod bearings, cylinder head studs, etc., which have led to considerable improvements in design resulting in greater reliability. A three-critical-speed damper has been developed for the elimination of torsional vibration, which has proved highly satisfactory. Certain Diesel power-boat engines have been found to be rated too highly, considerable improvement in performance being obtained in one case when the rating was reduced from 270 b.h.p. at 2,000 r.p.m. to 230 b.h.p. at 1,800 r.p.m. Tests have shown that in the manufacture of injection equipment expert workmanship, careful inspection, and suitable heat treatment are essential. Seizure can be caused by creep of the metal at high temperatures, and inadequately lapped surfaces are a frequent source of trouble. Non-corrosive materials should be used. Work is still progressing on the important subject of starting Diesel engines at low temperatures, but some interesting results have already been obtained. When the temperature was lowered below well-defined critical values there was a rapid increase in the cranking time required for starting, A marked reduction of the minimum starting temperature from about 55 deg. F. to 5 deg. F. was obtained by using an electric inlet-air heater. The use of special starting fluids and lubricating oils, increasing the compression ratio, and retarding injection several degrees during cranking were all found to improve cold starting. Approximately 150 protective coatings for exhaust mufflers have been investigated and the most generally suitable type to date are certain porcelain enamels, which have given exceptional operating results, but which are not always easy to apply uniformly on welds and sharp edges and are subject to chipping by thermal and mechanical distortion. Work is still being carried out on this subject. A number of unusual types of failure are discussed rather more fully. These include the cracking of cylinder heads due to inadequate cooling; failure of end bolts used to hold down the engine, due to lack of provision for the vertical thermal distortion of the sub-bases during operation; failure of bearings caused by skidding rotation of the crankshaft journals, which can be remedied by providing a properly counterbalanced crankshaft in the original engine design; and defective connecting-rod bearings due to faulty manufacture such as barrel-shaped bearing surfaces caused by the use of faulty jigs. Extensive tests have led to the adoption of chromium plating by the reversed-current process for most large, heavily loaded Diesel liners. Not only is wear reduced, but cast-iron surface failures are eliminated. The major causes of bearing failures have been shown to be in the following approximate order; fatigue, corrosion, wiping, defective manufacture, and such miscellaneous causes as poor design, failure of housings, etc. Work is being carried out on the various methods available for salvaging failed and worn engine parts. An outline is given of work to be carried out in the future. Engine efficiency, noise reduction, and specific power increase are all considered to be important. Four references are given.—*Abstract No. 1638, Journal of The British Shipbuilding Research Association, Vol. 3, No. 3, March 1948. Joachim, W. F. Trans. S.A.E., 2 (1948), p. 1 (Jan.).*

Unusual Furnace Distortion

If the furnace crowns come down in a cylindrical boiler, due to excessive accumulation of grease or scale forming on the top of the furnaces, it is usual that any deformation takes place from the top, but the reverse has occurred in the steamer "Arenados", of 4,861 gross tons, belonging to the Compania Arena, Ltd., Panama City. When this ship was docked by the Mercantile Dry Dock Co., Jarrow, for repairs, it was found that the centre furnace of the port boiler had closed in from the sides, leaving only ⅜-inch clearance. The top of the furnace had risen to such an extent that there was only finger space between the metal of the furnace and the lowest row of return tubes. The bottom of the furnace was hard on the shell. Although such severe distortion of this Morison corrugated furnace had taken place, there was no evidence of fracture in the material, but the distortion had pulled in both the boiler front and the chamber back as well as bendin~ several stays.—*The Journal of Commerce (Shipbuilding and Engineering Edition), No. 37,478, 8th April 1948, p. 6.*

New F.C.M. Two-drum High-pressure Boiler

An article in a recent issue of the "Journal de la Marine Marchande" describes a new design of water-tube boiler with accelerated natural circulation and with the walls of the combustion chamber entirely composed of generating tubes. The new boiler is built by the Forges et Chantiers de la Mediterranée. The salient features of the new boiler, known as the FCM 47/60 are shown in the accompanying drawing. It consists essentially of two welded drums, a furnace of parallelopiped form with evaporator and convection tubes



with a total evaporative surface of 173 sq. m. (1,865 sq. ft.), a superheater, economizer and air preheater; these are shown on the drawing. The boiler, which has been built and tested, has been shown to operate under the following thermodynamic conditions:—

Steam pressure	60 kilos (855lb. per sq. in.).
Temperature at the superheater outlet ...	480 deg. C. (896 deg. F.).
Continuous rated output	30 metric tons per hour.

The furnace is provided with three burners. The official trials took place on 6th November 1947 under Bureau Veritas survey. The C.G.T. have decided to adapt this type of boiler for one of their passenger and cargo vessels of PA type now under construction. The ship will be propelled by two sets of geared turbines developing 14,000 s.h.p. taking steam from three boilers identical with the prototype. Normally two boilers will be in operation.—*The Marine Engineer, Vol. 71, April 1948, pp. 175-177.*

Pressure Drop of Steam-water Mixtures in Boiler Risers

The author presents a simplified method for the determination of pressure drop for the flow of steam-water mixtures in vertical risers of boilers of the natural circulation type. The theoretical findings are compared with experimental data established at the Central Boiler and Turbine Institute, Moscow, for pressures ranging from 180lb. per sq. in. to 2,580lb. per sq. in. It is claimed by the author that the satisfactory agreement between theoretical and experimental data as illustrated by various diagrams included in the article, proves the correctness of the simplified assumptions upon which the theoretical approach is based. The formulæ given are claimed to be valid over a range of pressures extending from atmospheric pressure to 2,840lb. per sq. in. for a minimum water velocity of 4 inch per sec. The method is said to be applicable to vertical tubes of 1-inch to 3-inch internal diameter.—*V. A. Shvab, Kotloturbostroenie, No. 4, 1947, pp. 1-5.*

Modern Improvements in La Mont Boilers

The article discusses some modern improvements in the design of La Mont boilers, particularly those introduced by the International La Mont Co. in London. The considerable number of accidents that occurred with marine La Mont boilers was due not so much to the basic principle of that type of boiler, as to faulty or unsuitable tube material and to bad arrangement of the circulation system. Accordingly, the Spanish National Shipbuilding Co. (Elcano) has, in conjunction with the Spanish Admiralty and Lloyd's Register, issued new rules for testing boiler tubes. According to these new rules, the tube arrangement of La Mont boilers should not be horizontal as in old designs, but vertical, to provide a certain amount of natural circulation. Boilers with this arrangement can be fired up in an hour's time without using the circulation pump, and about 10 per cent of the normal steam production is possible during that stage. The superheater tubes have then, of course, to be filled with hot water and must be connected to the atmosphere. This greatly improves the safety factor of the plant. Modern La Mont boilers should be calculated for the maximum temperature under otherwise normal working conditions. If the temperature is to be lowered, air has to be injected below the superheater coils. La Mont boilers for large ships should have a separate auxiliary combustion chamber for the superheater tubes. The evaporator banks are arranged in the main furnace. During firing up, the auxiliary furnace is not used, i.e., saturated steam only is produced. The tube diameter has largely been reduced (to nearly 1 inch outside and 0·12 inch thickness). Modern La Mont boilers can attain an efficiency of 82 per cent calculated on the upper calorific value of the fuel.—*Abstract No. 1627, Journal of The British Shipbuilding Research Assoc., Vol. 3, No. 3, March 1948. Ingenieria Naval, 15 (1947), p. 714 (Dec.).*

2,200 b.h.p. Quadruple-screw Rhône Tug

A tug was launched recently from the Chantiers de Normandie, Grand Quevilly, for the Soc. Lloyd Rhénan et Compagnie Nationale du Rhône. She is a high-powered vessel of 2,200 b.h.p., but in view of the necessity for shallow draught there are four engines driving propellers in tunnels. The engines drive the propellers through reducing gears, which bring the speed down to 290 r.p.m. The main machinery is of the four-stroke M.A.N. type and each engine runs at 470 r.p.m. The tug is 229 feet in length with a beam of 28ft. 10in., the mean draught being only 1·25 metre or 4·1 feet. An interesting feature of the vessel is that electricity is used for all auxiliary purposes, and three-phase current at 190 to 220 volts is employed. There are two 50-kW. Diesel-engined alternators. She is named "Frédéric-Mistral".—*"The Motor Ship", Vol. XXVIII, No. 338, March 1948, p. 476.*

Measurement of Water Flow and Pressure Set up by Ships in Motion

In this paper the means available for measuring water flow and pressure in the vicinity of ships—model or full-scale—are discussed. The calibration and sensitivity of two types of recorder, i.e. the hot wire for velocity and the aneroid for pressure, are described in detail. The conditions which must be fulfilled when these instruments are required to follow fluctuating motions are considered. There follow practical examples of the application of the hot-wire velocimeter to ship models in a towing tank, for recording both mean velocities set up by the general motion of the ship and the microturbulence set up by its vibration. A means of recording the flow through a screw propeller is also described.—*E. G. Richardson, Paper read at a meeting of the North-East Coast Inst. of Engineers and Shipbuilders, 5th March 1948.*

Rolling Tests on Swedish Liner

Prior to delivery of the Swedish America line's motorship "Stockholm" by A/B Gotaverken, a new method of carrying out rolling tests was adopted for the first time in Sweden. The ship was moored head-on to the quay with mooring wires running straight ahead and astern but without any springs, so that her rolling motions should not be interfered with. A boom was run out from one side of the ship and a weight of 25 tons was suspended on a wire from the end of the boom. When the ship lay motionless in the listed position thus obtained, the wire supporting the weight was burned off by an acetylene lamp. As the weight fell, the ship righted herself, then rolled over to the other side, and during the subsequent movements, her rolling period was recorded by the stabilograph fitted on board and was found to be 22 seconds, which is a very favourable value for a passenger vessel.—*The Journal of Commerce (Shipbuilding and Enginering Edition), No. 37472, 1st April 1948, p. 7.*

Projected Brazilian and Spanish Liners

The author of this article comments on some particulars which have become available about Brazilian coastwise ships to operate from Buenos Aires, in the Argentine, to Manaos, on the River Amazon. He compares their design with two Spanish proposals for the North and South American routes respectively, noting certain similarities of arrangement and structure, and referring to the undoubted influence of pre-war German and Italian practice in the layout of public rooms and decks.—*The Journal of Commerce (Shipbuilding and Engineering Edition), No. 37484, 15th April 1948, p. 5*

Pitching and Pounding

In some instances the pitching or horizontal movement of present-day passenger liners of large size can be said to coincide with the wave period and successive increases in length have had regard to the wave conditions likely to be experienced on the service for which a ship is designed. On the other hand. some ships have been found, when built, to be just "out of step" or out of tune with average wave conditions. This condition is a dangerous one, and can result in heavy plunging, with masses of so-called "green seas" tumbling on board over the bows, which, if the speed is high, will be of sufficient force to carry all before them. This tumbling aboard of green water may be due to several factors, including hull design, weight distribution in terms of length and, of necessity, the course of the ship in relation to the direction of the waves. In modern hull design, much more attention is given to the form of the bow sections than previously obtained to obviate plunging. This has resulted in the application of a measure of flare in all modern ships, and it has been found by tank experiment that pounding can be largely eliminated by increasing the beam above the water-line and by introducing the broad V-form into the bow sections, with the flare portion in the upper sections only. Sectional fullness should be incorporated as rapidly as possible to produce the greatest resistance to horizontal movement before the foredeck is reached.—*The Journal of Commerce (Shipbuilding and Engineering Edition), No. 37484, 15th April 1948, p. 6.*

Long-bridge Deck Vessels

The 5,500-ton d.w. motor vessel "Warora", built at Burntisland for the British India Steam Navigation Company, is of the relatively rare Long-Bridge Deck type and is especially equipped for general cargo service in Indian waters. She is 350 feet in length b.p. with a beam of 50 feet, a depth moulded of 25 feet and has poop, long bridge, and fo'c'sle. She has four cargo holds, two forward and two abaft the machinery space. All the auxiliary machinery is steam driven, being supplied by an oil-fired boiler and a composite-type exhaust boiler at 120lb. per sq. in. The main Diesel engine is amidships and comprises a three-cylinder opposed piston Doxford basic type built by Barclay, Curle and Co., Ltd. It is rated at 1,780 b.h.p. and has a cylinder diameter of 20½ inch and a combined stroke of 81¾ inch.—*Lloyd's List and Shipping Gazette, No. 41604, 15th April, 1948, p. 9.*

Cargo Motorship "Fernland"

The single-screw motorship "Fernland" built by Bartram and Sons, Ltd., for Fearnley and Eger, Oslo, is a cargo liner of the open shelterdeck type, with machinery amidships, and has been constructed to meet the requirements of the Norwegian Sea Control and Lloyd's Register classification. The principal particulars of the vessel are:—

Length b.p.	425 feet
Breadth moulded	58ft. 9in.
Depth moulded to shelterdeck	37ft. 8in.
Depth moulded to second deck ...	29ft. 2in.
Loaded draught	26ft. 1in.
Block coefficient at load draught ...	0·695
Displacement	12,990 tons

Corresponding deadweight	9,050 tons
Service speed	14 knots
Service power at 115 r.p.m.	4,550 b.h.p.

The holds and 'tweendecks have a grain capacity of 533,294 cu. ft., while the deep tank for the carriage of vegetable oil has a capacity of 47,585 cu. ft. A total of 1,087 tons of fuel oil may be carried. The main propelling machinery consists of a Diesel engine built by John G. Kincaid and Co., Ltd., Greenock, to Burmeister and Wain-Harland and Wolff patents. The engine has eight cylinders and is of the four-stroke single-acting, airless-injection type with cylinders of 740 mm. diameter and 1,500 mm. stroke, and develops 4,550 b.h.p. at 115 r.p.m. All auxiliaries are electrically driven, taking current from three generators having trunk-type four-cylinder airless injection S.A. mirrlees engines. Each is coupled with a 150 kW. dynamo There is also a Cochran waste-heat boiler producing 1,400lb. of steam per hour at 100lb. per sq. in. pressure.—*The Shipping World, Vol. 118, 7th April 1948, p. 373.*

Spanish Motor Trawlers

Two deep-sea motor trawlers ordered by Pesquerias Espanolas de Bacalado, S.A., Madrid, have recently been completed and have run trials. They were built by Corcho Hijos, S.A., of Santander, and attained on trials a speed of 13·5 knots, at full load displacement. The vessels, the "Santa Marina" and "Santa Elisa", are intended for service on the Newfoundland banks. Their principal particulars are as follows:—

Length o.a.	233ft. 6in.
Length b.p.	209ft. 2in.
Breadth	25 feet
Depth	19ft. 4in.
Draught, full load	17 feet
Displacement	2,350 tons
Deadweight	1,200 tons
Engine power (normal service) ...	1,200 b.h.p.
Speed	13·5 knots
Fuel capacity	415 tons
Radius of action	28,000 miles

The vessels have been built to Lloyd's 100 A1 class, and will form a valuable addition to the Spanish deep-sea fishing fleet. They have well-raked steam and ample sheer both fore and aft, and bow and stern are fully rounded The large squat, well-streamlined funnel is sited just aft of the bridge structure, athough not moulded into it as in some recent vessels of this type. Its position and height appear likely to make the upper bridge uncomfortable in a following wind, but this is of little importance as the wheelhouse is of ample size, and connects with the bridge wings. The vessels are of interest in that they provide the Diesel-engined alternative to the type of steam trawler "Padua" built by Hall Russell and Co., Ltd., of Aberdeen for the Newfoundland cod fishing service of the Empresa Comercial Industrial de Pesca, S.A.R.L.—*The Shipping World, Vol. 118, 31st March 1948, p. 355.*

Light Alloys in Shipbuilding

An important step in encouraging the use of light alloys in ships recently has been the issue of tentative requirements for the quality and testing of aluminium alloys for shipbuilding purposes by Lloyd's Register of Shipping. Considerable attention is being given by the aluminium industry to the production of larger and thicker plates and sections suitable for shipbuilding, and proposals have recently been approved for the use of these materials in place of mild steel, not only for a variety of structural parts, such as deckhouses, hatched covers, webs, masts, etc., but also for the main hull structure of larger ships. Of the various Development Memoranda issued by the British Aluminium Co., Ltd., Memorandum No. 8 contains notes intended to be an introduction to the use of thick aluminium alloy sheet and plate for unstressed superstructures, deckhouses, wheelhouses and funnels.—*The Shipping World, Vol. 118, 31st March 1948, pp. 349-351, 360.*

The Salvage of M.V. "Wanganella"

The intercolonial M.V. "Wanganella" (9,576 tons) struck Barrett Reef in the entrance to Wellington Harbour at 11.40 p.m. on Sunday, 19th January 1947. Several attempts at refloating were made with successive tides, cargo was discharged, steel ballast and oil fuel dumped overboard to help lighten ship. Two mushroom anchors were laid out, almost at right-angles to the ship, from the starboard side, with heavy wire ropes which were brought inboard through the after port and starboard fairleads. These wires were then shackled to heavy sets of four and four blocks laid along each side of the deck. The holding ends of the blocks were made fast to bits on the forecastle head and the falls led to the windlass drums. All possible weight taken on these anchors, plus the towing power of three tugs and the ship's main engines, failed to move the vessel. The assistance of a salvage expert who happened to be in New Zealand at this time was called on by the underwriters. The decision arrived at by all concerned was that compressed air was the only feasible method of refloating. Inspection of the damage showed the hull to be badly holed in two places, the bows and the centre of No. 2 hatch port side. Slight leakage was also evident on the tank top starboard side of No. 3 hatch. The first job was to seal off Nos. 1 and 2 hatch openings. Some forty ventilators were sealed off, companion ways were plated in and stiffened with angles and welded. Wash basins, sinks, baths, etc., were stopped with concrete or wooden plugs. Pipes and electric cables leading through the main deck were concreted. Four Diesel driven air compressors of 2,000 cu. ft. per minute total capacity were brought aboard and set up. Air tests of No. 1 hatch showed the maximum pressure at high water to be 6lb. per sq. in. and that of No. 2 hatch 1½lb. per sq. in. It became, however, obvious that still more buoyancy was required to float off the vessel, and it was decided to build a cofferdam in No. 2 hatch to cover the 20ft. hole in the port side. A cofferdam of 48 feet length 16 feet depth and 3 feet average width in nine pieces was constructed in the shop, but before it could be installed the vessel could be refloated with the rising tide on 6th February when a heavy ground swell was running with a nor'-westerly gale.—*C. Head, New Zealand Engineering, Vol. 3, 10th January 1948, pp. 68-69.*

Standard French Motor Trawlers

In France the policy of standardization applies not only to ocean-going cargo tonnage, but also to fishing vessels. One of the standard types is a vessel 105 feet in length, and the prototype was completed some time ago by the Chantiers et Ateliers Augustin Normand at Havre. Seven similar trawlers are being built at the same shipyard and four others are under construction in different French shipyards. The main particulars of these trawlers are:—

Length b.p.	105 feet
Breadth moulded	22ft. 11in.
Depth	13ft. 3in.
Mean draught	11ft. 3in.
Gross register, about	235 tons
Machinery	450 b.h.p.

The engine is a M.A.N. four-stroke type constructed by the shipbuilders. It develops its power at about 350 r.p.m. and drives the propeller, through reduction gear, at 110 r.p.m., two flexible couplings being fitted, one between the engine and the reduction gear and the other between the reduction gear and the propeller. The eight cylinders have a diameter of 285 mm., with a piston stroke of 420 mm. Twenty trawlers of similar type are being built for the French Government by the Bath Iron Works, Bath, Maine.—*The Motor Ship, Vol. 29, April 1948, pp. 26-27.*

A 3,200 b.h.p. Tug

For service on the Missipi, to the order of the John I. Hay Co.. Chicago, one of the highest powered motor tugs in the world has recently been placed in service. She is the "Fort Dearborn" and was designed and built by the St. Louis Shipbuilding and Steel Co. The length is 156 feet, and the beam 35 feet. Two 10-cylinder opposed-piston Fairbanks Morse Diesel engines each of 1,600 b.h.p. are installed. They have cylinders 8⅛ inch in diameter, with a combined piston stroke of 10 inch, and run at 720 r.p.m. Variable-pitch propellers are used. They are 88 inch in diameter and operate in Kort nozzles.—*The Motor Ship, Vol. 29, April 1948, p. 14.*

Twin-screw Passenger and Cargo Steamship "Patria"

The twin-screw passenger and cargo steamship "Patria" has recently been completed by John Brown and Co., Ltd., Clydebank, for the Companhia Colonial de Navegacao, of Lisbon. A sister vessel, the "Imperio", is at present fitting-out in the same yard. These vessels are intended for the African service of the owners, trading between Portugal and the Portuguese West African and East African Colonies. The vessel has a well raked bow and cruiser stern, two masts and one large streamlined funnel. The principal particulars are:—

Length overall	531ft. 7½in.
Length b.p.	500ft. 0in.
Breadth moulded	68ft. 0in.
Depth to upper deck	44ft. 0in.
Gross tonnage	13,178
Net tonnage	7,689
Service power	13,200 s.h.p.
Service speed	17 knots

Passenger and crew and cargo capacities are :—

First class	86
First class or tourist (interchangeable)	32
Tourist class	168
Third class	118
Supplementary third class	230
Natives	12
Crew	166
Cargo capacity	11,230 cu. m.
Cargo capacity (insulated)	400 cu. m.

The propelling machinery and boilers have been constructed and installed by the builders. The boiler installations consists of two Yarrow side-fired three-drum type boilers with superheaters and economizers. The steam pressure at the superheater outlet is 430lb. per sq. in. and the steam temperature is 750 deg. F. The boiler tubes are of solid-drawn steel. The superheater in each boiler is located between nests of generator tubes so that temperature surge will be a minimum. The economizers are of the Foster Wheeler tubular type, arranged on the contra-flow principle and consisting of steel tubes with cast-iron gilled sleeves shrunk on. The main turbines were designed in collaboration with Parsons Marine Steam Turbine Co., Ltd. and consist of an impulse reaction high-pressure turbine and an all-reaction single-flow low pressure turbine, working in series. The turbines are designed for an initial steam temperature of 740 deg. F. and a vacuum of 28·5 inch of mercury at the top of the condenser. The service power of the installation is approximately 13,200 s.h.p. and the maximum power is approximately 14,500 s.h.p. The reduction gearing is of the conventional interleaved double-helical double-reduction type with primary pinions about 10·5 inch pitch circle diameter, running at 3,750 r.p.m. and meshing with primary wheels about 442·63 inch p.c.d. The secondary pinions are about 21·53 inch and run at 810 r.p.m. They engage with a main gearwheel of 148·29 inch p.c.d. which normally turns at 116 r.p.m. at full power. The primary pinions are connected to their respective rotors by flexible claw couplings. There are two main condensers of the two-flow Weir regenerative type, each with a cooling surface of 6,500 sq. ft. composed of 2,810 tubes of ¾-inch outside diameter. A Cochran boiler is arranged forward of the main boilers and supplies the ship's heating and domestic requirements, and the auxiliary steam line at 100lb. per sq. in. pressure in harbour when the steam generator is not in operation. When the ship is at sea and developing normal full power, steam is bled from the first stage of the high-pressure turbine to a steam generator capable of generating approximately 5,000lb. of steam per hour at 100lb. per sq. in. This steam generator will cover, at sea, the normal requirements of auxiliary steam in a highly economical manner.—*The Marine Engineer, Vol. 71, March 1948, pp. 110-115.*

Passenger Liner President Cleveland

The passenger liner "President Cleveland" of the American President Lines is the largest post war liner built in the United States and the largest liner ever built on the Pacific Coast. The vessel was built to the highest classification of the American Bureau of Shipping: + Al(E), + AMS, + RMS. Construction was carried out at the Bethlehem Alameda Shipyard. The main particulars are :—

Length overall	607ft. 6in.
Length b.p.	573ft.
Breadth moulded	75ft. 6in.
Depth moulded to promenade deck ...	61ft. 6in.
Depth moulded to A (bulkhead deck)	43ft. 6in.
Draught moulded, subdivision ...	30ft.
Normal power, s.h.p.	18,000
Sustained speed at sea	19 knots
Deadweight capacity	10,430 tons

The hull is built on the transverse system of framing. Welding is extensively used, although some connexions are riveted. A double bottom 5 feet deep extends continuously from the fore peak bulkhead to the after end of the propulsion motor rooms. The hull is divided into fourteen major watertight compartments by thirteen principal transverse bulkheads. Construction of the upper tier of houses (above the boat deck) of the navigating bridge, and of the outer casings of the two funnels is of aluminium, riveted throughout, with rivet holes punched small and reamed to size. Lifeboats and davits are also built of aluminium. There are two sets of General Electric Company turbo-electric machinery, one for each shaft, each set being entirely independent of the other in location and in normal operation. There are two machinery spaces, separated by fuel and water tanks, each containing two boilers, one turbine-driven generating set supplyinb electric power for propulsion, two turbine-driven generating sets for ship's lighting, etc. Aft of the machinery spaces and separated from them by a group of oil tanks are two propulsion motor rooms, each room containing the propelling motor for one shaft. Under normal operation one generator supplies power to one motor independently of the other generator and motor. But in the event of a casualty in one machinery space, both propulsion motors can be operated at about 40 per cent of normal power from the generator in the other machinery space, reducing the vessel's speed by only 25 per cent. Each propulsion motor has a normal rating of 9,000 s.h.p. at 120 r.p.m. propeller speed and a maximum continuous rating of 10,000 s.h.p. at 124 r.p.m. propeller speed. The turbo-electric propulsion system is of the a.c. type with the propulsion motors directly connected to the propeller shafting and normally operating as synchronous units. During starting the motors operate as induction motors. The main turbo-generators are of the three-bearing type. The turbine is an impulse unit of 14 stages. Throttle conditions are 590lb. per sq. in. and 815 deg. F., the steam being exhausted at about 1½ inch mercury abs. to the condenser. The two Combustion Engineering boilers in each machinery space generate steam at 600lb. per sq. in. g. pressure and 840 deg. F. with 240 deg. F. feedwater temperature at the economizer inlet. The boilers are of the two-drum, bent-tube type with convection-type superheaters, drum-type desuperheaters, water-cooled furnace and economizer. Each boiler has four mechanical-atomizing fuel oil burners. At the normal evaporation of 40,000lb. per hour boiler efficiency is 88 per cent, and at 44,000lb. per hour maximum evaporation it is 87·5 per cent.—*Marine Engineering and Shipping Review, Vol. 53, March 1948, pp. 38-77.*

A Highly Damped Inclinometer for Inclining Tests

In this paper the author gives an illustrated description of the instrument which comprises a heavy lead bob constrained to move in one plane in a damping fluid and whose sideways movement is measured by a travelling microscope built into the instrument. Extraneous movement of the ship (due to wind, etc.) is virtually eradicated, and experimental data are given of readings taken at the same time as ordinary pendulum readings under careful control. The ratio oscillation/reading is given and is reduced to vanishing point by the inclinometer, which when placed amidships was found to give values very close to the mean of the two pendulums. From these results it can be seen that the normal two pendulums can be replaced, with at least no loss of accuracy, by one small instrument 13 inch high. In all, over a dozen ships were tested, with most satisfactory results in every case, and details for six are appended. The instrument in final form is capable of very high accuracy in determining small angles of heel in ships, even in conditions which are not ideal.—*E. C. B. Corlett, Quarterly Transactions, Institution of Naval Architects, Vol. 90, No. 1, January 1948, pp. 64-74.*

Streamlines on Fine Hulls

The object of this paper is the calculation of the motion of the fluid over the whole surface of a hull of narrow beam. The functions necessary for the calculation for any narrow hull whatever have been calculated either algebraically or graphically, and are tabulated in eight tables which form the essence of the paper. The text describes the method used in the calculation of the values given in the tables. An example of the calculation of the lines of flow, and lines of constant pressure for one hull is also given, from which the direction and magnitude of the fluid velocity, and also the pressure, can be written down at each point of this particular narrow form. Finally, the paper includes some special methods to be used in the calculations, particularly in order to lessen the labour of the numerical work to be done on any given hull, to increase the accuracy of the calculation, and to provide an easy method of treating the case of flat-bottomed hulls, which has presented special difficulties with the method previously used for dividing the hull into separate elements.—*R. Guilloton, Quarterly Transactions, Institution of Naval Architects, Vol. 90, No. 1, January 1948, pp. 48-63.*

Hazards in Tanker Pump Rooms

The intention of this article is to remind tanker officers and pumpmen of the hazards involved in discharging volatile liquid cargoes. Rate of pumping seems to be of paramount concern in the transfer of cargo from ship to shore tank, little respect being paid to the potential dangers involved. It must be remembered that, while discharging, the cargo pumps are in constant contact with the cargo and that their correct operation depends on the skill of the operating pumpman. The common practice, when discharging bulk cargo with a centrifugal pump, is to remove cargo until the pump pulls away from the oil or loses its head. This practice is highly dangerous. There should be a set limit on the amount of oil to be removed from a tank by the centrifugal pump. This limit can be judged only by experience. Leaving a centrifugal pump running on a tank, after it has lost its head, may lead to dire results. Not being a vacuum pump, the seal is dropped when the head of oil uncovers the pump inlet ports. Then the cargo drains from the pump back into the tank and the whirling of the pump impellers causes oil and air to be churned in the impeller casing. With a product having a low flash point, it is easy to see what can occur. The pump casing becomes overheated, its cooling medium being lost as soon as the head of oil falls off and the impellers displace air and oil vapours until the correct explosive mixture is obtained. Then, a violent explosion can be expected. The author describes an incident aboard an oil tanker, where during discharging cargo the starboard main cargo pump (a centrifugal pump), after running fifteen minutes, had stopped abruptly. All manual efforts failed to turn the pump over. The shaft simply would not turn. The pump casing was removed, and the trouble was apparent immediately. The impeller sleeve had become blue hot, and had fused to the channel ring, thus stopping the pump. The intensity of the heat had been so great that it had cracked and belled open the ends of the impeller shaft sleeves. The channel ring actually was fused and braized to the shaft, with bronze drippings adhering to the outer surface of the ring. This particular cargo pump had been lined up and started on a full tank of high-octane gasoline. It hardly seems credible that, under such circumstances, the pump could become air bound, yet that is what happened. The pump had been started without first venting the casing and the impeller, being air bound, simply churned air and gasoline vapour. Fortunately the mixture was too rich for an explosion. The heated parts in the air-bound casing were quenched by gasoline after the pump had seized, the product from the full tank backing up into the pump casing.—*R. G. Wooler, "Marine Engineering and Shipping Review", Vol. 53, March 1948, pp. 92, 94.*

Field Tests Aid Diesel Fuel Study

Extensive tests on eighty-nine heavy-duty lubricating oils submitted to the Naval Engineering Experimental Station during the period 1940-46 by twenty-eight oil companies have convinced the authors that no physical, chemical or bench tests can serve as substitute for full-scale service tests in rating oils for their detergent properties in naval Diesel engines. In order to compare oils and to correlate their relative deterging characteristics, the authors explain that an "average weighted cleanliness rating" was devised. They determined the influence of crude oil source, manufacturing process, additive classification, additive metal concentration, and residual oil content of the base oil on the average weighted cleanliness ratings. The authors conclude that all these factors appear to have an influence on the cleanliness of Diesel engines. Further improvement in heavy-duty lubricating oils should be directed towards increased detergency in order further to minimize or eliminate the following factors in the order listed: port clogging, piston-skirt deposits, piston-ring sticking piston-ring-land deposits, piston-ring-groove deposits, cylinler-liner lacquer, and oil system sludge.—*Abstract of Paper by W. F. Joachim, W. E. Robbins, M. S. Gordon, and T. G. Timberlake, "Experience with Diesel Lubricating Oils", presented at the Fuels and Lubricants Meeting of the Society of Automotive Engineers (SAE) at Tulsa, Oaklahoma, 6th November, 1947; SAE Journal, Vol. 56, March 1948, p. 35.*

Problems Associated With Use of Diesel Fuels

Results are presented of recent investigations dealing with the nature of exhaust products resulting from combustion of Diesel fuels, particularly those products composing smoke. These findings, together with knowledge gained from the extensive research work in the field of Diesel engine combustion, demonstrate the significant influence of chemical composition and of some physical properties of Diesel fuels on combustion. The authors suggest development of some new inspection for improved control over certain properties of Diesel fuels.—*Preprint of paper bp W. L. H. Doyle and E. W. Landen, read before The American Society of Mechanical Engineers, December 1947.*

Developments in Technique in Fuels and Lubricants

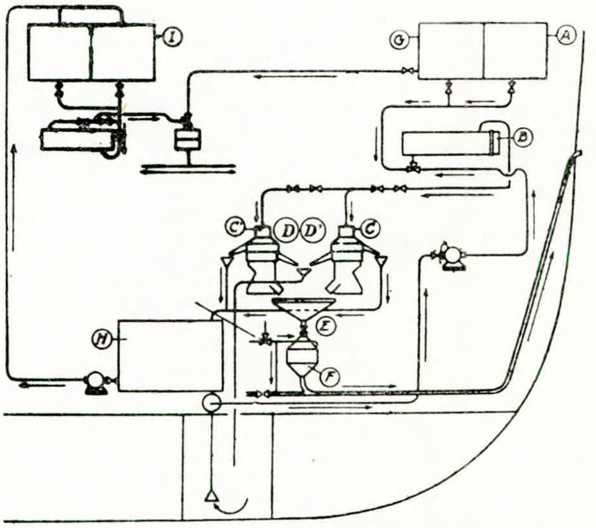
In this paper, which was read before the XIth International Congress of Pure and Applied Chemistry, London, in 1947, reference is included to the fuel requirements of gas turbines. The point is made bv the author that the fuel requirements of gas turbines are so different from those of the internal combustion engine that most certainly fresh stock will have to be taken of the fuel position. Marine gas turbines will call for a fuel of as high a calorific value as possible, possibly as low a flame temperature as can be achieved, and freedom from ash or any other material which is likely to affect the turbine blades. Its main competitor is the Diesel engine, and in order to compete successfully with the Diesel engine it will have to consume a fuel which is cheap enough to make up for the difference in thermal efficiency between the two types.—*J. A. Oriel, Institute of Petroleum Review, Vol. 2, February 1948, pp. 40-45.*

Marine Diesel Engine Fuel

Particulars have recently been published in France of the performance of some tankers of the Cie. Auxiliare de Navigation, in which the engines have operated for several years on fuel stated to be Bunker Oil No. 2, of which the following specification is given:—

Specific gravity 15 deg. C., 0·937.
Viscosity Engler 15 deg. C., 110.
Ash content, 0·4 per cent.
Calorific value, 10,892 calories.

The first ship to be selected for the operation of the machinery on this fuel was the M.S. "Rhea". in 1933, in which are two B. and W. six-cylinder four-stroke engines, each rated at 2,100 b.h.p., and having cylinders 550 mm. bore, with a piston stroke of 1,500 mm. They are of the air-injection type. For the purpose of purification, Titan separators are employed, and the main features are that these are automatic in their operation and that manual cleaning of the bowl is unnecessary. The residues are ejected overboard by means of a compressed-air-operated ejector. The general arrangement of the system is shown in the accompanying diagram. The fuel is delivered from the settling tank (A) to the heater (B), where the temperature is raised to 80 deg. C. Thence it passes into the two automatic centri-



Arrangement of plant for the utilization of boiler oil on the M.S. Rhea

fuges (C and Cl), which are arranged in parallel and eliminate the impurities. These are of two kinds; first the liquids, such as water and asphaltic impurities, which flow out through the funnels (D and Dl), and secondly, the solid impurities, which are automatically delivered into the hopper (E). They fall into the ejector (F) and are pumped overboard by compressed air. The purified fuel is discharged to the tank (H), from which it is pumped to the daily supply tank (1). It then passes to a heater and through a double filter to the engine, with a suitable connexion to the filter from the gas-oil tank (G). By 1939 the Cie. Auxiliare de Navigation had adopted heavy fuel for the engines of all of their motor ships, including the "Rhea", "Roxane", "Henry Desprez", "Sheherazade". "Salome" and "Theodora", some of these having airless-injection engines.—*The Motor Ship, Vol. 29, April 1948, p. 29.*

Oxidation of Mineral Oils

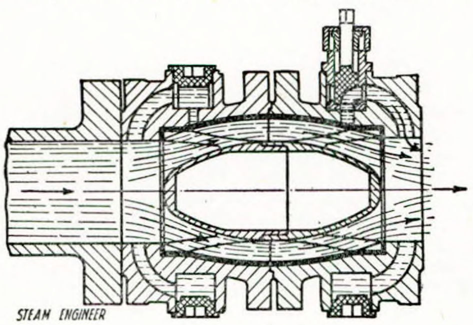
In a recent article published in the Schweizer Archiv Ang. Wiss. H. Stäger reviews the oxidizing conditions encountered by mineral oils in industrial use. Theories of oxidation are discussed. The behaviour of internal combustion engine oils is referred to with special reference to Diesel oils. Diagrams are presented which show temperature distribution at the cylinder walls and piston, and photographs show the appearance of the oxidation products as deposited on various engine parts. A laboratory oxidation tests is described wherein oil flows between two electrically heated plates, in the presence of an air stream, until oxidation has progressed to such an extent that flow is interrupted. Comparative tests indicate that this apparatus gives results closely similar to those obtained in engine practice. Deposits from a marine steam engine (cylinder wall temperature 250-270 deg. C., slide valve temperature 330 deg. C.) lubricated with naphthenic oil, were also examined, as were those from an air compressor operating at 206 deg. C. and 6 atmospheres. Laboratory oxidation tests (as for lubricating oils) were carried out on Diesel fuels (seven types). The use of gas turbines is briefly discussed especially with reference to the effect of the presence of H_2, H_2S, and SO_2 in the fuel on the metal parts.—*Journal of The Institute of Petroleum, Vol. 34, March 1948, p. 75a; Abstract No. 317.*

Expressions for Thermal Efficiency and Calorific Value for Use in Internal Combustion Engine Design

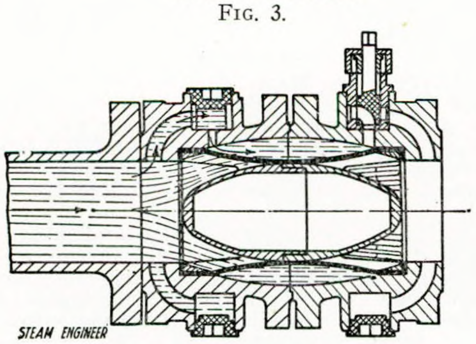
In an article contributed by C. Rogers to the Philosophical Magazine (Vol. 38, 1947, p. 134) expressions are given for $\frac{H}{1+y}$ and η_t used in the calculation of the indicated mean effective pressure of an internal combustion engine. H is the calorific value of the fuel, y is the air to fuel, ratio, and η_t is the variable specific heat thermal efficiency. Various types of combustion cycles are investigated, including the basic dual-combustion, Diesel, constant volume, and constant pressure cycles.—*Journal of The Institute of Petroleum, Vol. 34, March 1948, p. 76a; Abstract No. 318.*

Shockless Valve

The distinctive feature of the "diacon" shockless valve is a cylindrical diaphragm, made of natural or synthetic rubber, which, when subjected to external pressure, closes on a central cage and effectively seals off the flow of liquid. The cage consists of a solid torpedo-shaped core attached to a cone-shaped slotted grid. When the valve is open the liquid is diverted by the streamline core and passes through the slotted grid to the outlet side of the valve. If external pressure, by means of fluid air, is applied to the outer side



OPEN POSITION
FIG. 3.



CLOSED POSITION
FIG. 4.

of the diaphragm slightly in excess of the pressure within the pipeline the diaphragm is pressed to the cage and seals off the flow of the liquid. This external pressure may be applied in two general ways, the first being the use of a secondary pressure system, comprising compressed air, glycerine or mains water. In the second system adopted, use is made of the liquid within the pipe itself, to exercise a pressure on the outer side of the diaphragm (Figs. 3 and 4). When liquid is diverted from the pipeline to the outer annulus formed by the diaphragm of the housing, a difference in pressure will ensue owing to the fact that the liquid in the annulus is stationary whereas the liquid passing through the circular diaphragm is in motion. This will force the diaphragm towards the cage. When the diaphragm touches the cage the flow of liquid will cease and the pressure at the outlet side of the valve will drop, the pressure difference between the stationary liquid acting on the outside of the diaphragm, and the diminished pressure of the outlet side of the valve will effectively seal off the flow of the liquid through the valve. The release of the external pressure on this design of valve is obtained by the following method : entrance to the outer side of the diaphragm on the "up" side of the flow is by means of a small port, through which the liquid flows to build up the external pressure.. On the "down" side of the valve, a similar port is provided, having a small screw "on-off" cock attached to seal it off. The outlet port on the "down" side, however, is larger than the inlet port on the "up" side of the valve, with the result that as soon as the small screw cock is opened, the liquid is able to pass out at a greater rate than it can flow in, and the pressure is reduced immediately. This causes the diaphragm to expand and the valve is then open for the flow of the liquid. The illustrations shown depict a design suitable for simple on-off control only. In place of the cock shown in the illustrations a number of auxiliary attachments are available to enable the rate of flow to be regulated to fine limits. In addition, remote control can be effected by dydraulic, pneumatic or electric means.—*The Industrial Heating Engineer, Vol. 10, March 1948, pp. 75-76.*

Recording Engine Revolution Counter

A recorder described in a report published by the Torpedo Experimental Establishment, Greenock, measures the average speed of the engine over a succession of short time intervals throughout the run. A waxed paper record strip is driven at a speed proportional to that of the engine and a stylus controlled by an escapement mechanisc marks it at constant time intervals. The instrument is compact, robust and self-contained, and measures any speed in excess of 180 r.p.m. with a general accuracy of $\pm$ 5 r.p.m. The method for mounting the recorder for topedo trials is described.—*Abstract No. 1654, Journal of The British Shipbuilding Research Assoc., Vol. 3, No. 3, March 1948. Heseltine, P. E., Lt.-Cdr., R.N., and Mould, N. A. Torpedo Experimental Establishment, Greenock, S.T.R. No. 521 (Feb. 1947), A.C.S.I.L./A.D.M./47/632.*

The Hydrosphere—A New Hydrodynamic Bearing

A fitted, spherical bearing has been found to operate hydrodynamically when subjected to large values of thrust or radial-thrust load. An examination of the geometry of this bearing fails to reveal the usual wedge-shaped oil film in the direction of motion of the moving bearing surface. However, a wedge does exist normal to the direction of motion. The results of several experimental tests are analysed with respect to the qualitative theory presented, and the unique characteristics of this bearing are compared with those of other existing hydrodynamic bearings.—*Preprint of paper by M. C. Shaw and C. D. Strang, Jr., read before The American Society of Mechanical Engineers, December 1947, U.S.A.*

A Statistical Analysis of Some Mechanical Properties of Manila Rope

The three properties usually measured when fibre ropes are submitted to the Bureau of Standards for acceptance test are strength, weight, and size. The differences in the quality of the fibre and the methods of fabrication lead to some variation in these qualities. The results of tests on more than 800 samples of 3-strand manila ropes, ranging in diameter from $\frac{3}{16}$ inch to 3 inch, are tabulated and analysed by statistical methods. The methods used are discussed in considerable detail because they are believed to be applicable to a variety of similar problems. A list of references is given.—*Abstract No. 1623, Journal of The British Shipbuilding Research Assoc., Vol. 3, No. 3, March 1948. S. B. Newman anl J. H. Curtiss. Bur. Stand. J. Res., 39 (1947), p. 551 (Dec.).*

Asbestos-resin Bearings

Bearing materials fabricated from asbestos bonded by synthetic resin have now become available, which are suitable for water lubrication, and, according to an engineering contemporary, form a substitute for *lignum vitae*. The material is readily machinable by tungsten tipped tools and is available in sheets or blocks, or it can be supplied in finished forms, being dimensionally stable within controlled limits. A general purpose material is available impregnated with the colloidal graphite, ,this being resistant to alkalies and weak acids. It can be supplied either in moulded or laminated form, while another laminated product is suitable for use when sand or grit is met with, it being noted that this material should be used with a non-ferrous shaft liner. Among other varieties which have been developed are materials specially suitable for high bearing pressures and for damping oscillating movements. A considerable amount of operating experience with these materials has been accumulated under wartime conditions of service, and it has been found that the friction losses are in many instances lower than with plain oil lubricated bearings, some of the materials being successfully run dry.—*Shipbuilding and Shipping Record, Vol. 71, 8th April 1948, p. 423.*

Steering Gear Failures

In the Proceedings of the American Merchant Marine Council an accident is reported in which failure of the steering gear caused a T2-type tanker when leaving port in ballast to collide with a crane barge. The latter in turn bumped into a railway bridge knocking one span from its foundations into the water below. Fortunately, no lives were lost. On leaving the dock, the quartermaster reported to the master that the helm was hard over (35 deg.), while the rudder indicator showed only 15 deg. and although various speeds were ordered in an endeavour to get the vessel to respond to the helm, these were of no avail, and shortly after, full astern was unable to prevent the collision. The vessel was equipped with a hydraulic telemotor steering gear having two independent motor driven pumps and it had been the practice to operate with either pump, the fluid stop valves being open to both pumps and the by-pass valve closed. This practice was to facilitate quicker change-over in the event of a mishap to the motor in operation. At the time of the collision only the starboard motor was supposed to have been running but it was subsequently found that the by-pass valve on the port motor was opened one half-turn, the presumption being that the valve had vibrated open. When the by-pass valve was shut, the gear worked normally.—*Shipbuilding and Shipping Record, Vol. 71, 15th April 1948, p. 451.*

New Alloy for Tubes

A new copper-nickel brass alloy is now available in tubular form. This new alloy B.N.F.M.R.A. produced by Imperial Chemical Industries Ltd., Metals Division is said to have a high resistance to both corrosion and erosion and is recommended for all pipelines where un-alloyed copper tubes are prone to these forms of attack. Tubes made of it can be bent or flanged by any coppersmith.—*The Shipping World, Vol. 118, 21st April 1948, p. 421.*

Naval Radiographical Laboratory

Until 1944 the radiography of welding was carriel out in dockyards and shipyards by mobile parties operating from specially equipped pantechnicon vans. These vans consisted essentially of a dark-room for processing films, and storage space for the X-ray set when being transported from one dockyard to another. It was decided in 1944 that laboratories should be constructed in various parts of the country to meet the increasing demand for radiography, and the first of these was built in Chatham Dockyard. With the present equipment in use at Chatham it is possible to carry out radiography upon metallic specimens of up to 3½in. in thickness, keeping within a maximum exposure time of one hour. Normal routine exposures on thinner sections are made with an exposure of about 5 minutes, depending upon types of film, intensification screens and film-focus distances employed. The use of sets on board ships is facilitated by a mobile container which is attached to the laboratory. This consists of a container, based on the road-rail type, fitted with dark-room equipment specially designed by the Naval Construction Department's Radiography Section in the light of experience gained whilst using the pantechnicon vans.—*A. Wilson, Metallurgia, Vol. 37, April 1948, pp. 305-306.*

Drying Electrical Machinery

One of the disadvantages of the electric drive as applied to the propulsion of ships, is that in the event of the engine room being flooded or of excessive condensation occurring, the insulation may be severely, and even irreparably, damaged. In order that electrical machinery may be dried out as quickly as possible, a well-known American firm of shipbuilders and marine engineers has developed a system whereby a continuous supply of heated air at any desired temperature can be supplied to the machinery space once it has been pumped out. An example is given of the use of this system in which a liberty ship was sunk in 18 feet of water prior to being taken in hand for reconversion, the entire engine room being flooded. After being raised and towed to the shipyard where the reconversion was to be effected, one of these heated air generators, capable of delivering 10,000 cu. ft. of air per min. at a temperature of 350 deg. F., was installed on the main deck. A long heat-resisting canvas tube, 16 inch in diameter and about 90-feet long, was led from the hot-air outlet into the engine room, which had been previously pumped out, and air at a controlled temperature of 200 deg. F. to 250 deg. F. was circulated through the machinery space for a period of three days. In this time, it is stated, the entire flooded section was thoroughly dried out and got ready for re-insulation and external varnishing, a job which would otherwise have taken three or four weeks.—*Shipbuilding and Shipping Record, Vol. 71, 25th March 1948, pp. 367-368.*

Nylon Rope Experiments

Experiments are being carried out on the Tyne with a nylon tow rope. The rope is 120 feet in length, 7 inch in circumference, and weighs 174lb. The tests are being made on the tug "Hendon", belonging to the France, Fenwick Company, and the results will be compared with those of an equivalent manila rope used by another of the firm's tugs. The "Hendon" and another tug, the "Wearmouth", were placed stern to stern, with the nylon rope fastened to each vessel. The tugs developed nearly 2,000 h.p. in the tests, but the rope stood the strain. High costs may militate against the nylon rope, but it is claimed that it has advantages over manila ropes.—*Fairplay, Vol. 170, 8th April 1948, p. 894.*

The Rigidity Factors of Metal Cables

A study is made of the geometry of cables and the laws governing the tightening of the strands with internal pressures (proportional to the tension to which they are subjected in order to deduce the peripheral transmission of pressure. This simplifies the successive calculations of the friction work, accompanying the bending of a taut cable, under the limiting assumption of inextensible strands, as well as calculations of the tension of curvature deduced in the abstract case of constant radius of curvature.—*M. Panetti* (Reol Politecnico di Torino, Laboratoria di Aeronautica [Publ.] No. 188) *Journal of the Institute of Metals, Metallurgical Abstracts, Vol. 15, February 1948; p. 227.*

Dredger for South Wales Service

The twin-screw open bow bucket dredger "Abertawe", recently completed by Fleming and Ferguson, Ltd., Paisley, for the Railway Executive, Western Region, is now in operation in South Wales ports. Built to Lloyd's highest class, the vessel has dimensions of 160-feet l.b.p. by 40-feet breadth moulded and 14-feet depth moulded. She is fitted with an independent dredging engine placed athwartship at the forward end of the engine room. Transmission to top gearing is by means of belts, this giving a smoother drive for the work required of her. The dredger is capable of cutting her own flotation, and has a maximum dredging depth of 48 feet, the bucket chain being fitted with forty-two 27 cu. ft. buckets. Special attention has been given to the design and strengthening of the hull as the vessel frequently takes the ground between tides. To ensure greater safety there are six transverse watertight bulkheads, and should the well plating be pierced when working, an inner skin is fitted in way of the working part of the well to prevent flooding of the side compartments. Propelling machinery consists of two sets of triple-expansion engines, giving a collective horsepower of 1,000 at 120 r.p.m. on trials and a mean speed of 9·38 knots. The dredging engine is of similar size to one of the propelling engines and on trial loaded a 1,200-ton hopper in one hour. All auxiliaries are independently driven, and steam is supplied by two single-ended marine boilers.—*Shipbuilding and Shipping Record, Vol. 71, 26th February 1948, p. 256.*

Corrosion of Metals in Sea Water

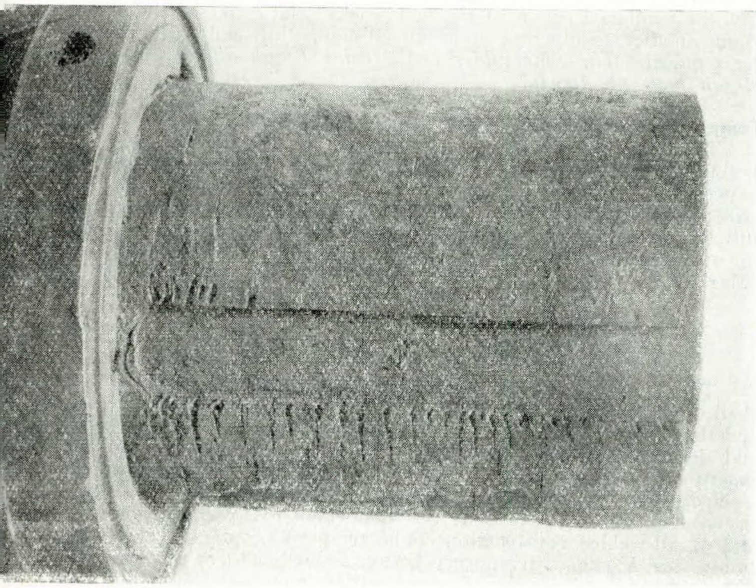
An article by Mr. D. D. Moore in "Port of Sydney" makes reference to the outstanding corrosion resistant properties obtained by the Preservation and Research Laboratory (of N.S.W.) with mild steel plates sprayed with aluminium to the thickness of 0·05in. After nine years' exposure in sea water, no corrosion of the steel had taken place. Sprayed zinc coatings have also given good results under these conditions. According to the Australian tests, an interesting aspect of the protective action of this type of coating is that the rate of corrosion of the aluminium applied is much less than that obtained when a thin sheet of aluminium of equivalent thickness is similarly immersed in sea water. This is thought to be due to the deposition of aluminium hydroxide in the pores of the sprayed coating, which assists in stifling the corrosion of the coating metal. A similar action occurs with zinc coatings. The author of the article states that metal coatings should be regarded as "barrier" layers which are themselves protected against corrosion by paint compositions. The metal coating then serves as a barrier against the dangerous pitting which frequently occurs on immersed steel, where paint compositions alone are used.—*Fairplay, Vol. 170, 4th March 1948; p. 625.*

Rapid Corrosion of Boiler Tubes

One of the most frequent causes of trouble to owners of war-built steamships is the weakness of the boiler tubes. Quite a few owners, after repeated repairs, sometimes at the most unsuitable and expensive ports, have been obliged to retube the boilers of vessels built during the war and therefore still in their early youth. A number of explanations are given for the unsatisfactory service of so many modern boilers. The material of the firetubes manufactured since 1939 may be at fault and Lloyd's Register is making active investigation to discover why rapid and destructive corrosion is so prevalent. A metallurgical test, it is understood, has shown no inferiority in comparison with the material, namely rolled steel, which was in use before the war. The suggestion has been made that the quickening of the process of rolling may leave pores open in the metal and this may account for lower resistance to corrosion. Every stage of manufacture from the billet to the finished article will call for and receive minute examination. An interesting theory has been advanced that the passing of a heavy electric current through the degaussing cables may have some bearing on the bad behaviour of boiler tubes. A marine engineer of great experience has stated that he has noticed a lessening of corrosion in specific cases since the discontinuance of degaussing.—*The Shipping World, Vol. 118, 7th April 1948, p. 364.*

Corrosion Fatigue

A typical corrosion-fatigue failure is illustrated in Fig. 1 showing a horizontal pump shaft, 6¾ inch in diameter, which broke (almost exactly in the middle of the boss of the gunmetal impeller), after running about twenty hours per day for some ten years, carrying stresses described as "moderate". The steel was of excellent quality, as shown by the following test values from material adjacent to the fracture: yield point, 17·64 tons per sq. in.; ultimate stress, 31·04



Typical corrosion-fatigue failure on horizontal steel pump shaft

tons per sq. in.; elongation, 33·5 per cent, and bend test, 180 deg. (good). A noteworthy feature of this failure is the development, parallel with the fractured face, of many deep and sharp fissures, starting chiefly from one edge of the key-way shown; a similar effect being found on the second key-way. On cutting longitudinally through the shaft across these fissures, it was found that the cavities were deep with very acute angles at the bottom. The failure in question was obviously due to the ingress of sea water to the cored-out boss of the impeller, where it came into contact with the mild steel shaft. The use of a shaft of greater tensile strength is of little advantage if the conditions are such as to give rise to corrosion-fatigue. Some measure of increased resistance to this type of attack can be obtained by nitriding, nickel plating or other methods; but the most effective method is to increase the corrosion-fatigue resistance of the metal as a whole. Thus, austenitic stainless steels of 18 per cent chromium, 8 per cent nickel type, properly heat treated are most suitable for pump shafts for service with sea water.—*The Allen Engineering Review, March 1948, pp. 4-5.*

Welding and Deadweight Capacity

The increase in deadweight capacity rendered possible in a cargo vessel or a tanker due to the employment of welding instead of riveting is variously stated, and comparisons are not always exact. In the case of the Wilhelmsen cargo ship "Tourcoing", however, precise particulars are available in relation to two sister ships, apart from the fact that the "Tourcoing" is wholly welded and the vessels, the "Titania" and "Talisman", are riveted. It is found that the deadweight capacities of the riveted ships are 10,090 and 10,100 tons, respectively, whereas that of the new vessel, the "Tourcoing", is 10,515 tons. The welded vessel is thus able to carry 4 per cent more cargo than the corresponding ship which is wholly riveted.—*"The Motor Ship", Vol. XXVIII, No. 338, March 1948, p. 464.*

Correct Welding Procedure in Ship Repairing

In this paper, read recently by Mr. A. W. Jackson before the Liverpool and district branch of the Institute of Welding, the author discusses a number of practical aspects of welding in shipbuilding. Discussing ways and means for avoiding the occurrence of contraction stresses, the author emphasizes the importance of observing the proper welding sequences and lays down the maxim that wherever possible the operator should always work towards freedom and not towards restraint. Undercutting should be watched and dealt with by putting down another run with a small rod as undercutting undetected was the source of fractures. In repair work the welding of riveted seams to reinforce them should be avoided unless absolutely necessary. If required to do so, the rivets should first be cut out, the seam screwed up welded and then re-riveted. Otherwise, if the seam was welded with the rivets left in, they would in all probability be slackened by the welding heat. Composite joints employing riveting and welding were bad designs. The author suggests that a series of lectures could with advantage be given to platers and loftsmen. Unless they were made to realize that the plating techniques for riveting and welding were entirely different it was not reasonable to expect that the welder would always turn out a first-class job.—*The Journal of Commerce (Shipbuilding and Engineering Edition), No. 37484, 15th April 1948, p. 2.*

Shipbuilding Radiography

The purpose of this paper is to survey the practical aspects of X-ray inspection of ships' welds in peacetime, to provide guidance to those responsible for the work and to indicate the scope and limitations of the method. Radiographic inspection may be applied both to castings and welds. Already the Admiralty specifies radiographic tests of turbine casings and pressure vessels. High-pressure butt-welded steam pipes may also be subject to radiographic approval. The paper, however, is confined to the radiographic examination of welds in ships' structures although the remarks of the author apply, in the main, to most of the other uses of radiography in shipyards.—*Paper by L. Mullins read at a meeting of the Institute of Engineers and Shipbuilders in Scotland on the 9th March 1948.*

The Effect of Normalizing on the Micro-structure and Tensile Properties of Weld Metal

Some samples of welded mild-steel plates were stress relieved at 660 deg. C. and other samples were normalized at 900 deg. C. The microstructures of these samples were examined and compared with those of samples from the same welded plates which had received no heat treatment subsequent to welding. Further samples, some in the as-welded condition and others after normalizing at 900 deg. C., were subjected to tensile tests. The results showed that the effect of normalizing on welded mild-steel plates is to refine and make more uniform the structure of the weld, at the same time relieving the parent metal of the structural alterations due to the heat of welding. On normalizing, the tensile properties of the weld metal become nearer those of the parent metal, but, with the combination of parent metal and welding rods tested, the yield of the weld metal is still in general considerably higher than that of the parent plate. This may have a very marked adverse effect on the behaviour of a welded plate deforming under explosive loading. Details are given of the composition of both the steel and weld deposits, as well as of the welding procedure.—*Abstract No. 1592, Journal of The British Shipbuilding Research Assoc., Vol. 3, No. 3, March 1948. G. A. Keay, Admiralty, Naval Construction Research Establishment, Report No. N.C.R.E./R.32 (June 1947). A.C.S.I.L./A.D.M./47/639.*

Welding Tests

New qualification tests to be passed by welding operators in order to obtain certification by the Canadian Welding Bureau are laid down in the recently published standards of the Canadian Standards Association. The tests include a fillet weld test which provides a unique method to determine the operator's ability to make a fillet weld and yet test it in a similar manner to a butt weld in a simple bending machine. Operators are divided into three categories depending on the number of different positions in which they can weld. Those who pass the test requirements in all positions are designed as class "O". Those who pass in all positions except overhead are designated as class "V", and those who pass only in the downhand position for butt welds and the horizontal position for fillet welds are given the designation of class "F".—*Canadian Shipping and Marine Engineering News, Vol. 19, March 1948, pp. 25-26.*

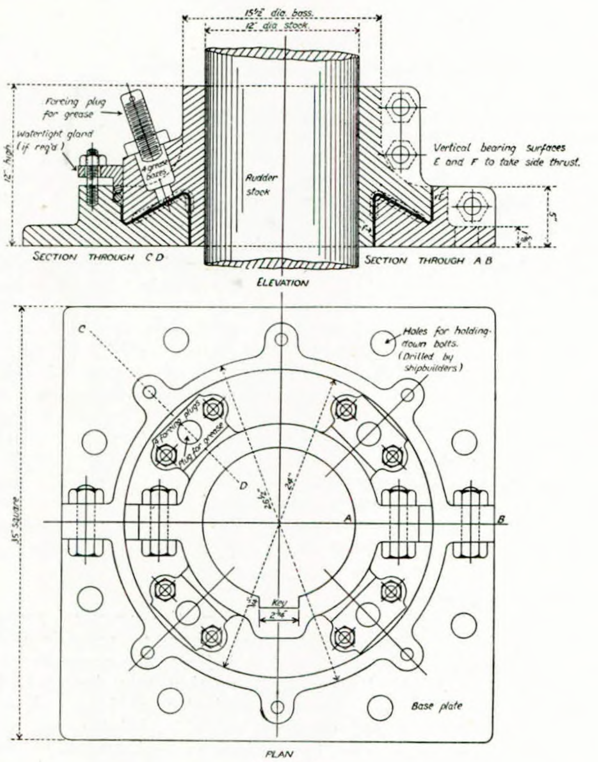


FIG. 6.

A Self-centring Rudder-carrier

The accompanying illustration, Fig. 6, shows the essential features of the latest design of the self-centring rudder-carrier developed by Mr. C. A. Jackson of Sunderland. This device is suitable for rudder stocks of every size, and the one illustrated was fitted in the recently completed steamship "Silverbriar". The vertical load is seen to be inclined away from the rudder stock—a feature which assists the retention of the lubricant in the bearing. With a surface of opposite slope, there would be a tendency for lubricant to gravitate away from the bearing. The arrangement of the bearing surfaces provides adequate area to support thrusts perpendicular to the axis of the stock. Provision for lubrication is made in the form of four grease boxes, with suitable forcing plugs.—*The Shipbuilder and Marine Engine-builder, Vol. 55, March 1948, pp. 172-173.*

Novel Marine Pump

The construction of the Megator pump, which works on the triple-ram principle, is shown in Fig. 3. The pumping action is derived from three eccentric disks, which fit closely into recesses in three shoes, of composite construction, in which phenolic plastic and natural or synthetic rubber are employed. For marine work, in particular, oil resisting synthetic rubber is invariably employed, on account of the possibility of oil being encountered, and, also, in order that full advantage may be taken of the interchangeability of the components of pumps installed for a variety of duties. The casings are of cast-iron or bronze and the rotors of nitralloy or Monel. The shoes, though free to move vertically, are held in close contact with the cover plate by the hydraulic pressure developed during pumping, the cover plate itself forming the division between the suction and delivery sides of the pump. Liquid entering the suction branch passes through a channel arranged across the body of the pump into the space adjacent to the cover plate. In the cover plate are twelve ports, four corresponding to each shoe, two being inlet ports leading from the suction side, and two discharge ports leading into the body of the pump, to which the delivery branch is connected. Two ports are formed in each shoe; and, as the shoe moves up and down, these ports come alternately opposite the pairs of inlet and discharging ports in the cover plate. The vertical movement of the shoes is maintained by the eccentric disks, which, at the same time, provide the pumping action. Although the displacement effect of each disk varies cyclically, the combined action of the three disks, which are set at 120 deg. to one another, results in a smooth, continuous flow and uniform turning moment.—*The Shipbuilder and Marine Engine-builder, Vol. 55, March 1948, pp. 166-167.*

Temporary Hull Repairs to the Tanker "Markay"

This 500-feet tanker, after sustaining damage to the extent of having about 200 feet of the forward bottom plating and internal structure torn off, by running ashore at Skye, proceeded under her own power in winter to Swansea and, after temporary repairs which still left about 125 feet missing, crossed the Atlantic to the U.S.A. for complete permanent repairs. The principal dimensions of the "Markay" are :—

Length overall	520 feet.
Length b.p.	500 feet.
Beam moulded	68 feet.
Depth moulded	37 feet.

The hull was of part-welded and part-riveted construction, the shell seams from the keel to the upper turn of the bilge being welded and those above riveted; all deck plating seams were riveted. Shell and deck plating butts throughout the ship were welded. Bottom longitudinals were welded to the shell, side and deck longitudinals riveted. The two oil-tight longitudinal bulkheads and the oil-tight transverse bulkheads were of the Bethlehem-Frear corrugated type and of all-welded construction. The temperory repairs included fitting a steel V-shaped temporary bottom extending over the fore peak and deep tank and new longitudinal girders, new portions of existing bulkheads and plating over the buckled and pierced shell, with cement filling. To ensure that the reinforcement proposed would maintain maximum stresses within safe limits, strength calculations were made, the weight curve being based upon Bile's curve, modified to suit tanker form. Corrections were made for steel structure lost and added for ballast, stores, etc.—*Paper by A. Reid, read before the Institution of Naval Architects at the Spring Meeting, 17th-19th March 1948.*

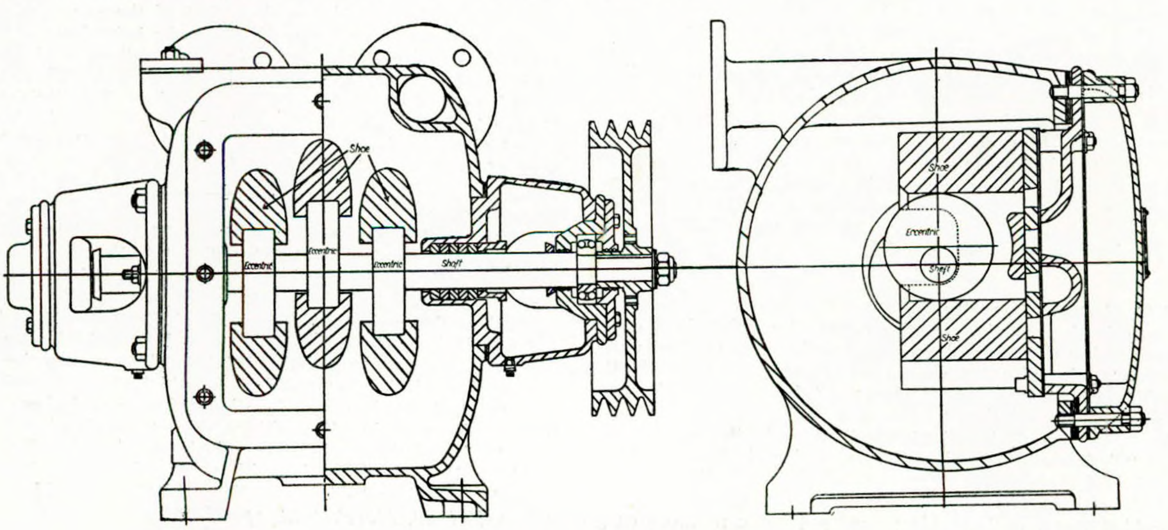


FIG. 3.—*Typical arrangement of Megator pump*

ENGINEERING ABSTRACTS

Section 3. Shipbuilding and Marine Engineering

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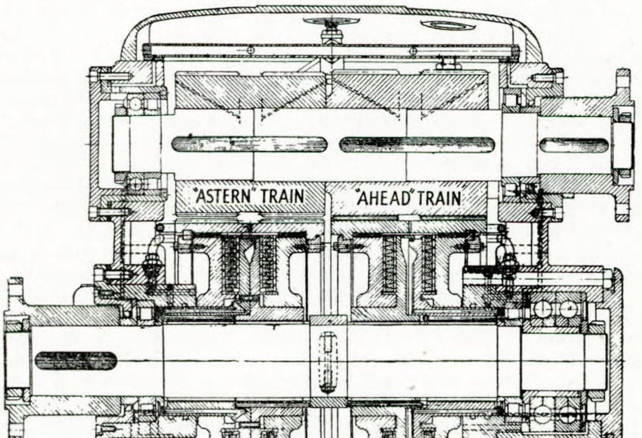
Marine Reverse-reduction Gearbox

An oil controlled marine reverse-reduction gearbox for which patents are pending has been developed by David Brown and Sons (Huddersfield), Ltd. The gearbox shown in section in the accompanying figure is one of a range designed for use in tugs, trawlers, coasters, and pleasure and high-speed craft; but other gearboxes are available for reverse only. A further development is the reverse or reverse-reduction of a number of engines coupled through a common gearbox to a screw. Duplicate oil pumps of equal capacity are installed, one



The David Brown marine oil-operated reverse-reduction gearbox

being a standby. Operation of a lever on the outside of the box changes over from one pump to the other and continuity of oil supply is achieved. The unit shown transmits 510 b.h.p. at 600 r.p.m. input to 302 r.p.m. output (rating: ahead, 52,000-hour life; astern 6,500 hours). Hobbed double helical gears are employed, with a working facewidth of 10¼ inch for the ahead gears and 9¾ inch astern. The latter includes an idler gear. At the bottom of the gearbox are two David Brown 6H Roloid pumps gear-driven from the astern wheel, fitting into a housing which facilitates their assembly and dismantling. Both run continually but one only discharges oil under pressure; the other circulating it. The oil is passed to a distributing cylinder, in which the position of the control piston decides whch pumps shall pass the pressure oil. With the control piston being operated from an external lever the change-over can be effected so rapidly that continuity of oil supply is assured. Pressure oil delivered from one or other of the pumps is led from the gearbox to an externally situated heat exchanger and from there back to the gearcase. The oil control valve, of the rotary type. has four outlet ports, arranged to connect to the clutch engaging and disengaging cylinders, one port to each chamber, which are arranged so that any one of the three conditions set out below can obtain. *Neutral.*—Pressure oil to the ahead and astern clutch disengaging cylinders and the engaging cylinders connected to the exhaust side of the valve. *Ahead.*—Pressure oil to the ahead clutch engaging cylinder and the astern clutch disengaging cylinder: the ahead clutch disengaging cylinder and the astern clutch engaging cylinder being connected to the control valve exhaust. *Astern.*—Pressure oil led to the astern clutch engaging cylinder and the ahead clutch disengaging cylinder; the astern clutch disengaging cylinder and the ahead engaging cylinder being connected to the control valve exhaust. The control valve incorporates a stop which prevents it from going into that position which would engage both ahead and astern clutches simultaneously.—*The Shipping World, Vol. 118, 12th May 1948, p. 480.*

A Modern Marine Power Plant

This paper presents the salient features of a new cargo vessel power plant design and the reasons that led to the selection of the equipment specified. The machinery under discussion is that finally specified for a new cargo ship design designated the C-3-S-DB3. None of these vessels have been built. The power plant finally specified is a geared steam turbine normally of 12,500 s.h.p., but with a maximum power of 13,750 s.h.p., with steam conditions of 850lb. per sq. in. gauge, 900 deg. F. at the superheater outlet. Propulsion is by a single screw at 90 r.p.m. Most auxiliaries are motor driven and three 400 kW. turbine generators are provided. The adoption of 850lb. per sq. in. 900 deg. F. cycles does not introduce any new problems concerning the turbine and gear design. Blading materials will be the same with this cycle as they are with the 450lb. per sq. in. 750 deg. F. cycle. As far as the rotors are concerned, the same material as is specified at present with the 600lb. per sq. in., 850 deg. F. cycle is used. In regard to gear design factors, there is a present tendency to increase the allowable loading in order to reduce space and cost. However, it is felt that any effort in this direction should be carefully considered since it directly affects maintenance, which is extremely difficult to evaluate, so that reductions in cost and space might materially increase the operating cost. Prior to the war, it was the U.S. Maritime Commission's practice to limit the tooth loading by using a K factor of 65. However, during the war, for production reasons, the Victory gears were designed with a factor K of 100 for the first reduction and 70 for the second reduction. Studies of this experience are in progress at present and the results indicate the possibilities of utilizing higher factors. Based on these results, the DB3 gears have been specified for a K factor of 75.—*Abstract of paper by A. W. Woods read before the Philadelphia Section of The Society of Naval Architects and Marine Engineers on the 19th December 1947, Marine Engineering and Shipping Review, Vol. 53, April 1948, pp. 61-66.*

Floating Turbine Test Laboratory

A temporary floating test laboratory to study casualty conditions in turbines was set up aboard the U.S.S. Noa in 1946 by the U.S. Navy's Bureau of Ships with the co-operation of the General Electric Co. Its establishment was prompted by the casualties of wartime operation which introduced new problems in this field. The tests were attended by engineers of the General Electric Co., Schenectady, who supervised measuring instruments and correlated data which enabled them to check casualties in the turbines under controlled conditions. Each piece of steel in the turbine responds in expansion to any change in the temperature of the steam to which it is exposed. Thus when some casualty condition alters the normal temperature gradient in the turbine from inlet to exhaust, thermal expansion of the steel structure of the turbine may upset the carefully designed clearances allowed for rotation. Casualty conditions may be imposed by derangement of some equipment external to the turbine itself. For example, vacuum may be lost when an element of the condensing system is damaged. Steam to the turbine can be secured immediately, but when it is vital to keep the ship under way by means of another shaft, the forward movement of the ship will cause the idle propeller to drive the disabled shaft at fairly high speed. This immediately sets up abnormal conditions in the turbine. This particular problem required that a shaft be "dragged" under varying conditions of speed and partial vacuum, while keeping careful record of temperatures and pressures in the turbine. To obtain these records, the turbine casings were opened and forty-four thermocouples were placed at selected points in the cruising turbine, the high-pressure turbine and the low-pressure turbine. Also, pressure-measuring devices were installed to measure particularly very small variations in pressure. One interesting feature of the pressure-measuring station was a specially designed manometer board. This board was fitted with twelve glass-tube mercury columns equipped with damping tubes to lessen the effect of pitch and roll of the ship. It also incorporated a variable-level mercury reservoir and air bleed system so that pressure differentials could be observed readily.—*Marine Engineering and Shipping Review, Vol. 53, April 1948, p. 52.*

Machinery of the Cunard White Star Liner "Asia"

This paper describes the machinery of the Cunard White Star Liner "Asia" and gives results of the early passages across the North Atlantic. The main propulsion plant consists of two turbines of the Richardsons, Westgarth Brown-Boveri type for ahead propelling, one high-pressure and one low-pressure, each driving a separate pinion which gears with a separate primary wheel. The high-pressure ahead turbine is of the impulse reaction type comprising a two-row impulse wheel and twenty-seven rows of reaction blading with a conical rotor and cylinder designed to maintain a constant ratio of blade speed to steam speed throughout. The length of the first row of reaction blades is about 1⅜ inch, increasing in each row to 2$\frac{13}{16}$ inch at the exhaust end. Steam is admitted to the turbine through three nozzle boxes welded into the cylinder, the centre box, containing eight nozzles, being always open to steam from the manoeuvring valve and the other two boxes with two nozzles each being hand-controlled. With this arrangement, powers from 6,500 to 8,000 s.h.p. can be obtained with full opening of the manœuvring valves. Steam for use in the generator coils is bled from the back of the impulse wheel at a pressure of about 185lb. and a temperature of about 510 deg. F. Steam for feed heating is taken from the exhaust belt at about 32lb. pressure and a temperature of 360 deg. F. Incorporated in the cast-steel high-pressure cylinder casing but separate from the ahead turbine by a wall and labyrinth packed gland, is an astern turbine consisting of a two-row impulse wheel designed to develop about 35 per cent of the total power of both ahead turbines and exhausting to the astern turbine incorporated in the low pressure turbine. The main gearing is of the double-reduction type, reducing the rotational speed of the turbine through the primary gear to about 731 r.p.m., and through the secondary gear to 116 r.p.m. at the propeller shafting. The design is of the orthodox interleaved type with the primary wheels running in the gap between the two helices of the main wheel. There is no central bearing on the pinions, the length over the secondary pinions and primary wheel being just within classification requirements for the diameter of pinion required. The pinions are of nickel carbon steel of 40 tons ultimate tensile strength, with longitudinal elongation of 22 per cent and transverse of 16 per cent. The wheels are built of steel plates bolted to forged steel rims and the secondary main wheel has a cast-iron centre on which the forged steel rims are shrunk. The rims are of carbon steel 31/35 tons tensile with 26 per cent elongation and to satisfy 180 deg. bend test on a 1-inch square section. There are two boilers of the Foster Wheeler "D" type built for a working pressure of 480lb. per sq. in. in the drums and a temperature of about 750 deg. F. at the superheater outlet. The total generating surface of the two boilers is 6,840 sq. ft. and the economizer surface 4,810 sq. ft. The boilers are arranged to burn oil fuel under a balanced system of forced and induced draught. Each boiler has four burners arranged so that the oil fuel is sprayed to a common focal point. Desuperheating coils are fitted in the steam drums of both boilers to provide about 6,000lb. of steam per hr. at at a temperature of about 450 deg. F. for auxiliary purposes when required.—*Paper read by W. R. Loveridge at a meeting of the North-East Coast Institution of Engineers and Shipbuilders on the 9th April 1948.*

Cycloidal Propulsion

Today 250 vessels have been fitted with cycloidal propulsion based on the principles proposed by Schneider and developed by the firm of J. M. Voith. All the above are Voith-Schneider propellers, but today cycloidal propellers are being manufactured based on the Voith-Schneider and Kirsten systems, whilst others are being developed on original principles. The Kirsten propeller is a development of the Kirsten-Boeing propeller on which experiments were made in the early 1920's. The blades in the fixed-pitch type rotate on their own axis once per revolution of the propeller and are disposed in symmetrical alignment about a line passing through the centre of the rotor and through the axis of the blade, which is at right-angles to the direction of thrust. Change of direction of thrust is made through a gear train integral with the propeller but linked to the bridge control unit through twin air motors. The blades of the variable-pitch Kirsten propeller perform the same oscillating motion as do those of the Voith-Schneider. The control of pitch and direction is through a mechanical gear and rack and the reciprocating action of a slide crank —again similar to the Voith-Schneider, differing only in method of application. Units of both Kirsten fixed-pitch and variable-pitch propellers have been tested during the past eighteen months, the former in the U.S. Navy vessel LSM.458 with two 7-feet diameter propellers, and the latter in a 45-feet harbour tug belonging to the U.S. Army and having two propellers each 3-feet blade orbit diameter. Further developments are in hand, particularly on light-weight propellers for shallow-draught tugs. About 90 per cent of the vessels fitted with cycloidal propellers have a draught of 6 feet or less and it would appear, both from theoretical considerations and practical results, that this method of propulsion should always be considered for shallow-draught vessels. The large swept area and low speed of revolution ensure good propulsive efficiency which, coupled with the variable pitch and manœuvring characteristics, substantially improve the serviceability of these craft, and particularly so for towing vessels. A feature appreciated in light-scantling shallow-draught passenger ships is the absence of vibration with the cycloidal propeller. This is presumably because any part of the blade is a constant distance from the hull and thus works in the same water velocity, whereas the tips of a screw are under changing velocity conditions with every revolution.—*Paper by Capt. E. C. Goldsworthy read at a meeting of The Institution of Engineers and Shipbuilders in Scotland, on March 23rd 1948.*

Propelling Machinery for T.S.S. "Orcades"

Work on the construction of the new "Orcades", the 31,000-tons passenger liner now building at the Barrow yard of Vickers-Armstrongs, Ltd. for the Orient Steam Navigation Co., Ltd., is progressing satisfactorily. The largest passenger liner yet built at Barrow, this twin-screw turbine-driven vessel will carry passengers, mail and cargo between the U.K. and Australia and is designed to complete the voyage between England and Melbourne in twenty-eight days instead of the pre-war thirty-six. Each of the twin screws is driven by a set of geared turbines of the Parsons type, designed for a collective shaft horse-power of 42,500. The astern turbines are capable of developing not less than 65 per cent of the normal ahead power. The gearing for the h.p. ahead turbine is of the double-reduction type comprising an independent primary set of gears driving a secondary pinion on the main wheel. Single reduction type gearing is used for the i.p. and l.p. ahead turbines. The h.p. ahead turbines are of the impulse-reduction type, the i.p. of the all-reaction type and the l.p. ahead turbines of the double flow all reaction type. Impulse h.p. and l.p. astern turbines are incorporated in the i.p. and l.p. ahead casings. Steam to the turbines is delivered at 500lb. per sq. in. and at 850 deg. F. from two large and two small water-tube boilers of Foster Wheeler controlled superheat design. Weir's regenerative condensers are fitted to each set of turbines. Thrust blocks and tunnel bearing blocks are of the Michell self-lubricating pivoted type. —*The Shipping World, Vol. 118, 28th April 1948, p. 443.*

Steam and Gas Turbines for Marine Propulsion

This paper gives a general review of the present position of steam and gas turbines for marine propulsion. The section on the marine steam turbine examines steam conditions and present-day conformations of propulsion units. The gas turbine section begins by a consideration of possible advantages, and goes on to discuss the lines of development which are being pursued, with particular reference to the open cycle gas turbine utilizing all rotary turbines and compressors. The section on transmission systems deals generally with all types of marine turbine machinery, and is followed by a section on manœuvring arrangements. The last section of the paper deals with possible lines of development in the future for both steam and gas turbine main propelling machinery.—*Paper by T. W. F. Brown, Proc. I.Mech.E., Vol. 157, 1947, pp. 175-188.*

English Electric L-series Diesel Engines

The L-series of engines built by the English Electric Co., Ltd., which are essentially non-reversible constant-speed units and which have been fitted to the Diesel-electric vessels "Patricia" and "Vecta", is now superseded by the RL and SRL series. For marine duty, engines of the RL and SRL series are available in slightly modified form, identified as the RLM and the RLSM types. In these new types the engine speed has been increased from 375 to 428 r.p.m. The cylinder bore, piston stroke and b.m.e.p. remain the same, but the increase in speed has resulted in the output per cylinder being augmented by about 15 per cent. The ouput based on B.S.I. rating is given as 715,858, and 1,144 b.h.p. for 5, 6, and 8 cylinders of the RLM type respectively, while the corresponding powers for the supercharged RLSM tvne are 1,070, 1,287, and 1,716 b.h.p. respectively, the speed in all cases being 428 r.p.m. To meet actual marine-service requirements the units would be de-rated to the extent of about 20 per cent below the figures given. The results of shop tests at variable output and constant speed carried out on a five-cylinder unit of the RLS series are charted in Fig. 3. It will be noted that the recorded fuel consumption at full load is well within the guaranteed figure of 0·37lb. per b.h.p.-hr. A table included in the article shows that the old LM-type engines of the motorship "Patricia" showed specific fuel consumptions of 0·396 (port engine) and 0·385 (starboard engine) lb. per hr. at 110 per cent of full load, as compared with a figure of 0·370lb. per hr. for the new RLS type.—*The Shipbuilder and Marine-Engine Builder, Vol. 55, May 1948, pp. 352-356.*

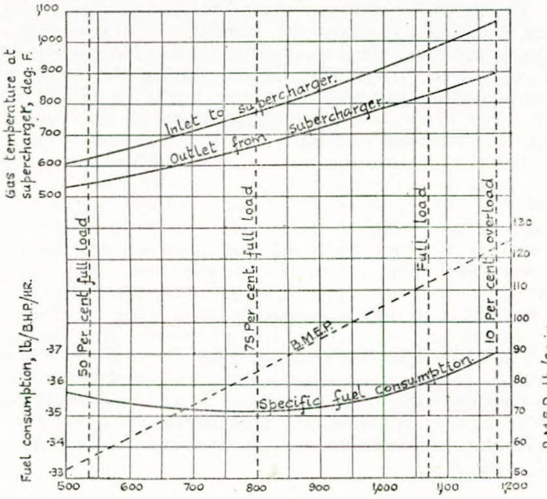


FIG. 3.—*Results of shop tests on SRL-type five-cylinder engine*

The Lubrication of Oil Engines

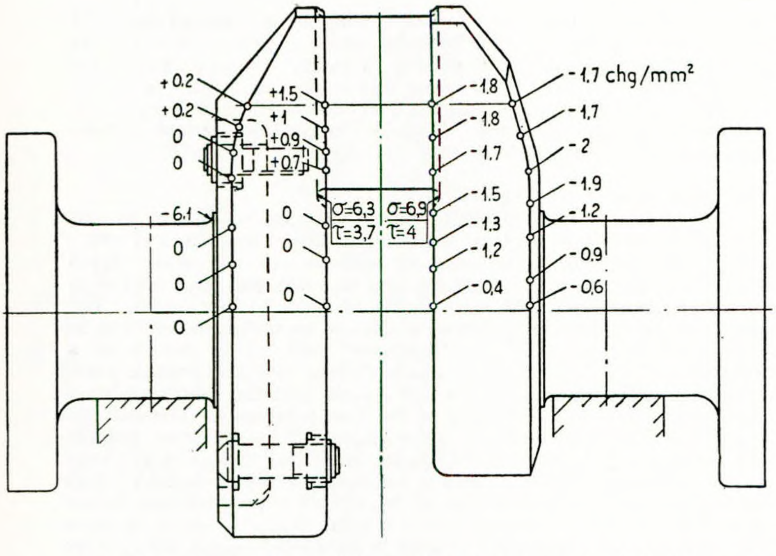
The uncompounded straight mineral oils are no longer recommended for severe service in high-output Diesel engines and eventually will probably be replaced by additive oils of various types which have been in general use for several years and have proved to be far superior to straight mineral oils for general lubrication. The heavy duty Diesel engine lubricating oils are commonly referred to as "additive", "compounded" or "detergent" oils. They consist of a well-refined base mineral oil to which various synthetic organic compounds have been added. These compounds have the following beneficial effects on the performance of the base lubricants. The additive contains oxidation and corrosion inhibitors and its presence reduces the formation of organic acids, sludge and other oxidation products in the lubricant. There is also some evidence which indicates that the inhibitor alters the character of the oxidation products and makes them less gummy. It also contains a foam inhibitor which reduces the formation of foam when the oil is intimately mixed with air or gas. The compounding material contains a powerful detergent which keeps the rings free, reduces the formation of lacquer and keeps the engine clean. The detergent washes away and carries in suspension the oxidation products formed by partial combustion of the lubricating oil film and prevents the deposition of lacquers and gummy materials in the ring belt area which cause piston ring sticking. In the case of the compounded oil, the engine remains clean while the oil becomes dirty. Therefore, while using these oils, one should not be concerned if the oil turns dark or even black in colour after only a few hours of use. The carbonaceous materials carried off into the oil are in a very finely divided form and are surrounded by a protective film which prevents them from settling out on the engine parts or damaging the frictional surfaces. The compound in many of the oils improves the affinity of the lubricant for metal surfaces and thus reduces cylinder wall wear and inhibits the formation of rust in the presence of moisture. In double-acting engines it reduces the formation of lacquer deposits on the piston rods and in the stuffing boxes, and thus prevents high wear and scuffing. When changing from a straight mineral oil to a heavy duty compounded oil in engines that are not cleaned prior to the change, a moderate increase in oil consumption may be noted. This is due to removal of deposits in the ring belt area of the pistons by the detergent action of the oil with resultant slight increase in clearances. New or overhauled engines started on compounded oils will have oil consumption rates of the same magnitude as with straight mineral oil. However, the compounded oil will maintain low oil consumption for a much longer period than will straight mineral oil. This may be attributed to the fact that the compounded oils drastically reduce fouling or oil ring slots and piston oil drain holes and minimize cylinder and ring wear, thus controlling relative consumption for a longer term of operation than an uncompounded oil.—*Motorship, New York, Vol. 33, April 1948, pp. 42-45.*

New Distributor Type Bosch Pump

The American Bosch Corporation has announced a new single-plunger type PSA fuel injection pump which is suitable primarily for small Diesel engines. In this new design a single plunger and a single delivery valve do the work formerly allocated to four or six plungers and delivery valves, depending upon the number of cylinders to be served. The fuel injection pump is driven at crankshaft speed on 4-stroke engines. It is of the cam-actuated constant-stroke throttled-intake type, the single plunger having a continuous rotary motion, thus serving as its own fuel distributor. Although a multi-outlet unit, it has only a single delivery valve.—*Motorship (New York), Vol. 33, April 1948, pp. 36-38, 65.*

Coupling of Crankshaft Sections

In large multi-cylinder engines single piece crankshafts may be either impossible or inconvenient to use and the problem of coupling two or more crank-sections therefore arises. The use of flanged couplings introduces disadvantages such as greater engine length and engine weight, and designs have therefore been developed in which the sections are coupled in a crank web. While the increase in the distance between cylinder centres in this design is moderate, the deviation from standard dimensions nevertheless is undesirable. For this reason a special type of web coupling has been developed which makes it possible to retain normal cylinder centres so that either a



single-piece or a web-coupled crankshaft can be fitted in the same engine. The stress and strain characteristics of the coupling were ascertained on a scale model of a single crank of the crankshaft of a 4,500 h.p. Diesel, with crankpins of 460 mm. diameter. This model was subjected to a bending test, the bending load being produced by a hydraulic cylinder capable of exerting a load of 8,500 kg. The load was applied with the crank in a position of 15 deg. past upper dead centre, corresponding to a cylinder pressure of 60 kg. per sq. cm. for the actual engine. The torsion test was carried out by applying a torsional load of 300 kg. to the flanges of the model. As will be seen from the accompanying figure, the stresses recorded for the coupling are slightly lower than those prevailing in the solid web.—*G. Simonetti. Bolletino Tecnico Fiat Stabilimento Grandi Motori, No. 1, 1948, pp. 21-26.*

Reciprocating Engines and Water-tube Boilers

The steam reciprocating engine with ordinary slide valves is unsuited to the high pressures and superheats at which the water-tube boiler, if it is to work on good economy, must generate steam. These difficulties may always be overcome by the employment of special types of reciprocator such as the Lentz, the Christiansen and Meyer, the Skinner "Unaflow" and others. John Readhead and Sons, South Shields, have recently obtained from Frank C. Strick and Co., Ltd., London, an order for a passenger/cargo liner of 11,000 tons dead weight, a repetition of previous orders. The propelling machinery is to consist of a steam reciprocating engine working in conjunction with a Bauer-Wach low pressure exhaust turbine, steam being supplied by water-tube boilers. Vessel speed will be about 14½ knots. The same shipyard has under construction for Norwegian owners a vessel which is being built under a Norwegian patent, with water-tube boilers on a special platform above the engine room supplying steam to a special Frederiksstad steam motor. There is a considerable range of choice for the owner who wishes to employ a really modern reciprocating engine with water-tube boilers. One of the most highly developed is the Lentz, in the latest version of which the high-pressure cylinder differs from the type which has been familiar for many years, the double-beat steam inlet and exhaust poppet valves being superimposed instead of alongside each other in a fore-and-aft line with radial steam passages to the cylinder In the basic double-compound engine, the upper and lower exhaust valves of the high-pressure cylinder serve as the steam inlet valves to the low-pressure cylinder and there is no intermediate steam receiver. In the latest type of Lentz engine the cams are adjustable. There is a separate valve rocking lever for each inlet valve, and another for the corresponding exhaust valve, the valve closing gears having a common spring concentric with the inlet push rod. The exhaust-valve closing mechanism is interesting because the spring load can be varied, as also can the adjustment at the bottom of the spring.—*Lloyd's List and Shipping Gazette, No. 41,610, 22nd April 1948, p. 6.*

Germany's Shipbuilding and Marine Engineering During the War

A critical review of Germany's Shipbuilding and Marine Engineering advances during the war period has been specially written by the British Shipbuilding Research Association. Among the subjects covered in the report are ship construction, boilers and steam propulsion, gas turbines, steering devices, auxiliary machinery and equipment, and cargo handling equipment. The report analyses the differences between British and German practices and points to some interesting features. Commercial competition was planned to the "Queen Elizabeth" by the construction of a 300,000 h.p. vessel developing a speed of 36 to 38 knots. The construction of concrete ships as an emergency measure was undertaken and they proved quite successful. Much research and development work went on in Germany to use gas turbines for ship propulsion.—*B.I.O.S. Overall Report No. 2, 1948.*

Cargo Motorship "Venezuela"

The single-screw cargo motorship "Venezuela" recently completed by Burmeister and Wain, Copenhagen, for Det Forenede Dampskibsselskab has the following principal dimensions: length overall, 439ft. 9in.; length b.p., 415 feet; breadth moulded, 57 feet; deadweight, 9,200 tons; load draught (summer freeboard), 25ft. ¾in. Speed on trial was 13·5 knots. The main engine is a Burmeister and Wain direct reversible single-acting, two-stroke cycle Diesel engine of the crosshead type, with seven cylinders, the bore being 620 mm. and the piston stroke 1,150 mm. The engine has been designed to deevlop 4,725 i.h.p. or 3,850 b.h.p. in normal service, at 135 r.p.m. corresponding to a mechanical efficiency of 81·5 per cent. These figures are equivalent to a brake mean effective pressure of 76·5lb. per sq. in. and a mean piston speed of 1,020ft. per min. In accordance with the builders' practice, the rotary scavenging-air pumps are located at the back of the engine. The pistons and cylinder liners are kept short, to give the least possible height of engine, while the pure crosshead principle is retained. the cylinders and crankcase being kept apart. Electric power is provided by three 120 kW. generators. Each is driven by a single-acting, four-stroke cycle, three-cylinder trunk-piston engine, the cylinder bore being 245 mm. and the stroke 400 mm. The output of each engine is 180 b.h.p. at 500 r.p.m.—*The Shipbuilder and Marine Engine-Builder, Vol. 55, May 1948, pp. 345-349.*

Twin-screw Passenger and Cargo Steamship "Sidi Bel Abbes"

The recently launched "Sidi Bel Abbes" is a twin-screw passenger and cargo steamship of 402 feet overall length, other particulars are; extreme breadth 53ft. 6in., moulded width 27ft. 3in., and 1,850 metric tons on 19ft. 5in. mean draught. She is built to the order of the French Government on behalf of the Société Générale de Transports Maritimes à Vapeur, Paris, for service in the Mediterranean. The builders are Swan, Hunter and Wigham Richardson, Ltd., who also constructed the two sets of Parsons turbines for the vessel, with single-reduction double helical gearing. Steam is supplied by two La Mont boilers, manufactured by the John Thompson Water-Tube Boilers, Ltd., Wolverhampton. The boilers, which are of the forced and controlled circulation type, with superheaters incorporated, are arranged for burning oil under forced draught, and are fitted with air-heaters. The designed working pressure is about 500lb. per sq. in. and the total steam temperature is 750 deg. F.—*The Shipbuilder and Marine-Engine Builder, Vol. 55, May 1948, p. 377.*

Feed-water Treatment

A standard code of practice for the treatment of marine-boiler feed-water has now been published by the British Standards Institution (B.S. No. 1170). As the results of wartime experience Lloyd's Register of Shipping had asked the Institution to explore the possibility of preparing a standard method of chemical treatment of feed-water. Vessels were frequently delayed during the war owing to leaky tubes, distorted furnaces and other faults resulting from bad feed-water. The general, introductory, section of the Code stresses the need for education and training of sea-going personnel and instruction in the control of treatment by testing. The section on engineering factors deals with the maintenance of boiler plant at full availability, and gives guidance on those points of detail likely to bring about contamination of boiler feed-water if neglected. The abitrary plan followed of dividing treatment into three classes applicable to the main types of boilers commonly installed on board ship and to feed-water of varying quality is open to some objections on purely technical grounds, but they are heavily outweighed by the practical advantage gained in simplifying the procedure for the seagoing engineer. The objections lose much of their force when it is remembered also that the treatment scheme finally adopted will be modified to suit the circumstances of a given case by the consultant made responsible for advice, supplies and port services.—*Lloyd's List and Shipping Gazette, Shipbuilding and Engineering Section, No. 41,610, 22nd April 1948, p. 7.*

Whale-oil Factory M.S. "Thorshövdi"

The M.S. "Thorshövdi" is a twin-screw oil-tank and whale-oil factory motorship. The principal particulars are: 638ft. overall length and 600ft. between perpendiculars, by 77ft. 4in., by 41 feet to second deck and 57ft. 3in. to upper deck; 23,500 tons deadweight; 18,000 tons gross; capacity of cargo tanks, 1,080,000 cu. ft.; 12½ knots speed on loaded trial. The vessel was built by Burmeister and Wain, Copenhagen, for A/S Thor Dahl, Sandelfjord. The vessel has a flensing deck, poop, and long forecastle, together with an upper forecastle, and is otherwise arranged as a tank ship. The propelling machinery consists of two Burmeister and Wain single-acting, two-stroke cycle, six-cylinder, crosshead-type, airless injection Diesel engines, together developing 7,400 i.h.p. (6,000 b.h.p.) at 125 r.p.m. Electric power is provided by three 133 kW. generators, each of which is driven by a Burmeister and Wain direct-coupled, four-stroke cycle, four-cylinder airless-injection Diesel engine at 425 r.p.m. Power for the whale-oil factory is provided by three Burmeister and Wain two-stroke cycle, airless injection, Diesel engines developing 800 b.h.p. at 300 r.p.m., and each coupled to a generator of 533 kW. The extensive steam-generating plant consists of six oil-fired forced-draught, four-furnace boilers, each having a heating surface of 300 sq. m. and designed to work at a pressure of 12·5 atmospheres. The vessel was launched on the 15th April.—*The Shipbuilder and Marine Engine-Builder, Vol. 55, May 1948, pp. 378-379.*

Tanker "Gulflube"

Designed according to the customary arrangement for modern oil carriers the "Gulflube" is a three-island, single-screw, turbine-driven tanker with straight raked stem and cruiser stern, with machinery and crew's quarters aft and deck officers' accommodation and navigation spaces in a midship deck house. Her principal characteristics are as follows:—

Length overall	471ft. 4in.
Length b.p.	450ft.
Beam moulded	64ft.
Depth moulded	34ft. 10in.
Draught to assigned waterline	28ft. 5⅜in.
Deadweight, tons	12,850
Cargo capacity, b.b.l.	103,400
Bunker capacity, b.b.l.	4,950
Shaft horsepower, normal	5,500
Propeller speed r.p.m.	100
Speed at full rate, knots...	15

The cargo space is divided into twenty-eight compartments, the full depth of the hull, by oil-tight bulkheads extending from the bottom shell to the upper deck, eleven transverse and two longitudinal, the latter continuous and running from the forward cofferdam to the after end of the fuel tanks, with deep brackets beneath the upper deck in dry cargo spaces forward and beneath the upper deck aft. A double bottom with watertight tank top in the machinery space is subdivided for reserve feed and wash water, drain well, lubricating-oil sump and fathometer sump. The fore and aft peaks are used for ballast only. Welding has been used exclusively throughout the vessel, with riveting confined almost entirely to the seams of the shell plating and to the seams of the upper deck plates. All deck houses and enclosures are of welded construction. The main propulsion machinery consists of one high-pressure and one low-pressure turbine, driving a four-blade solid bronze propeller of 18ft. 9in. diameter through double-reduction gears. This unit has a normal ahead rating of 5,500 s.h.p. at 100 r.p.m. Steam is supplied to the throttle at 450lb. per sq. in. and 750 deg. F., with 28½ inch vacuum at the exhaust flange. The high-pressure turbine is of the combined impulse-and-reaction type, the low-pressure turbine of the single-flow reaction type, exhausting downward to a main condenser athwartship below the turbines. Either turbine may be operated singly. in case of emergency. An astern turbine, capable of providing ample torque for stopping and manœuvring the vessel, is installed in the low-pressure turbine casing. Two single cross-drum, straight-tube boilers are located on a flat in the machinery space above and aft of the turbines. A combustion-control system automatically regulates the fuel and air supply to the steam generators to meet the fluctuations in the steam demand.—*Marine Engineering and Shipping Review, Vol. 53, April 1948, pp. 36-46.*

Passenger and Cargo Liner "Parthia"

Built at the Belfast shipyard of Harland and Wolff, Ltd., the "Parthia" is the fourth new liner to join the post-war fleet of the Cunard White Star Line. The general dimensions of this vessel are:—

Length overall	531ft. 4⅜in.
Length b.p.	500ft.
Breadth moulded	70ft.
Load draught	30ft. 2⅞in.
Gross tonnage, approximately	13,340
Net tonnage, approximately	17,480
Service power, approximately... ...	13,700 s.h.p.
Maximum power, approximately ...	15,000 s.h.p.
Service speed	17 knots
Cargo capacity, general...	362,380 cu. ft.
Cargo capacity, insulated	60,050 cu. ft.

The boiler installation consists of two Harland and Wolff-built Foster Wheeler controlled-superheat type boilers, with superheaters and economizers; these boilers are of the latest divided furnace type. Steam pressure at the superheater outlet is 430lb. per sq in. and the steam temperature is 750 deg. F. The superheater in each boiler is of the convection multiple-pass type arranged to ensure constant steam temperature down to about 30 per cent of full power. The economizers are of the Foster extended-surface design, made by E. Green and Sons, Ltd., with U-bend elements fitted with cast-iron gills. Balanced draught is used, two Howden forced draught fans supplying the air for combustion and two induced draught fans aspirating the gases from the combustion chambers and discharging them to the dust collectors and funnel. The oil-burning installation is on the Wallsend-Howden patent pressure system. The main turbines were designed in collaboration with the Parsons Marine Steam Turbine Co., Ltd., and have a service power of approximately 13,600 s.h.p. and a maximum power of 15,000 s.h.p. Astern power is provided by a simple astern turbine incorporated in the after end of each low pressure ahead casing. The reduction gearing is of the conventional double-helical double reduction type. Pinions and gearwheels are housed in a mild steel fabricated gearcase, the main engine motor-driven turning gear being secured at the after end of the gearcase. The latest Michell type of single-collar thrust block carries the propeller thrust, each block being fitted immediately aft of the gearcase. —*The Marine Engineer, Vol. 71, May 1948, pp. 189-199.*

The Positioning of Propellers and Shafts

The author refers to U.S. Navy requirements for at least a 20 per cent increase in the full power speed of Naval auxiliary ships as well as vessels comprising the protective screen of a task force. Such a speed increase requires a doubling of the thrust output of the propeller and a review of the principal factors determining the interaction between the hull and the propeller is therefore called for. The present paper surveys the variation in overall propeller performance occasioned by the positioning of propellers and the alignment of shafts, with the objective of appraising the modern trend in the achievement of superior ship propulsion. There is no justification for the prevailing tendency to position propellers in a so-called "favourable wake". The usual wake distribution over a propeller disk imposes a load limitation which becomes a liability rather than an asset as "what is gained in potential wake is lost in thrust deduction". The flow of water to the propeller is never in a horizontal axial streamline but there is a non-axial flow. Non-axial flow causes a single-screw ship fitted with a right-hand rotating propeller to turn to port when driving the vessel ahead. Non-axial flow will adversely affect propeller performance in the field of cavitation, and in order to avoid non-axial flow the shaft wake and spread angles should be minimized. This calls for positioning the propeller as close to the hull as practicable. Propellers not only interact with the hull but where more than two shafts are employed they vie each other for the available water supply. Propellers should therefore be lined up across the ship with adequate clearance between propeller disks. A graph is given by the author which indicates the influence of shaft skegs in reducing the rotation of the slipstream and upon propeller performance at varying slip ratios. Propulsive efficiency can be further improved on a propeller operating behind a conventional skeg by providing a more symmetrical inflow to the propeller. In place of the conventional V sections it is desirable to use full U or even bulbous sections in the skeg. The most universal source of objectionable hull vibrations is an insufficient propeller blade tip clearance at the upper arc of the propeller rotation. In low powered ships it is customary to provide a tip clearance of 1 inch per foot of propeller diameter for single screw ships and for outboard strut supported propellers an allowance of 2 inch per foot of diameter is usually provided. But this rule of thumb is not applicable for positioning the propellers of a modern ship in which over 50,000 shaft-horse-power may be transmitted on a single shaft. The author lists the variables which determine the intensity of the pressure field around a hydrofoil and the factors influencing the propeller blade tip clearance; and a proposed tip clearance formula embodying these variables is given. No modifying coefficients are necessary to make this formula applicable to similar ships of varying sizes. The formula specifies not only the minimum propeller blade tip clearance for acceptable vertical and transverse vibrations but also determines the optimum position for the propeller shaft alignment.

The formula contains a factor of service *Z* which embodies a consideration for reasonable comfort of passengers and crew in addition to fatigue of the hull structure and component parts. The working service factors may be computed by the proposed formula for existing ships having acceptable performance, and then this service factor may be confidently applied for the positioning of the propellers in the design of similar ships even though the hull size and installed s.h.p. is increased many fold.—*N. J. Brazell, Journal of the American Society of Naval Engineers, Vol. 60, February 1948, pp. 32-48.*

Floating Docks

In this paper, which was originally read before the Svenska Teknologföreningen, Stockholm, the author gives a survey of the various types of floating docks in use. The stability problem and questions of static strength are dealt with, special reference being made to the 8,000-ton dock at Constantza, Rumania. The operational characteristics of the pump plant of 2,500 tons per hour capacity of the Constantza dock are given. Examples of British, American, and French practice are briefly discussed. The relative capital cost of a floating dock is shown to be roughly one-half that of a corresponding dry dock, which explains the preference given to the latter type.—*E. Palmblad, Teknisk Tidskrift, Vol. 78, 17th April 1948, pp. 241-248.*

The Diesel-electric Tanker "Auris"

After her trials off the Tyne, and subsequent acceptance by the owners, the Diesel-electric tanker "Auris" has entered the service of the Anglo-Saxon Petroleum Co., Ltd. Built by R. and W. Hawthorn Leslie and Co., she is already designed and constructed so that, at a later date, one of her four Diesel engines can be replaced by a gas turbine now under construction at the Rugby works of the British Thomson-Houston Co., Ltd. Of the single-deck type with poop, short bridge and forecastle decks, the Auris has been constructed to Lloyd's 100 A1 class under special survey, and has been specially designed for the carriage of petroleum in bulk. The main particulars are as follows:—

Length, overall	482ft. 6in.
Breadth	59ft. 0in.
Depth moulded to upper deck ...	34ft. 10in.
Deadweight	12,000 tons (approximately)

The cargo space is divided into nine main oil tanks which are subdivided by two longitudinal bulkheads, thus making twenty-seven separate cargo tanks. The propelling machinery consists of four Hawthorn-Sulzer Diesel engines, each coupled to an alternator supplying current to the propeller motor and to the propulsion auxiliaries. This motor delivers 3,750 s.h.p. at 120 r.p.m. The four engines and alternators are arranged at floor level with the electrical control gear on a flat above the alternators at the forward end of engine-room. The main motor is in a separate compartment immediately aft of the engine-room. The two boilers arranged above the main motor, are equipped for exhaust or oil. A special feature of the installation is that all the propulsion auxiliaries are driven by a.c. motors with their speed varying directly with the engine speed. The four Hawthorn-Sulzer engines, constructed at the St. Peter's Works of Hawthorn, Leslie and Co., Ltd., are of the latest four-stroke cycle, trunk piston type, supercharged by exhaust gas turbo-blowers. Each engine has eight cylinders and develops 1,100 b.h.p. at 275 r.p.m. An electrical governor controls the engine speed within fine limits from half to full speed and a mechanical governor safeguards against overspeed, should the electrical system become de-energized. The cylinder tops and valve gear are enclosed to ensure quiet running. The alternators are of the salient pole three-phase double unit design with independent field and a.c. windings normally operated in series. The polarity of one-half can be reversed in order that switching can be effected at zero voltage. Each alternator has a capacity of 830 kVA and the current is 3-phase, 50 cycles at 1,600 volts. Each alternator is arranged for forced air cooling. The propeller motor operates as a synchronous motor between full and half speeds. Below half speed, the motor runs as an induction machine with variable slip depending on the applied voltage.—*The Shipping World, Vol. 118, 5th May 1948, pp. 465-467.*

Navy's First Light Metal Coastal Craft

The first light metal alloy coastal craft to be completed in this country was recently launched from the North Welsh yard of Saunders Engineering and Shipyard, Ltd. The craft, an experimental one, is the M.B.T. 539. She is 75 feet in length, and has a beam of just under 20 feet. Her machinery is of normal internal combustion type, and is sufficient to give her a high speed and good endurance. The main interest in this craft lies in the fact that her hull, including frames and skin, is made of an aluminium alloy, which weighs about one-third the weight of steel. The hull will be somewhat lighter than an equivalent hull of wooden construction. Such a saving in weight can be used to make possible increased speed, increased range or increased armament and equipment. The method of construction may make possible the more rapid production of such craft.—*Fairplay, Vol. 170, 29th April 1948, p. 1,044.*

New Argentine Coastal and River Vessels

This article discusses the plans made by the Argentine Republic for the expansion of coastal and estuary shipping and describes the features of the vessels for this purpose now under construction at the Ingalls Shipbuilding Corporation, Pascagoula, Miss., U.S.A. The principal characteristics of the new motorships are as follows:—

Length, overall	232ft. 5in.
Length, b.p.	215ft. 0in.
Beam, deck, moulded	42ft. 6in.
Depth, moulded, midship, at side	15ft. 6in.
Draft, designed, moulded ...	9ft. 0in.
Displacement, designed draft ...	1,680 tons (approximately)
Cargo deadweight, designed draft	1,000 „ „
Cubic capacity, bale	7,000 cu. ft.
Service speed	8·7 knots

These vessels are to be built to the highest classification of the American Bureau of Shipping for Hull and Machinery and under their survey. Welding is to be used for construction and will also be in accordance with the classification rules. Two Enterprise Diesel engines rated 350 h.p. at 250 r.p.m. will constitute the main source of power. This does not appear to be a very large power for a craft of this size, but it apparently produces the required service speed deemed adequate by the owners for the service contemplated. Certainly the operating costs should be very modest. The engines are the Model DMG 6 which are direct-reversible units having six cylinders with a bore of 12 inch and a 15-inch stroke. Each of the engines is supplied with a heat exchanger type of cooling system, fresh and raw water pumps, a Duplex lubricating oil pump, fuel oil booster pump and a Quincey air compressor. The engines are under the control of the bridge officer through a remote control arrangement. Power and mechanical steering are provided by the Sperry electro-mechanical steering system.—*Motorship (New York), Vol. 33, April 1948, pp. 39-41.*

Coast Guard Cutter Equal to Heaviest Ice

The Commandant of the U.S. Coast Guard recently arranged for an inspection trip by representatives of the United States and Canada to witness the operation of the Coast Guard ice-breaker "Mackinaw" on the Great Lakes in conditions that have heretofore been impassable to normal vessels, to demonstrate the possibility of extended navigation in ice-covered waters. The demonstration consisted of negotiating ice fields of 38-inch solid ice, where progress was practically unimpeded, and windrows (piles of broken ice) were as deep as 25 feet, which is deeper than the draft of the vessel. The demonstration was extremely successful, in that not even the heaviest windrows could stop the "Mackinaw". The vessel was designed by the U.S. Coast Guard and built in Toledo, Ohio. She is 290 feet in length, with a 71-feet beam, of 5,000 tons displacement, and 10,000 s.h.p. divided between three propellers, two aft and one forward. Power is provided by six 2,000 h.p. Fairbanks Morse opposed-piston Diesels. The use of the bow propeller was shown to be extremely efficient for this type of operation and the Diesel electric machinery provided the herculean power to perform these tasks.—*Motorship New York, Vol. 33, April 1948, p. 53.*

New Johnson Cargo Liner

The latest addition to the fleet of the Swedish Johnson Line, the "Golden Gate", attained a mean speed of 21·4 knots on her trial run. She is the second of a series of five express cargo liners of 9,000 tons deadweight being built by Kockums Mek. Verkstads A/B, Malmö, for these owners. Special provision is made to facilitate rapid loading and discharging in port. Seven hatches enable an extra large number of stevedore gangs to work simultaneously on board these ships, and fourteen fast 41-feet electric cranes, which reach to the second railway-track on the pier, contribute towards facilitating the handling of cargo. In addition to the ordinary holds, the ship is equipped with 30,000 cu. ft. of refrigerated cargo space for carrying meat at a temperature just below 0 deg. F., and 65,000 cu. ft. for fruit at about 30 deg. F. The "Golden Gate" is an all-welded open shelter-decker with an overall length of 502 feet, moulded depth of 39ft. 10in., and draught 26ft. 7in. She is powered by two Kockum-M.A.N. Diesel engines developing 14,000 b.h.p. at 110 r.p.m.—*The Syren and Shipping, Vol. 207, 5th May 1948, p. 160.*

The Motorship "Godafoss"

The motorship "Godafoss" is the first of three cargo motor vessels being built by Burumeister and Wain, of Copenhagen, for H/F Eimskipafjelag Islands, Reykjavik. She is the first motor vessel to be built for these owners. The main dimensions of the vessel are as follows:—

Length, b.p.	290ft.
Breadth, moulded	46ft.
Depth to upper deck	29ft. 6in.
Draught	21ft. 3⅜in.
Speed, loaded	15 knots
Deadweight	2,700 tons
Gross tonnage	2,905 tons

The vessel has been built to Lloyd's highest class, and the hull has been welded wherever possible. All butts have been welded for navigation in ice and the vessel has been strengthened with heavy main and intermediate frames. She has a cruiser stern and a streamline rudder of the B. and W. type. The four hatchways are provided with B. and W. patent hatch covers consisting of all-welded sections linked together; they can be opened or closed in a few seconds by means of the winches. The machinery has been built to Lloyd's special survey with strengthening for ice. The main engine is a B. and W. direct reversible, single-acting, two-stroke, 9-cylinder trunk type Diesel engine, with airless injection. The cylinder diameter is 500 mm., stroke 900 mm., and the normal output is 3,700 i.h.p., corresponding to 2,950 b.h.p. at 160 r.p.m. The auxiliary engines are three 3-cylinder, four-stroke trunk type Diesel engines with airless injection, each direct coupled to a dynamo of 120 kW., 220 volts, and 500 r.p.m. The Diesel engine cylinders have a bore of 245 mm., and 400 mm. stroke. Output per engine is 180 b.h.p.—*The Shipping World, Vol. 118, 21st April 1948, pp. 423-424.*

New Era Opens in Tanker Construction

A significant feature of the new programme of tanker construction is the provision for higher speed and greater carrying capacity. This is especially pronounced in the vessels now being built in the United States, but the same trend is observable in Europe. The new American tankers for which orders have been placed since January, are slightly superior in speed to the T-2 design but have a cargo capacity 70 per cent greater. Fifteen of these super tankers are now on order for three American oil companies. They are of 16,750 ton gross and 26,000 d.w. each, with a service speed of 16 knots, and each will carry 228,000 barrels of oil. Their overall length will be 628 feet with 600 feet b.p. Moulded beam will be 82ft. 6in. and moulded depth to the upper deck 42ft. 6in. Draught will be 31ft. 6in. As compared with the T-2's, the new design is 125 feet longer with a 12-feet greater beam and 4-feet greater depth, but carrying capacity will be 88,000 barrels more. It is notable that the draught is only 1 foot greater than that of the T-2's, enabling the new tankers to use practically any port navigable by the T-2's. Hulls of the new vessels will be of steel welded and riveted construction. They will be of the single-deck type and will have single screws. Turbo-electric drive will be installed, with a high-pressure geared steam turbine capable of developing 12,500 s.h.p. at 112 r.p.m.—*World Petroleum, Vol.. 11, April 1948, pp. 54-55.*

Structural Design and Its Applications

During a severe storm the bow of the thirty-one year-old riveted ship "Oakey L. Alexander" broke off, and the structural failure was afterwards examined and compared with structural failures of welded ships. The fractures were found to have started at the square corners of the hatches. In addition to the main fractures which caused the ship to break in two, two minor fractures were found at other hatch covers but they did not continue to spread. The fracture of the plates was of the "cleavage type", square to the plate surface. At the starboard deck seam and certain other positions, the fracture changed to the "shear" type at 45 deg. to the plate surface. "Shear" fractures are rarely found in welded ships except at the termination of a fracture. In this case, the fracture seemed to have run from the hatch corners to the riveted seams, where a slight pause occurred and the type changed to "shear". The load on the riveted seams, however, was so great that it caused the ultimate failure of the entire hull. All characteristics of welded steel ship failures were present, showing that the structural failures of the two types of ship are essentially the same. The presence of the riveted seams undoubtedly arrested the spread of cracks in numerous cases of riveted-ship failures, but this resistance is probably the only real difference between the two types of structures.—*Abstract No. 1585, Journal of The British Shipbuilding Research Association, Vol. 3, No. 3, March 1948. MacCutcheon, E.M. Welding Journal, Vol. 27 (1948), p. 52 (Jan.).*

Descaling Tanks by Electrolysis

Oil tankers carrying light spirit are particularly susceptible to corrosion in those tanks in which water ballast is carried on the outward voyage, and, unless the scale formed of corrosion products which results is removed at intervals, the rate of deterioration of the steel is particularly severe. It is stated that for some unknown reason this deterioration has been particularly bad in certain tankers during recent years, in spite of frequent descaling of the tanks. Normally, the scale, which fortunately is not particularly adherent, is removed by scraping, but an alternative process is now available whereby this can be done by electrolytic means. In this method, which was evolved in the United States during the war, the procedure is to deposit on the walls of the tank to be cleaned a thin coating of magnesium salt, which forms beneath the scale or rust and thus loosens it. This is done by filling the tanks with sea water and using a number of carbon electrodes which are placed in the tank. A fairly high current density has to be used, and the time taken for completing the operation depends on the number of electrodes available.—*Fairplay, Vol. 170, 22nd April 1948, pp. 990, 992.*

Sea Water Contamination of Boiler Fuel Oil and Its Effects

The author explains that the problems of deterioration of furnace refractories and the formation of bonded deposits have become so prominent that a better understanding of the underlying causes is essential. Since the summer of 1942 it had become more and more apparent that a change in the quality of the boiler fuel oil supplied was causing a good deal of difficulty in boiler rooms of ships of all classes of H.M. Navy. The author explains that this change was due to a change in the cracking processes in connexion with the production of aviation fuels. The consequence was that this grade of fuel oil, when contaminated with sea water and agitated by the motion of the ship, will readily form an emulsion so stable that separation does not take place under prevailing conditions. Any sea water with which the oil has come into contact will therefore remain in the oil and will consequently be introduced into the furnace when the sodium chloride content of the sea water will react with the silica and alumina of the firebrick at high temperatures. In the opinion of the author a higher grade quality of firebricks made from material found in this country may be likely to increase the resistance to normal wear and tear, but is not likely to offer greater resistance to the action of the sea water under high temperature conditions. Cases of firebrick failure due to excessive slagging are therefore likely to continue unless the entry of sea water into the furnace is eliminated.—*Paper by Eng'r Rear Admiral C. J. Gray, C.B.E., D.S.O. and Wycliffe Killner, R.N.S.S., read at a meeting of The Institute of Marine Engineers on January 13th 1948; Trans. I.Mar.E., Vol. 60, March 1948: No. 2, pp. 43-54.*

Sulphur in Diesel Oil

It is generally recognized that corrosion is one of the most fertile causes of wear in Diesel engine cylinder liners. Some interesting data bearing upon this question was given in a paper published in a recent issue of Transactions of the American Society of Automotive Engineers. Experiments were carried out on an engine having a single cylinder 5⅝ inch diameter with a piston stroke of 8 inch and the rate of wear was determined by a chemical analysis of the crankcase oil for iron content, it being considered that this method offers the best means for studying relative rates of wear as influenced by any one given variable. The results, it is stated, indicate that two distinct corrosive actions cause wear in a Diesel engine under normal operation, viz., the action of the sulphur and that of the carbonic acid formed by the condensation of moisture in the presence of CO_2. The tests were carried out at coolant temperatures of 100 and 160 deg. F., the wear being considerably greater at the lower temperature due to the fact that the dew point of the combustion gases correspond to a cylinder wall temperature in the region of 120 deg. F. The rate of wear increases with the sulphur content of the fuel, showing a marked increase when the sulphur content is in the region of 1·3 per cent. Neither nitrogen nor naphthenic acid was found to have any appreciable effect on the rate of wear. It is of interest to note that there is promise of the development of a lubricating oil which will largely offset the increase of wear due to sulphur in the fuel.—*Shipbuilding and Shipping Record, Vol. 71, 6th May 1948, p. 543.*

Method for Testing Wire Rope

Electromagnetic methods for testing steel wire ropes for flaws have been in use in England and Germany for many years, but cannot be said to be completely satisfactory. Among the various methods employed, that developed by T. F. Wall may be considered the best, and the Swedish apparatus described represents an improved version of this type. The sensitivity of the apparatus is exemplified by a diagram showing the indication obtained when testing a wire rope in which nine wires out of 224, that is, 4 per cent, were broken. While in this case the faulty wires were located on the outer periphery of the rope, the same result will obtain with the faults located in its interior. The apparatus permits the testing of wire ropes *in situ.* It can be operated by alternating current of 50 cycles frequency, but for laboratory tests a frequency of 20 cycles is preferable.—*S. Forsmark and D. Olsson, Teknisk Tidskrift, Vol. 78, April 1948, pp. 255-256.*

Causes of Cleavage Fracture in Ship Plates

This paper describes the various tests conducted at the University of California on flat steel plates containing severe notches. The tests were conducted under contract with the United States Government to determine the possible causes of brittle types of failure that occurred in several of the all-welded merchant ships during the war. Notched plates of various widths ranging from 3 to 108 inch were tested over a range of temperatures. Of the different lots of steel that were available three lots were of semi-killed ship quality steel, one lot was a nickel alloy, one lot was a fully killed steel, and one lot was a quenched and drawn steel. The maximum load, load at formation of first crack, load at failure, energy absorption to maximum load, the mode of fracture, reduction in area, and strain distribution were determined for all test specimens. Standard identification tests, as well as studies of crack speed and strain hardening were conducted as an auxiliary programme. It was found possible to produce, under controlled laboratory conditions, brittle cleavage fractures similar to those found in fractured plates from ships that failed in service. The temperatures at which the mode of fracture changed from a ductile shear type to a brittle cleavage type were determined for the several steels by tests on various widths of plate. The tests generally arranged the steels in the same order with respect to tendency toward embrittlement. The nominal strengths of the wider notched plates were found to be only a fraction of the strengths of the steels as indicated by standard tensile coupons. Speed of propagation of cleavage cracks was observed to range from about 6,000ft. per sec. to 200ft. per sec. in these tests. Micro-hardness surveys of fractured plate indicated that considerable local plastic flow may precede rupture by cleavage.—*A. Boodberg, H. E. Davis, E. R. Parker and G. E. Troxall, The Welding Journal, Vol. 27, April 1948, pp. 186s-199s.*

Factors Influencing the Weldability of High Tensile Alloy Steels, and a New Weld Cracking Test

The paper consists of a short review of the factors controlling the weldability of steel, together with an account of certain work carried out in connexion with the welding of armour type steel. After referring to the basic principles governing the weldability of steel, and describing the influences of alloying additions, the paper discusses the problem peculiar to deep-hardening steels, and summarizes current views on the causes of hardened-zone cracking. A detailed description is given of an improved welding test, and of some of the work carried out with it. The results of this work are then related to the theories already described.—*Paper by P. L. J. Leder, discussed in writing by The Institution of Mechanical Engineers.*

Stainless Clad Steel

The development of stainless-clad steels—steels in which the stronger backing, or boiler plate quality, is faced with a veneer of stainless steel—has been announced by Colvilles, Ltd., of Glasgow, whose technicians have been engaged for many years on the technical problems involved. The effect of this development provides steels which can now meet the requirements and be used in those circumstances which had previously demanded the use of stainless steel, and applied at a cost reported to be only 75 per cent of such stainless steels. The new steels are constructed by sandwiching a thin stainless veneer and a more solid boiler plate slab, which are rolled together after heating, thus achieving workable strength and complete surface protection. The weld achieved by this means is a permanent bond which permits cutting, shearing, machining or other fabrication. Welding can also be carried out although in this case some alteration in technique is involved. The principle use of the new steel—there are already many uses in view—will lie in those industries where protection against corrosion is vital.—*The Shipping World, Vol. 118, 28th April 1948, p. 444.*

Turbine Metallurgical Research

In a note on recent research activities, the British Thomson-Houston Co., Ltd. record that important investigational work has been carried out latterly on large rotor forging, in collaboration with the suppliers, in order to ensure the maximum possible freedom from defects. The elimination of hydrogen by the use of heat-treatment cycles and the determination and control of residual stresses in the forgings, have given very promising results. The supersonic flaw detector used in these investigations, together with a combined magnetic and fluorescent method of crack detection, has proved to be more sensitive than the straight magnetic test for revealing fine hair-line cracks in forgings. Problems in connexion with the choice of material for gas turbines have been investigated. As will be recalled, the gas turbine activities of the firm include a 1,200 h.p. set coupled to a 800 kVA alternator for ultimate installation in the Diesel-electric tanker "Auris". Great care had to be exercised in the selection of suitable alloys for the various parts, not only from the high temperature creep strength aspect required of the disks and blades in the h.p. rotor, but for resistance to attack at high temperature from combustion gases having high sulphur content. Numerous problems in the field of welding have also been met and overcome in this work. In the steam turbine field creep and stress relaxation properties of turbine bolt materials are being investigated, and for this purpose a stress-relaxation testing machine is being constructed in the firm's laboratory. The material at present most widely used for high temperature, high-pressure casing flange bolts, namely, a chromium-molybdenum steel, has certain disadvantages under modern stresses and temperatures. Results based upon ordinary creep tests indicate to B.T.H. that a molybdenum-vanadium steel will be satisfactory, and it is planned to make a series of stress relaxation tests on this class of steel.—*The Marine Engineer, Vol. 71, May 1948, p. 188.*

Water-cooled d.c. Generator

The British Thomson-Houston Co., Ltd., reports an interesting development in connexion with eleven 850 kW. turbo-driven d.c. generators for the P. & O. line. The design incorporates a closed air circuit with water cooler as a self-contained unit. The armature is excluded to provide free access to the brushgear, and, at the same time, to prevent carbon dust being deposited in the machine windings. The cooler is situated at baseplate level, thereby reducing the possibility of trouble arising from cooling water leakage. A further advantage is that the heat loss of the machines is taken away by the cooling water instead of having to be withdrawn from the engine room air.—*B.T.H. Activities, Vol. 19, Jan.-Feb. 1948, p. 268.*

Prevention and Extinction of Fires by Inert Gas

This article discusses the employment of boiler flue gases and exhaust gases of internal combustion engines as fire-extinguishing and fire-preventing medium in ships. The efficacy of exhaust gases in this respect is discussed with reference to British and American literature on the subject. Data on the quantity of gas required for specific purposes is given. A cargo space of 3,000 cu. m. containing cotton bales will require the emission of 3,600 cu. m. of CO_2, or 383 cu. m. of exhaust gas of a spark ignition engine, or 520 cu. m. of boiler flue gas, or 1,125 cu. m. of Diesel engine exhaust gas. The article includes the layout of a plant for the compression and discharge of 2,000 cu. m. per hr. of boiler flue gas to be installed in a tanker and to be used in port when atmospheric air enters the tanks during the process of discharging. This installation includes a gas washing plant and the requisite number of compressed gas bottles. In the case of a cargo vessel the installation will be equipped with a deodorizing plant consisting of an activated carbon filter. From 150 kg. of fuel oil fired 2,000 cu. m. of protective gas can be obtained. Reference is made to a special type of undulated cylindrical compressed gas container to be used in place of the usual type of compressed gas bottle. It is claimed that the employment of the undulated type, manufactured by a French company, will lead to a better space utilization and simplified piping layout, although the weight of plant is the same.—*H. Faure, Le Genie Civil, Vol. 125, 1st April 1948, pp. 129-133.*

Demag Electric Cranes

The substitution of cranes on board ships for cargo winches and derricks has been suggested as a means for speeding-up the loading and unloading of cargo, and it appears that this is by no means a new idea. As far back as 1880 hydraulic cranes of the Brown type were installed on the steamship "Quetta", and it is stated that on one occasion 1,300 tons of vargo were worked through two hatches in ten hours—a remarkable performance. Hydraulic cranes, in spite of being speedy and silent, have gone out of general favour. Except for certain specific trades steam cranes were never very extensivly adopted, while the use of electric cranes was confined more or less to the ships of the Hugo Stinnes line before the war. An American report on "Cargo Cranes Constructed by Demag" (of Duisberg) has been published, and here the advantages and disadvantages of the electric crane are discussed. These Demag cranes, which are designed for a working load of three tons, have a maximum radius of 46 feet, and are generally installed between two hatches, so that they can serve both. A feature of the design is that the load remains at the same height irrespective of the angle of the jib, so that once the operator has raised the load to the desired height, he can manœuvre it with facility. —*Fairplay, Vol. 170, 22nd April 1948, p. 990.*

ENGINEERING ABSTRACTS

Section 3. SHIPBUILDING AND MARINE ENGINEERING

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Some Recent Advances in Mechanical Engineering on Shipboard

This paper deals with the development of geared-turbine machinery for typical North Atlantic liners. The ships referred to are the "Franconia", "Duchess of Bedford", "Empress of Britain", "Queen Mary", "Queen Elizabeth" and "Caronia". Referring to the latter vessel which will shortly be completed, the author points out that the machinery of this ship was designed immediately following the 1939-45 war and marks another advance in mechanical engineering on board ship. The steam pressure in this vessel is 600lb. per sq. in. and the temperature is 800 deg. F. The arrangement of the main machinery in the "Caronia" is shown in Fig. 12. The vessel is seen to be driven by two shafts each shaft being driven by three turbines. The high pressure turbines of the "Caronia" drive the propeller shafts through double-reduction gearing. The reduced size of high-pressure turbine which can be fitted at the increased rate of revolutions possible with double-reduction gearing, is of great advantage at the higher steam pressures and temperatures adopted in the "Caronia". The gear teeth of the high-pressure primary pinion and gear wheel are of the "all-addendum" type, i.e. the pinion teeth are all addendum and the wheel teeth are all dedendum. The low pressure turbine casings and gear cases are of fabricated construction. The bearing housings are made of cast steel and the remainder is built up of welded steel plates. By adopting this method of construction a considerable saving in weight is effected. Steam is supplied for main and auxiliary purposes by six water-tube boilers of the Yarrow double-flow type similar to those fitted in the "Queen Mary" and "Queen

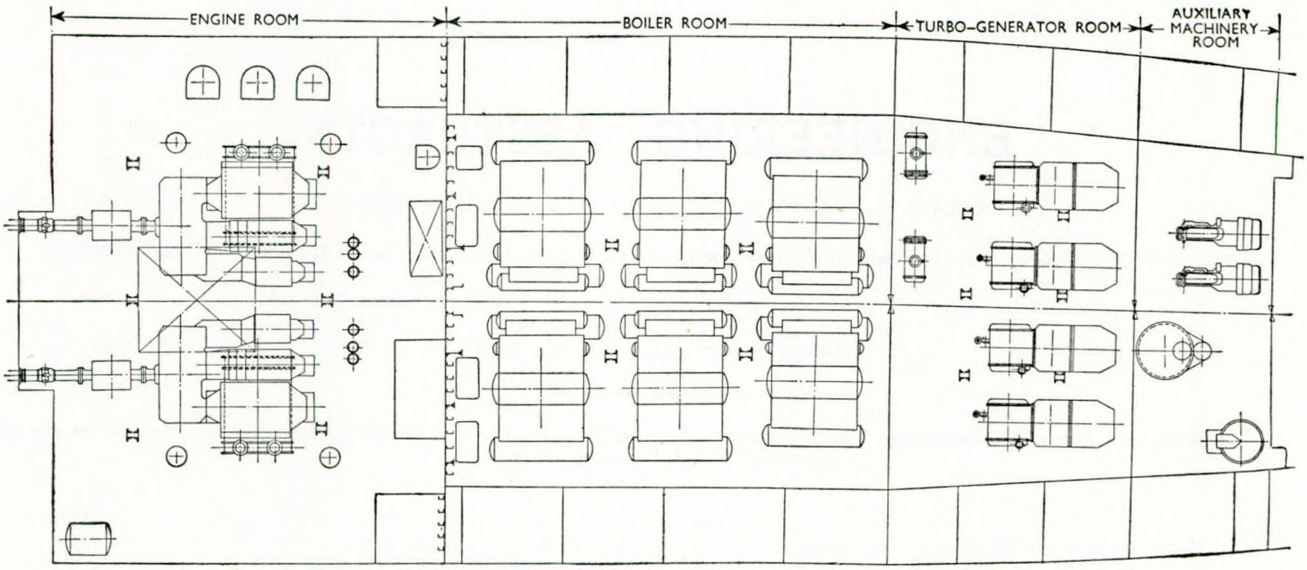
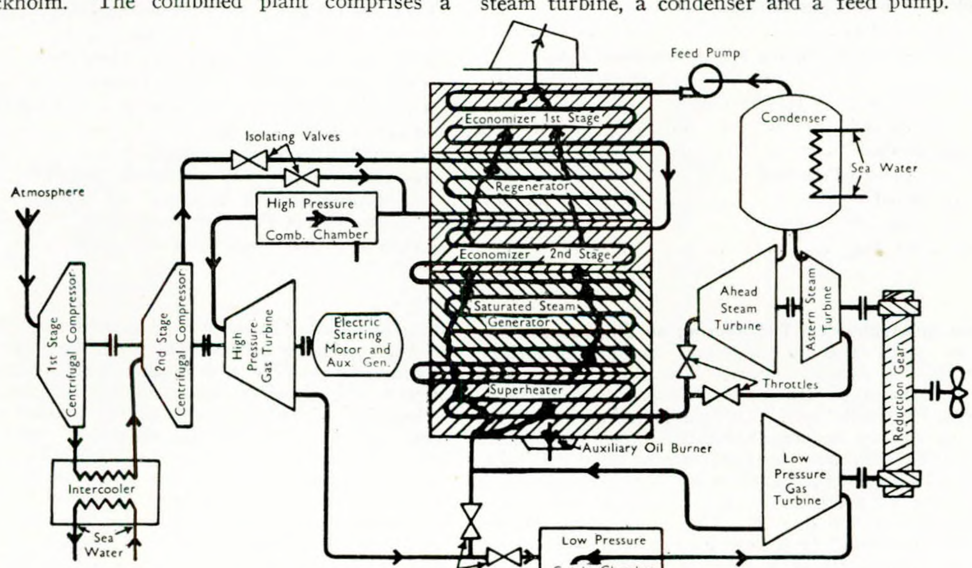


FIG. 12.—*Arrangement of machinery of T.S.S. "Caronia"*

Elizabeth" except that the boiler drums are of all-welded construction. The superheater drums are made from solid-drawn tubes with closed-in ends. Rotary regenerative air heaters of the Howden-Ljungstrom type are fitted. The supply of low-pressure steam for heating purposes is obtained by bleeding the turbo-generators, and not by fitting desuperheaters and reducing valves, as in the "Queen Elizabeth". In the "Caronia", only one funnel and funnel hatch is fitted; unlike those of the "Queen Mary" and "Queen Elizabeth", the boilers operate on the closed trunk system of forced-draught with open stokeholds and induced draught fans. The turbo-generators of the "Caronia" are of special interest, because they are the first pass-out turbo-generators to be fitted on board a British ship. These generators take boiler steam at 600lb. per sq. in. and 800 deg. F., and steam is bled from the turbines at 60lb. per sq. in. for thermotank heating, calorifiers, galleys, etc.—*Paper by T. A. Crowe read before the Institution of Mechanical Engineers at the Glasgow Summer Meeting on 15th June 1948.*

Combined Gas and Steam Turbine

Experimental work has lately been carried out in connexion with a proposed combined gas and steam-turbine system for marine propulsion, for which a special degree of reliability, flexibility and manoeuvrability is claimed. It has been developed by Aktiebolaget de Lavals Angturbin, Stockholm. The combined plant comprises a geared steam-turbine unit of approximately one-half the required shaft-horse-power, plus a gas turbine which not only develops the remaining 50 per cent of the output but provides the hot gases for the boiler, first for superheating the steam, secondly for generating saturated steam, and finally for regeneration in the gas-turbine cycle and feed-water heating in an economizer. The steam plant is equipped with an astern turbine, and with this plant isolated, the ship can be manoeuvred in a similar manner to any geared turbine vessel. Under these conditions the boiler is oil-fired. The arrangement of the various units may be examined from the layout diagram. The h.p. gas-turbine group comprises a two-stage air compressor, fitted with intercooling, a regenerator, a combustion chamber, a high-pressure gas turbine, and a combined electric-starting motor and generator. The air compressor is of the centrifugal type, with which an adiabatic efficiency of 80 per cent is anticipated. The compression is carried out in two stages to allow for intercooling. Sea water is used as the cooling medium in the intercooler. The regenerator is integral with the steam boiler. The gas turbine is of the reaction type with an efficiency of 83 per cent; the starting motor is a direct-current unit serving also as a generator to provide power for electrical auxiliaries at sea. The low-pressure gas-turbine group consists of a combustion chamber and gas turbine, the latter being of the reaction type, with an efficiency of 83 per cent. The steam group comprises a boiler, economizer and regenerator, an ahead steam turbine and an astern steam turbine, a condenser and a feed pump. The boiler generates



General arrangement of the layout of a combined marine gas and steam turbine installation steam, either from the exhaust gases of the gas turbine or from oil-fired burners, or from a combination of the two heat sources. The hot gases entering the boiler pass first over the superheating tubes, next over the saturated steam generating tubes, then through the second stage of the economizer, the high-pressure gas turbine group regenerator, and finally through the first stage of the economizer to the funnel. The ahead steam turbine has an efficiency of 78 per cent, and the astern steam turbine is of the impulse type. It is claimed that the overall thermal efficiency is approximately 33 per cent.—*The Motor Ship, Vol. 29, No. 341, June 1948, pp. 114-115.*

Diesel Research Aided by Exhaust Condenser

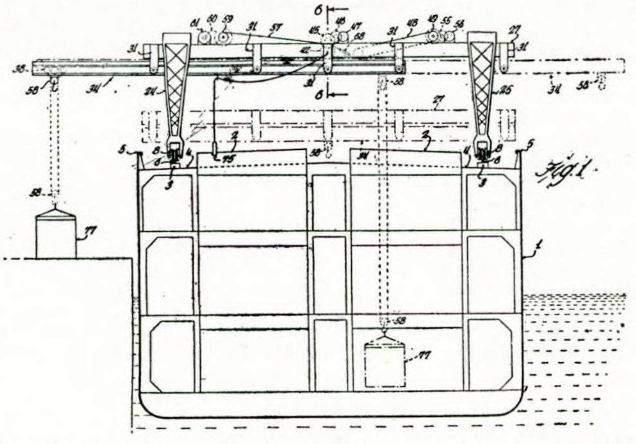
Diesel-engine research is being aided by a newly developed short-cut for evaluating the end products of combustion. A condensing system is used to cool and condense the entire exhaust from the engine so that the cumulative amounts of small fuel fractions (which would normally elude the investigator of single combustion cycles) can be collected, weighed and analysed. Results are obtained quickly, with the burning of very little test fuel, as compared with earlier test methods. The apparatus consists of a large condensing system which cools the exhaust down to −10 to 0 deg. F. The exhaust is piped from the engine to a surge tank to reduce pressure pulsations. Then it passes through two large stainless-steel condensers. Each condenser consists of an inner well with a spiral cooling fin that fits into the condenser. The water vapour resulting from combustion is condensed and collected on the surfaces of the condenser which are cooled by a mixture of dry ice and naphtha in the well. Some of the water runs out of the first condenser into a drain bottle, while the remainder freezes on the cold surfaces. The gases also pass through two small condensers of similar construction, although by this time they have lost most of the water and heavy vapours. A small amount of material collects on a cloth filter at the outlet of the condensing system. The solid material is collected primarily in the surge tank and the first two condensers, although a little may continue through the system to the filter, to be collected there. Test data indicate that in a normally loaded engine the liquid component of the exhaust decreases with increased fuel/air ratio or load. The solid content, however, either remains nearly constant or increases slightly, with an increase in fuel/air ratio until the smoke point of the engine is reached, when a large increase in solids occurs.—*SAE Journal, Vol. 56, May 1948, pp. 43-47.*

4,500 b.h.p. Gas Turbine on Boiler Oil

The 4,500 b.h.p. gas turbine which has been developed by the General Electric Co. of America has run trials totalling over 300 hours, and it is stated that during more than half this period the machine has operated on Bunker C fuel. This set runs at 6,700 r.p.m.—*The Motor Ship, Vol. 29, No. 341, June 1948, p. 104.*

Improvements in Cargo Hoists

This invention relates to an improved cargo hoist for ships for lifting cargo from alongside the ship to within the hold or *vice versa.* The cargo hoist proposed incorporates the principle of horizontal movement on track and of hoisting and lowering therefrom; at the same time it dispenses entirely with any structure which need remain aloft while the ship is at sea. It has the additional advantage of mobility permitting its movement fore and aft for utilization above



a plurality of hatches ranged lengthwise of the ship. Moreover it may be readily used to lift or lower on either side of the vessel and all its motions may be conveniently controlled from positions permitting full observation of the load being handled. As will be seen from the accompanying illustration, the hoist includes two pairs of trucks which can be shifted on the respective runways fore and aft on the deck of the vessel. To each pair of these trucks are pivotally connected the lower ends of a pair of shear-legs which at their upper ends are pivotally connected. This enables the hoist to be brought in the lowered position while the ship is at sea and the cargo hoist is not in use. In this position the cargo hoist occupies a favourable position with regard to disposition of weight upon the ship and windage is substantially reduced. Visibility is also little impaired when the hoist is in the lowered position. The hoist is brought into the operative position by bringing the trucks simultaneously together to raise the hoist to the position shown in full lines.—*British Patent No. 598580, issued to Harnischfeger Corporation, Milwaukee, Wisc., U.S.A. The Shipping World, Vol. 118, 12th May 1948, p. 480.*

New Type of Hatch Cover

The new Burmeister and Wain hatch cover is adapted to all sizes of hatch and when handled by the deck winches can be opened or closed in about half a minute. The covers are of rectangular section and are plated at the upper and lower sides to obtain the maximum modulus of strength. They are capable of turning on a shaft mounted with rollers approximately in the middle of the covers, and these are joined together by hinges fitted with double pins. It is stated that these hatches cannot be crushed or lifted out of the hatchways by the action of the sea. They can be opened separately, one or more at a time, when the pins of the hinges are taken out.—*The Motor Ship, Vol. 29, May 1948, p. 59.*

Monel Shaft Sleeves on Army Dredges

The article reports experience in the use of Monel shaft sleeves in sea-going hopper dredges, which operate under severely corrosive and abrasive conditions. The adoption of centrifugally cast Monel sleeves with cutless rubber bearings has substantially solved the problem of frequent replacement, since the Monel sleeves give an average life three times that of any sleeve material previously used. Production of Monel sleeves for four dredges recently ordered by the U.S. Army Engineers is described and illustrated.—*The Nickel Bulletin, Vol. 21, March 1948, p. 37. (Abstract from Pacific Marine Review, June 1947.)*

Longitudinal Vibration of Marine Propeller Shafting

The author gives detailed account of cases in which longitudinal vibration of the propeller shafting has been the cause of seizure, serious scoring and excessive wear in the flexible couplings of naval vessels and has in some cases given rise to unacceptable vibration of the bridge structure. Other defects such as difficulty in retaining stern gland packing, wear and loosening of stern tube bushes and loosening of rivets in thrust block seats have been attributed to the same cause. In three- and four-shafted ships the vibration is aggravated when turning because the blades of the inner propeller on the outside of the turn cut into the slip stream of the outermost wing propeller. It has therefore been necessary in the majority of cases to reduce the power on the outermost wing shaft when turning at high speed, a procedure which introduces difficulties in control and reduces manœuvrability. The author relates how theory suggested that the vibration was magnified by resonance between the natural frequency of the system and the impulse arising from the number of blades on the propeller, and predicted that the amplitude would be reduced to an acceptable figure by changing the number of blades. Details are given of the vibration trials carried out to confirm the theory, and it is seen that the predicted improvement is, in fact, achieved. The trial results are utilized to yield fundamental data as to thrust block flexibility, entrained water, thrust variation, damping factor, and the effect of turning. Using this information complete calculations are set out for a particular line of shafting, showing the effect of two possible thrust block positions and of using three- or five-bladed propellers. A second example treats the case of a very long shaft and shows that there is a need for further data. The author established two sets of general principles to be applied, one to the curing of trouble in existing ships, and the other to its prevention in new construction.—*Paper by C. P. Rigby, Trans. I.Mar.E., 1948, Vol. 60, No. 3, pp. 67-90.*

Vibration Generator

The construction and operation of a vibration generator capable of exerting forces up to 44,000lb. and used by the U.S. Navy Department to investigate the dynamic characteristics of ships, bridges, and similar large structures is described in a report prepared in 1947 by E. O. Berdahl of the David Taylor Model Basin o fthe U.S. Navy Department, Washington, D.C. The U.S. Navy acquired the generator from the Losenhausen Works in Dusseldorf, Germany, in 1931. The use of vibration generators to study the elastic characteristics of ship structures was suggested by German experience in the late 1920's, the report states. The Germans mounted and operated the generators on ships, setting them in resonant vibration so that the relative stiffness of the structure could be determined with appropriate recording devices. If the natural frequency and corresponding stiffness of the ship were found to be lower than estimated satisfactory values, it was concluded that either the ship's joints were not sufficiently rigid or there was a defect in the design or construction of the vessel. The generator, described in the report as "capable of producing large vertical sinusoidal forces at low frequencies", weighs 49,000lb. It has an accompanying control apparatus weighing an additional 500lb. The equipment has suitable lugs for handling with a crane. The vibrator develops a vertical sinusoidal force with a maximum single amplitude of 44,000lb. at speeds from 105 to 480 r.p.m. It will generate a comparable maximum force of 11,700lb. in the same direction at its lowest running speed of 54 r.p.m. The machine consists of two parallel shafts geared together by two large single-helical gears, one on each shaft. The arrangement ensures synchronous rotation of the two main shafts in opposite direction. Each main shaft is driven by a direct current motor through one or two alternate reduction gear trains with speed ratios of either 6/1 or 16/1. Each shaft carries a 6,000lb. eccentric which may be adjusted to various amounts of unbalance. The machine produces a sinusoidal force perpendicular to its base (the base must always be horizontal). The magnitude of the maximum exciting force developed is directly proportional to the amount of unbalance. In operation the vibrator is run at resonance while the structure under study is explored with instruments to determine its mode of vibration. Notably, the generator is used to determine the dynamic characteristics of structures with low natural frequencies. On ships it can simulate exciting forces of the shaft frequency and to some extent blade frequency indicating the approximate resonance frequencies likely to be excited in the operation of the ship. By varying the speed of the generator, the resonant frequencies of the hull, and local resonances as well, can be determined, making it possible to anticipate and avoid undesirable resonances in the structure.—*Marine Engineering and Shipping Review, Vol. 53, No. 4, April 1948, p. 71.*

Small Model Experiments and Viscosity Effects

The application by Mr. W. C. Wigley of viscosity corrections to wave resistances and profiles for models of the order of 16 feet in length, raises a question which this paper attempts to answer, namely, whether there is a scale effect. This could most satisfactorily be answered by using very large models, e.g., four times the linear scale. Such tests being impracticable, the writer has repeated on the 4-feet scale a few selected experiments. Those described consist of (a) measurement of the resistances of an unsymmetrical model with full and fine end leading (and hence the Ⓒ difference when the direction of motion is reversed), and (b) plotting of the wave profile of a simple symmetrical 4-feet model by photography. The reversal tests show that the Ⓒ difference becomes nil at substantially the same relative speed as that found for the 16-feet model, and the profile tests agree closely with the 16-feet results. These experiments indicate that the viscosity effect on the wave formation is nearly independent of scale —a matter of considerable practical importance. Fig. 9 of the paper shows the residuary Ⓒ resistance of 4-feet and 16-feet models in both directions on a base of $f=v/\sqrt{gL}$, with the Ⓒ differences inserted using a larger Ⓒ scale.—*Paper by R. T. Shiells, read before the Institution of Naval Architects, at the Spring Meeting, 17th-19th March 1948.*

Calculations Illustrating the Effect of Boundary Layer on Wave Resistance

The main object of this paper is to examine the possible effect of the boundary layer in producing a virtual modification of the lines of the ship near the stern. This is regarded as a deflexion of the streamlines due to increased displacement thickness of the boundary layer in this region. By superposing a source distribution to produce this additional deflexion, expressions can be obtained for the modified wave resistance. No attempt is made to attack the problem directly for actual ship forms. Instead, an indirect method is taken of considering some ideal simple forms and assuming small modifications of the lines near the stern such as might reasonably be ascribed to boundary layer effects. It is shown that such variations suffice to eliminate the humps and hollows on resistance curves at low speeds while making relatively much less difference at high speeds, a result which would improve the general comparison between calculated and measured wave resistances. The paper also includes some remarks on experiments with plank-like forms which are not wholly submerged, and an attempt is made to assess numerically the wave-making resistance in such experiments on skin friction.—*Paper by Professor T. H. Havelock, read before the Institution of Naval Architects at the Spring Meeting, 17th-19th March 1948.*

Unusual Welding Stresses

When the British Engine, Boiler and Electrical Insurance Co., Ltd., was called upon to investigate the failure of some main steam pipes, a dangerous practice in welding was discovered. In the course of the examination some light-coloured areas were noticed which appeared to be weld metal, and it was subsequently found that an operator, in welding on flanges or a branch, had hit the surface of the pipe with the end of his electrode in order to break off the slag. When this was done, beads of weld metal adhered to the pipe, and cracks were intially caused by contraction of the hot weld metal deposited on a cold surface. It is pointed out by the company that, when the parent metal is cold, a globule of molten metal penetrating below the surface is quickly chilled by the surrounding metal, and in doing so endeavours to contract radially on planes parallel to the surface. Free contraction, however, is prevented by the rigid surrounding metal, and a radial tension is therefore set up between the two metals. Although other factors enter into the problem, such as the temperature gradient and the varying properties of the metals with temperature, it is easy to see how an appreciable tangential tensional stress, leading to extensive radial cracking, can result. This, in fact, is what happened, resulting in failure of steam pipes after about five years' service.—*The Journal of Commerce, Shipbuilding and Engineering Edition, 6th May 1948, No. 37502, p. 6.*

Shipyard Management of Welding

In this paper the author makes particular reference to the practical and economic aspects of welding in shipyards. With one exception no cracking or any trouble with welding was experienced in the shipyard referred to by the author. The cracking experienced occurred on the welded seam of a $1\frac{1}{4}$-inch engine bedplate when welded to the 0·5-inch tank top plating. Much thought was given to the cause of this rather puzzling type of crack and to the action to be taken. Examination of the plate material proved this to be free from defects; and the explanation given is that at the time of welding a very cold N.E. wind was blowing and owing to a shell plate not being erected the engine seat was subject to a very cold and forceful draught. The conclusion arrived at was that the different rates of longitudinal contraction, i.e. the thin plate cooling quicker than the thicker plate, very much accentuated by the cold wind, were the cause of these cracks, or the sudden local application of heat which occurs in welding may have been sufficient to cause the crack in the very cold parent metal, which would run into the weld metal as it contracted on cooling. The job was successfully rewelded by pre-heating and maintaining the heat in the thin plate during and after welding, so that both plates cooled together. Other subjects dealt with by the author are economic aspects to be considered with respect to the relative values of riveting and welding before deciding to weld a particular job. A comparison of all welded and riveted engine seating is given and the future of welding in shipbuilding is discussed. The author believes that the amount of welding done on a vessel in future depend upon (a) the service for which it is intended, (b) the cost of building including allowance for extra deadweight carried, and (c) the availability of repairs.—*W. R. Mellanby, Transactions of The Institute of Welding, Vol. 11, No. 2, April 1948, pp. 52-62.*

1,520 b.h.p. Geared Diesel Installation

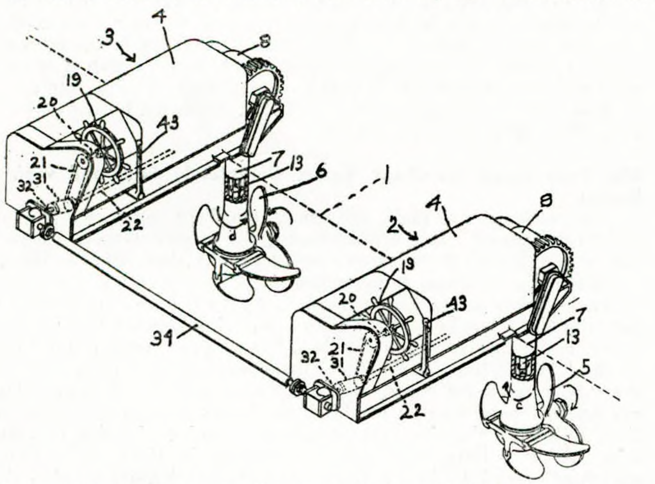
Although a considerable number of geared installations with engines of the Polar type, built in Sweden, have been made, this development has not occurred in mercantile ships in Britain, and plant of the type recently completed is, therefore, of special interest. It comprises a 1,520 b.h.p. Polar engine, constructed by British Polar Engines, Ltd., Glasgow, coupled to a single-reduction gearbox through an electro-magnetic slip coupling, the gear ratio being 2·86 to 1. The engine has eight cylinders with a bore of 340 mm. and a piston stroke of 570 mm. and the power mentioned is developed at 300 r.p.m., with an overload capacity of 10 per cent for one hour. The installation is for a collier now being built. A B.T.H. electro-magnetic slip coupling is utilized, the inner and outer parts being built up of structural steel plates and bars, fabricated by welding and annealed before machining. The slip is 1·5 per cent at full output and the coupling absorbs 15 kW. at 220 volts. The reduction gear, manufactured by David Brown and Sons, Ltd., is of double-helical construction and of alloy-forged steel. The rim of the wheel is shrunk on to a cast-iron centre carried on a carbon-steel shaft, and the gears have a working face of 33 inch. A Michell thrust bearing is provided for the output shaft. A fabricated gearcase in two portions is used, the bottom portion being of box section. The bearing housings are of cast steel and are welded in, being fitted with white-metal-lined forged-steel bearing shells. The gears are lubricated through a pump driven from one end of the output shaft and, in addition, there is a stand-by electrically operated pump, which is started up before the gearbox and continues running until a pressure of 10lb. per sq. in. is reached in the lubricating system. The engine is a standard Polar two-stroke single-acting design, provided with rapid manoeuvring gear for increasing the speed of reversing. Compressed air is supplied to the pistons operating the cylinder compression-release valves, which are opened at the top of the compression stroke as long as the engine is turning in the reverse direction to that desired. The compression thus acts as a brake in the cylinders in which the pistons are ascending. An opposed-piston double-acting type of scavenging pump is employed and a starting-air compressor is fitted on the top of the pump. Of the two lubricating-oil pumps, one draws oil from the drain tank and discharges to the main lubricating-oil tanks and the other forces the oil through the filter and oil cooler to all the principal bearings and piston crowns. The engine has attached cooling water and bilge pumps of the double-acting-plunger type, driven from eccentrics on the scavenging-pump crankshaft.—*The Motor Ship, Vol. 29, June 1948, p. 94.*

An Eight-cylinder 20,000 b.h.p. Engine

The last of the series of eight engines, each developing a maximum of 20,000 b.h.p. intended to replace the existing machinery in the Italian passenger liners "Roma" and "Augustus", carried out trials at the Fiat Works recently. This type has twelve cylinders 650 mm. in diameter. Six similar units, but with ten cylinders, are being built for the three 20-knot passenger and refrigerated cargo liners under construction in Italy for the Flota Mercante del Estado Argentino.—*The Motor Ship, Vol. 29, June 1948, p. 102.*

Improved Propeller Mechanism for Barges

This invention relates to propeller mechanism for barges and similar boats, and particularly to propeller mechanism of the known type in which the propeller is carried at the lower end of a vertically extending propeller housing member which is mounted to be turned by the steering mechanism about a vertical axis for steering the boat, and in which the propeller is driven by a vertical shaft within the housing. In propeller mechanism of this type the transmission of power through the vertical shaft to the propeller produces a turning moment on the propeller housing which tends to turn it about its vertical axis in the same direction as that in which the shaft is turning. This turning moment is resisted by the steering mechanism and thus puts an added load on the latter when it is actuated to steer the boat in one direction and assists the steering operation when the



steering mechanism is operated to turn the boat in the other direction. This adds to the difficulty of steering because it makes the steering of the boat in one direction much harder than in the opposite direction. It is one purpose of this invention to provide a novel propeller mechanism for barges and other boats having twin unit propeller mechanisms which are so arranged that the turning moment on the propeller housing of one propeller unit is balanced by that of the other propeller unit, thereby making the steering of the boat in one direction as easy as in the other direction. A further object of the invention is to provide a twin unit propeller mechanism in which the steering mechanism of the two units is coupled together so that the two propeller housings can be simultaneously operated for steering the boat. It is also an object of the invention to provide a novel twin-unit propeller mechanism which is so constructed that its entire operation can be controlled from either unit. The invention is adapted for use in connexion with propeller mechanisms comprising two separate propeller units, each having its own power source, propeller and driving connexions between the motor and propeller, and also in connexion with mechanisms in which both propellers are operated from the same source.—*British Patent No. 598598 issued to Murray and Tregurtha, Inc., Quincy, Mass., U.S.A. Complete Specification accepted: 23rd February 1948. The Shipping World, Vol. 118, 26th May 1948, p. 518.*

Maintaining Temperature in Gas Turbines

An arrangement for maintaining a constant temperature in gas turbines, notwithstanding rapid changes of load, is illustrated in Fig. 3. Air from a low-pressure compressor (1) passes through a cooler (2) into a high-pressure machine (3) and thence through a heat exchanger (5). The major part of the supply then passes into a gas heater (10) and is delivered to a turbine (13). A certain amount of air is extracted

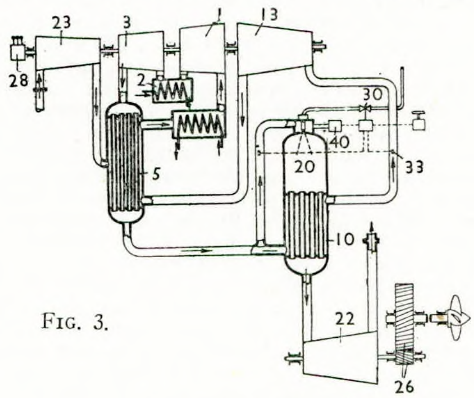
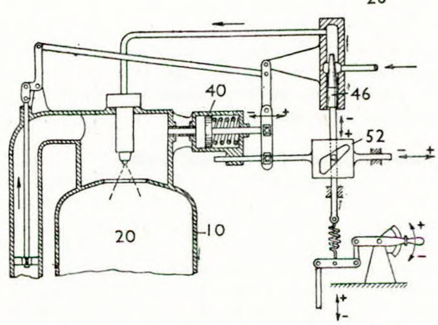


FIG. 3.



from the circuit and is passed to the gas heater (10) as combustion air, the gases being supplied to the turbine (22). The make-up supply is obtained from the atmosphere through a compressor (23). The compressors (1, 3, 23) are driven by the turbine (13), while the turbine (22) drives a variable-pitch propeller through gearing (26). An electric motor (28) is used to start the machinery. The fuel-regulating device (30) is adjusted by a temperature impulse transmitter (33) and a pressure impulse transmitter (40) is connected to the combustion chamber (20) of the gas heater (10). If the temperature of the heated gas rises above normal, the transmitter (33) displaces the valve (46) and the fuel supply is decreased. Adjustment of the valve (46) is determined by a curved opening in a plate (52). (Patent No. 594,309. R. Strub, La Chaux-de-Fonds, Switzerland.)—*The Motor Ship, Vol. 29, June 1948, p. 120.*

First Gray-Polar Geared Diesel Installation

Two tankers will be built by William Gray and Co., Ltd., West Hartlepool for S. G. Livanos and Co. Each of these tankers will be equipped with two Gray-Polar five-cylinder engines of 2,000 b.h.p., driving one propeller through hydraulic couplings and gearing. They will have cylinders 500 mm. in diameter with a stroke of 700 mm., the speed being 250 r.p.m. The following are the main details of these tankers: length b.p., 470 feet; breadth moulded, 62ft. 6in.; depth, 34ft 6in.; deadweight capacity, 12,000 tons; corresponding draught, 27ft. 6in.; speed on trials, 13 knots. In addition, Van Nievelt Goudriaan and Co.'s Stoomvart Mij., Rotterdam, have contracted with the same builders for a 9,200-ton cargo liner; in this case the owners will supply a 3,200 b.h.p. Stork engine, a six-cylinder single acting two-stroke unit with cylinders 700 mm. in diameter with a piston stroke of 1,200 mm. The details of the vessel are as follows: length, 435ft.; breadth, 59ft. 6in.; depth, 36ft.; draught, 24ft. 6in.; service speed, 12 knots.—*The Motor Ship, Vol. 29, May 1948, p. 78.*

Japanese Naval Diesels

The British Intelligence Objectives Sub-Committee in a report on "Japanese Navy Diesel Engines" comes to the conclusion that the Japanese engineers and designers showed a marked lack of originality in dealing with the problem of new designs. The number of models standardized for production on a large scale was restricted to five, these being copied from European design and modified where necessary to meet Japanese requirements. A description of each of these types, with detailed performance data is given and a study of this data shows that not one of the designs could be regarded as being in any way outstanding. Among the engines which did show a definite degree of originality was a compound Diesel of which two experimental units were made. It did not, however, reach the production stage. The smaller of the two, of which a sectional elevation through the cylinders is given in the report, comprises two high pressure cylinders each 100 mm. (3·94 inch) diameter with a piston stroke 200 mm. (7·88 inch) which exhausted into a single low pressure cylinder 200 mm. diameter having a piston stroke of 250 mm. (9·85 inch). In all three cylinders there is a compression and an expansion process, but while the h.p. cylinders operate on the four-stroke cycle, in the l.p. cylinder, a two-stroke cycle is employed. The engine was designed to develop 210 h.p. at a speed of 1,500 r.p.m., but owing to combustion difficulties not more than 150 h.p. was obtained. Apparently the transfer valves were a source of trouble because of the high temperature of the exhaust from the h.p. to the l.p. cylinders which, it is stated, were of the order of 1,200 to 1,300 deg. F. An additional diagram of these valves together with a chart of the working process in the engine is given which shows that when the l.p. pistons are at the bottom of their respective cylinders, one h.p. cylinder is just completing its suction stroke whereas the other is just beginning its exhaust stroke. On the upward stroke of the l.p. piston the scavenging air is forced into one of the h.p. cylinders and it is only as the l.p. piston reaches the top of its stroke that the transfer valve on one h.p. cylinder is shut and the other opened, thus allowing the exhaust from that cylinder to pass to the l.p. cylinder to yield its power stroke. It will be agreed that the fundamental idea in the design of this engine is ingenious, but only prolonged experiment could reveal whether a commercially practicable engine could be developed working on this principle.—*Shipbuilding and Shipping Record, Vol. 71, 13th May, 1948.*

Pulsating Combustion of Pulverized Coal

It has long been known that the combustion velocity of pulverized coal rises with increasing fineness of the pulverized product. But in spite of an increasing surface/volume ratio with progressing combustion, the speed of the combustion reaction does not rise but actually decreases, as the formation of a layer of products of combustion prevents the access of oxygen to the particle surface. This difficulty can be overcome by imparting to the fuel particles a relative motion with respect to the combustion air, so that the combustion products are swept away and the oxygen molecules are given access to the particle surface. Production of turbulence in the furnace by jet action is unsatisfactory and also requires large amounts of excess air. A better method is the employment of tangential corner firing which produces centrifugal action. An observation of comparatively recent date is the favourable effect upon combustion exerted by acoustic vibrations.

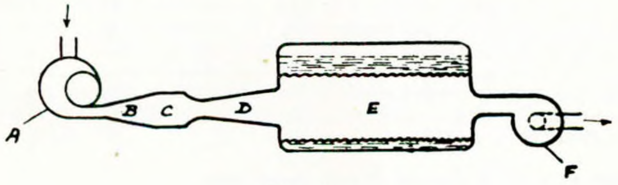


Fig. 1.

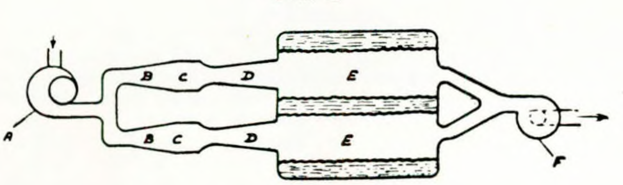


Fig. 2.

The latter produce a relative movement between the fuel particles and the gas, the vibrations constituting a stationary oscillation of the gas in the furnace cavity. An especial advantage is that these oscillations extend through the entire furnace volume and are not limited merely to part of it. These oscillations can be produced by the pulverized coal burner by operating it on the principle of the "singing flame". The oscillations can be intensified by providing for a resonance effect of the gas columns. Even automatic aspiration can be obtained in this way by using conical gas throats so shaped that they offer a greater flow resistance in one direction than in the other. The oscillations produced will also serve to improve the heat transfer to the furnace walls. A burner and furnace operating according to

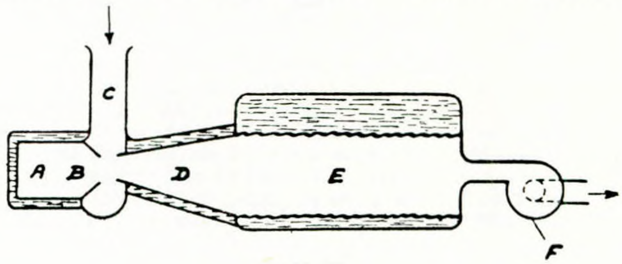


Fig. 3.

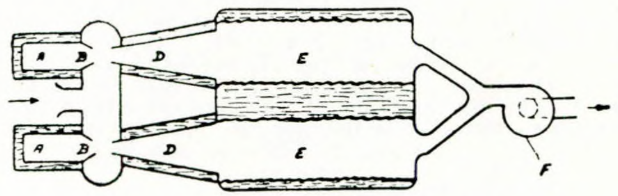


Fig. 4.

this system are outlined in Fig. 1. Here the blower A delivers the pulverized coal-air mixture into a pre-combustion chamber C in which combustion of the volatile constituents is effected. This chamber is refractory-lined so as to safeguard ignition. The conical passages B and D offer a smaller flow resistance in the direction of the furnace, and thus enhance the fan effect. In the furnace E the gas column is in resonance with the oscillations and the coke particles are subject to the resultant scavenging effect. The flue gases are subsequently discharged into a cinder catcher F and then into some other suitable heat exchanger. A duplex system of this kind is shown in Fig. 2. Cyclic precompression and expansion of the gases is produced in the arrangement shown in Fig. 3, where A is a water cooled combustion chamber with a throat B. The fuel-oil mixture is introduced at C and passes into the combustion chamber A, from which it is cyclically ejected into the diffusor D and to the furnace E. A duplex system of this type is outlined in Fig. 4.—*F. H. Reynst, Chaleur et Industrie, Vol. 29, March 1948, pp. 74-76.*

The First Large Merchant Vessel Completely Equipped with Velox Boilers

In addition to high efficiency, excellent manoeuvrability, low weight and small space requirements, the Brown Boveri Velox boiler can be put in or out of service more rapidly than other boilers. This advantage is of great importance on ships operating over relatively short distances as the losses involved by such boiler equipment during the frequent stops in port are very low. This was the main reason why Velox boilers were chosen for the 2,500 s.h.p. passenger ship "Bore II" of the "Angfartygsaktiebolaget Bore" shipping company operating on the Abo-Stockholm route, which between periods of twelve hours at sea has to spend twelve to thirty-six hours in port either at Abo or Stockholm. This, the first merchant vessel to be fitted exclusively with Velox boilers, was put into service in 1939. The first large merchant vessel to be equipped with Velox boilers is also destined for service over relatively short routes. This is a 2×7,250 s.h.p. ship of the Cie Générale Transatlantique for service on the Marseilles-Algiers route. It is propelled by geared turbines. Three Velox steam generators each built for an evaporation of 30 tons per hour at 56 kg. per sq. cm., 480 deg. C. and 90 per cent efficiency at full load were ordered for this ship from the company's concessionaire in France, the Cie Electro-Mécanique, Paris. The charging sets are started electrically, while the auxiliary pumps are also driven by electric motors. Alternating instead of direct current is provided for the ships auxiliary power network, the supply being at 380 volts and 50 cycles. The Velox boilers, which are designed for crude oil firing, are equipped with separate, vertically arranged superheaters. A regulating evaporator, connected in parallel with the superheater, maintains the superheat within the permissible limits during manoeuvres. The Velox boilers are built in accordance with the specifications laid down by Bureau Veritas. The Velox boilers and the propulsion turbines are merely separated by a non-watertight bulkhead and so form a power generating unit. The steam pipes are thus much shorter and the arrangement of the propulsion plant more convenient. This, together with the automatic boiler regulation, which has proved most satisfactory both in marine plants already delivered and on over eighty Velox boilers in land stations make it possible to operate with less personnel than with other types of boilers.—*Th. Egg, Brown Boveri Review, Vol. 34, Nos. 4/5, April/May 1947, pp. 94-95.*

Shaw Savill's New Steam Tonnage

The decision of the Shaw Savill and Albion Co., Ltd. to use steam turbines in post-war tonnage was taken afaer a long and deliberate investigation which lasted for the latter two years of the war. With a firm who had for the previous twenty years built Diesel-engined tonnage exclusively, this meant the remodelling of ideas in design. The usual trouble with Diesels had been experienced, and although the delays in turn-round during the war years had been minimized by careful nursing and extensive overhauling and renewals, it was felt that with the advancing years the Diesel engine would inevitably cancel out the economy of running with high cost of overhaul and repairs allied to all the attendant delays due to shortages of material in the post-war world. Horse-power with Diesels up to 35,000 s.h.p. had been used, and a wide range of types had proved themselves economically sound in various services, and the fuel coefficients were undoubtedly higher than those obtained with steamships. This, from the owner's point of view was ideal, but the cost of fuels, repairs, and upkeep began to be factors that had to be weighed more carefully in the balance. A comparison over the years showed that, by and large, turbine machinery reliability was reflected in very low cost of maintenance and overhaul. Other features compared showed that: (1) turbine consumption can be more or less constant between full and half power if the machinery is properly designed; (2) lubricating oil consumption is much lower in turbines than in Diesels; (3) the most efficient propeller speed can be readily employed with geared turbines, and is simply obtained. This does not always obtain with direct-drive Diesel, even if some sacrifice of weight is made. (4) Simplicity of design and ability to run at overload without detriment are in favour of turbine drive. (5) Weight is low, which partially offsets the additional bunkers that are necessary. (6) From the passengers' point of view, freedom from noise and vibration are important factors. Many practical points such as manœuvring have had consideration, and although it is hard to break down prejudices it has been proved that the modern high-pressure turbine can be manœuvred with very nearly as much speed and confidence as a normal Diesel. In one case turbines were reversed from full ahead at 120 r.p.m. of the propeller shaft to full astern at 84 r.p.m. in 96 seconds. The vessel's speed was 18½ knots and in four minutes it had lost way and come to rest.—*R. K. Craig, The Marine Engineer, Vol. 71, 1948, Annual Steam Number, pp. 237-240.*

Handling Oil Spills with Chemical Spray

The transportation of marine fuel oil is comparable to that of other liquids of like bulk and viscosity, but the matter of fire hazard always should be taken into consideration, even though, by comparison, fuel oil possesses a higher combustion point than finer oils and gasoline. Most experts agree that the principal hazard lies in pumping with the possible danger of attendant oil spills and oil slicks. Where these occur, the obvious procedure is to neutralize or eliminate the hazards created. Chemical cleaners are the answer to the problem of removing oil spills and slicks, since chemicals can neutralize or eliminate the fire and accident hazards of a pool or slick of oil. The increasing use of such agents may be considered indicative of their effectiveness. The equipment is very simple, consisting of a hose with a spray nozzle, a pump and a tank containing the liquid chemical. The equipment may be placed on a truck or pier, or shipboard pumps, hoses and a small auxiliary tank may be used. The answer to efficient oil removal lies in the technique of the spraying operation. It is imperative that a fine spray be used, since a heavy stream does not get a chance to mix with the oil, but, instead, is driven right through the oil into the water.—*S. M. Summ, Marine Engineering and Shipping Review, Vol. 53, May 1948, pp. 50-51.*

Seven New Mormac Ships

The seven combination passenger-cargo liners built by Ingalls Shipbuilding Corporation and operated by the Moore-McCormack Lines were designed for a normal speed of 17½ knots, but average speeds as high as 19 and 20 knots were recorded. These vessels operate from Boston to ports along the east coast of South America. The vessels are of all welded construction, shelter-deck type with raked stem and cruiser stern. Each vessel is propelled by a high-speed cross-compound turbine, through a double reduction gear and single screw. Six of the ships received extra hull strengthening at the forward end to withstand ice conditions. General specifications of the ships are:—

Length	492 feet
Beam	69½ feet
Depth	49½ feet
Displacement	17,600 tons
Draft	28½ feet
Designed speed	17½ knots
Normal horse-power	8,500 s.h.p.
Maximum horse-power	9,300 s.h.p.

The vessels are equipped with two "D" type Foster Wheeler marine steam generators which supply steam for propulsion and the operation of auxiliaries including evaporators for fresh water, refrigeration system, and general hotel load. Maximum boiler steam capacity is 55,000lb. per hr. and design pressure is 525lb. per sq. in. When operating at a normal rating of 37,500lb. per hr., steam is delivered from the superheater outlet at 465lb. per sq. in. and 765 deg. F., with a boiler efficiency of over 87 per cent. While normal demand for low temperature, low pressure steam requires not more than 2,000lb. per hour per boiler, additional steam is available through reducing valves for cargo oil pumps and washing tanks. Under normal conditions 72,950lb. of h.p. steam is produced. Of this quantity, 70,732lb. are supplied to the propulsion equipment and to two turbo-generators, and 1,518lb. desuperheated for auxiliary needs. While 63,882lb. are fed to the prime mover to produce 8,500 s.h.p., 3,425lb. are supplied to each of two 207·5 kW. generators. The 1,518lb. of desuperheated steam is distributed as follows:—465lb. divided into three lines connecting to steam jet air ejectors, which serve main and auxiliary condensers and a distiller; 460lb. used to operate the ventilating and dehumidifying system; and 398lb. supplied to the evaporator system. The boiler section consists of a 42-inch diameter steam drum connected to a 32-inch diameter water drum by a bank of tubes arranged vertically in two groups and bent to enter the drums radially. These tube banks are separated to provide space for the superheater. The group of tubes nearest the furnace is made up of three rows of 2-inch tubes staggered to form a radiant heat screen between the furnace and superheater elements. The second group of tubes consists of fourteen rows of 1¼-inch tubes. The two drums are also joined by four 3-inch tubes, two supporting each side of the superheater bank, and six 3-inch downcomer tubes, three set within the insulation of both the front and rear walls, to ensure adequate circulation. Excepting a brick lined front wall mounting four wide range oil burners, the furnace is entirely cooled by water tubes. The superheater, consisting of U-bend elements placed horizontally and rolled into two square headers, is arranged for five passes of steam. Each header is divided by welding into it two diaphragms, perforated to permit drainage, which guide the steam progressively upward from the bottom of one header to the top of the other.—*Heat Engineering, Vol. 23, No. 1, 1948, pp. 2-5.*

Prediction of Pressure Drop During Forced-circulation Boiling of Water

In a number of engineering flow systems it is important to be able to predict the pressure drop occurring during the forced-circulation boiling of water. The main difficulty is the estimation of the friction factor. Several approaches to this problem have been suggested in the technical literature available. This paper combines several of these data references and then extends them in order to establish a new approach, which is, however, tentative and still requires experimental verification. The new method postulates that the pressure drop resulting from the flow of a boiling mixture is made up of two parts: (1) the pressure drop due to the frictional forces acting during the two-phase flow; and (2) the pressure drop resulting from the rate of increase of momentum of the mixture as it flows through the tube and vaporizes. A procedure for the rapid calculation of the two pressure drops itemized is established, from which a set of curves are developed. These curves can be employed for a quick estimation if the exit quality, the boiling pressure, and the pressure drop for 100 per cent liquid are known. The proposed method is definitely an extrapolation of existing data and as such requires further experimental verification. Based on a meagre amount of data, a comparison of predicted and measured pressure drops with pressures from 18 to 3,000lb. per sq. in. abs., and exit qualities from 4 to 100 per cent, indicates that the method has promise.—*Paper by R. C. Martinelli and D. B. Nelson, read at the Annual Meeting of the American Society of Mechanical Engineers, No. 47-A-113 (1947).*

Machinery and Equipment of Modern Colliers

In this article the writer discusses the proportional equipment of modern colliers and refers to several specific examples ranging from the relatively small tonnage used in British waters to the large vessels on the Australian and Chilean coasts. In this latter respect the author comments on a new ship designed to unload 8,000 tons of coal with her own gear in coastal harbours. This vessel, the "Federico Schwager", which is owned bv the Schwager Mining Co., is one of the largest of her kind in the world. The company supplies bunker coal alongside a coaling pier in Coronel. The delivery is made direct from mines to the ships' holds by means of a mechanical conveyor at the rate of between two and three hundred tons per hour. The Federigo Schwager discharges her own cargoes in Valparaiso, where the big rise and fall of the swell when discharging cargo in open waterways call for special mooring arrangements. The cargo-handling appliances in the Federigo Schwager consists of derricks with a fairly long reach over side and particularly high, so that there can be sufficient tolerance to pick up whatever rise and fall there may be with no fear of the ship damaging her cargo gear. There are four large cargo holds, each of almost equal capacity, carrying a total of over 8,000 tons of coal. Each hold is served by four 7½-ton derricks and steam winches. Two derricks to each hold are provided with 5½-ton grabs, as a result of which it is estimated that the ship will discharge a full cargo of coal in three working days of not less than eight hours duration. The rigging of the derricks is so arranged that they swing overboard to a distance of 12 feet. This British-built vessel has a dead-tonnage of 9,340, length b.p. 415ft., length overall 440ft. 6in., extreme beam 57ft. 10in., and when fully loaded draws 25ft. 4in. in service.—*A. C. Hardy, The Journal of Commerce (Shipbuilding and Engineering Edition), No. 37514, 20th May 1948, p. 5.*

The Tanker "La Saône"

The tanker "La Saône", which was launched last February, is one of two identical vessels ordered in 1938 by the French Navy from the Ateliers et Chantiers de France at Dunkirk. Originally these two vessels had been intended for use as fleet oilers, and in order to adapt them to merchant marine requirements, it was decided to carry out a number of modifications. The main particulars of the two vessels are: length overall, 160m.; length b.p., 153 m.; breadth, 22 m.; draft, 12·2 m.; deadweight, 15,200 tons; displacement loaded, 23,400 tons; service speed, 14 knots. The propulsion plant consists of two sets of Parsons turbines normally developing 7,200 h.p., supplied with steam at 27 kg. per sq. cm. and 350 deg. C. from three boilers. An auxiliary boiler is also provided. The turbines were built by the Compagnie de Fives, Lille, and the boilers were constructed by the shipbuilders. The original designed maximum power of the turbines is 14,750 h.p., but for reasons of fuel economy the power is now reduced to the aforementioned figure of 7,200 h.p., this reduction being obtained by blanking-off nozzles. This leaves the possibility to revert to the original power should this be required at some future date.—*Journal de la Marine Marchande, Vol. 30, 13th May 1948, pp. 802-805.*

A New Salvage Method

The author describes a new method of salvaging all types of sunken ships at sea or in harbour; it involves the use of a number of devices which the author has patented. The main device is an underwater salvage dock, some sketches of which are shown. It is a type of large reinforced-concrete caisson, which is placed over the sunken ship like a diving bell, either resting on the sea bed or anchored to it to suit requirements. On the upper side of this dock there are engine rooms, which may be formed from obsolete submarines complete with their engines and auxiliaries. The internal space of the dock—the author recommends 56,000 tons—is pumped out with compressed air supplied from the engine rooms, and the wreck can then be raised by means of a large travelling crane inside the dock, or the material can be salvaged and transported. The dock is preferably used in conjunction with a special floating workshop for which the author recommends a displacement of 1,500 tons. This ship carries a large pumping set for assisting in pumping the water out of the dock, and for providing compressed air. In addition, the floating workshop can be employed for observation of wrecks to be salvaged, repairing them under water, and towing them into harbour.—*Abstract No. 1740, Journal of The British Shipbuilding Research Association, Vol. 3, No. 4, April 1948, p. 191. Belloni, A., Rivista Marittima, Vol. 81, January 1948, p. 57.*

Purse Seiner of Advanced Design

The new purse seiner "J. A. Martinolich", which is soon to get into service on the Pacific coast, may completely upset all past practies in purse seiner design and powering. This vessel was designed to be faster than any other in the fleet and to have a far greater average cruising radius, to have completely refrigerated holds, electrified throughout to do away with line shafts to winches and windlass, and in addition carry more fish than had heretofore been possible in any vessel of the same gross tonnage. Obviously, nothing less than the latest marine engineering developments would permit such a combination. The vessel is powered by a 1,600 h.p. Fairbanks Morse opposed piston Diesel and a Western Gear Works planetary, in-line reduction gear. Use of this type reduction gear permitted the two most desired features—a light weight, medium speed Diesel of extremely high power output for a vessel of 98-feet length by 26-feet beam, and a slow speed propeller. The engine turns at 720 r.p.m. and swings an 83-inch diameter by 55-inch pitch Coolidge propeller at one half engine speed—which will give a cruising speed of 13½ knots. This is from 2 to 4 knots faster than any other vessel in the same type of operation. Development of the "Pacific-Western" straight-line reduction gear has covered a number of years. First installation of such a unit was made by Western Gear Works in 1946 in the tuna clipper "Sherry Ann". These reduction gears utilize spiral bevel planetary gears instead of the conventional herringbone gears, with the result that the 1,000 h.p. "Pacific-Western" unit in the "Sherry Ann" measured only 44 inch by 46 inch overall and weighed only 4,500lb. A herringbone unit of the same capacity would require a driving pinion 22 inch in diameter and 18-inch facelength and a driven gear 44 inch in diameter, assuming that such gears could be properly case-hardened and adequate tooth bearing contact maintained. The weight of a conventional herringbone unit would be from three to five times the weight of the "Pacific-Western" bevel planetary reduction gear, depending upon the service factor. In addition, the vertical offset of the input and output shafts would present nearly insurmountable installation problems in a vessel like the "Sherry Ann".—*Motorship (New York), Vol. 33, May 1948, pp. 26-27.*

Power—Length—Speed

Considerable economies in the operation of Diesel powered small commercial vessels can be effected through the proper choice of power and length when a fixed speed is required. The not infrequent paradox of a larger vessel, similar in form to another vessel, carrying a bigger cargo at the same speed with equal engine power, has interested many builders and operators. In each case the larger vessel benefits by increased cargo capacity and a higher ratio of deadweight to displacement for slightly increased hull cost, but with the same initial investment in power plant with equal fuel consumption. A similar phenomenon on occasion occurs, to a lesser degree, when an existing vessel is lengthened by addition of parallel sections amidships. The ship often maintains its original speed although carrying increased displacement and cargo. The simple explanation is that as length is increased, a region of speed occurs where the wave-making resistance is decreasing faster than the frictional resistance is increasing due to gain in wetted surface. In the case of many forms where wave-making resistance is substantial, there is a certain length for a given speed where the total towrope horse-power is minimum. This information for a particular hull form can be derived from a model test. It is sometimes overlooked by the naval architect that this single model test also can be used to predict the performance of any number of vessels, all similar geometrically and differing only in scale, or linear relation to the original model. If this family of various sized vessels is then compared for power at equal speeds, it is frequently an important discovery that there is one length for each speed which drives easier than a smaller or larger unit. The author discusses a typical case of this kind based on the tests of a model recently carried out at the University of Michigan Naval Tank, of which the author is the director.—*L. A. Baier, Motorship (New York), Vol. 33, May 1948, pp. 34-35.*

New 1,900 s.h.p. Tug

The tug "Intritas-I", which recently arrived at Strasbourg, is the most powerful vessel of its kind ever built in Holland. The three engines of 650 h.p. each are run on gas-oil. The vessel is used for the towing of oil barges and can tow eight barges simultaneously.—*Journal de la Marine Marchande, Vol. 30, 20th May 1948, p. 869.*

Tunnel Stern River Tug

This article describes a locally built tunnel stern river tug of 22·40 m. overall length and 1·53 m. maximum draught. The vessel is of wooden construction and was first powered by an 150 h.p. semi-Diesel driving a screw propeller of 1·50 diameter. The latter was also locally made. When towing two barges, a speed of 5·5 knots was obtained. A Petter Diesel of 215 h.p. at 500 r.p.m. equipped with a 2/1 reduction gear is now installed.—*German Frers, Navitecnia (Buenos Aires), Vol. 2, February 1948, pp. 11-15.*

The Anchor Liner "Caledonia"

Work upon the "Caledonia" was begun in November 1945, and the vessel had her trials some short time ago. The "Caledonia" was built by the Fairfield Shipbuilding and Engineering Co., who also constructed the Doxford-type engines under licence. The main details are:

Gross register	11,315 tons
Length overall	506 feet
Breadth moulded	66 feet
Depth to upper deck	35ft. 6in.
Draught, loaded	27ft. 6in.
Deadweight capacity	10,417 tons inclusive
Service speed, loaded	16½ knots
Number of passengers	304
Cargo space	442,200 cu. ft.

She has seven decks, a very slightly raked stem, a cruiser stern, large steamer-type funnel, and two pole masts. The engine-room accommodates two standard Fairfield-Doxford opposed-piston engines of the largest cylinder size to be made in this country. Each engine has four cylinders with a diameter of 725 mm. and a combined stroke of 2,250 mm. It develops 5,700 b.h.p. at 120 r.p.m., as a trial trip output, and maintains 5,100 b.h.p. continuously at sea at 115 r.p.m. The engines are of normal Doxford design in every respect, with single crank-shaft-driven scavenge pump between nos. 2 and 3 cylinders. The cooling of pistons and cylinder jackets is effected through two circuits by distilled water, inlet and outlet temperatures being recorded on each cylinder, whilst pyrometers give an indication of the exhaust gas temperatures at the cylinder outlet. The starboard engine exhausts direct into a silencer in the funnel, but the port engine may either exhaust to the Cochran composite boiler or direct to the funnel, according to requirements; a change valve is provided at the level of the upper engine grating. The average exhaust gas temperature at the cylinders is in the neighbourhood of 500 deg. F. The pressure of the jacket-cooling water is some 20lb. per sq. in., and of the piston cooling at the outlet, 40lb. per sq. in. The outlet temperature for the piston-cooling water ranges round 165 deg. F., and for the jacket cooling, 145 to 150 deg. F. The scavenging air pressure is in the neighbourhood of 1½lb. per sq. in.—*The Motor Ship, Vol. 29, May 1948, pp. 66-73.*

10,000-ton Italian-built Swedish Ship

Recently the launch took place from the Cantieri Navali di Taranto, Italy, of a 10,000-ton motor ship, the largest built in that country for Swedish owners. The vessel is the "Selma Salén" built for Sven Salén, Stockholm. This ship is of the open shelter deck type with a capacity of 640,000 cu. ft. in six holds, three forward and three aft of the engine-room. The double bottom extends over the whole length of the ship, fuel oil being carried in Nos. 2, 3, 4, 5 and 6 tanks, and water ballast in No. 1 and alternatively 2, 3, 4 and 5 tanks. The Fiat propelling engine is a two-stroke double-acting seven-cylinder unit of 6,000 b.h.p. which at 125 r.p.m. gives a loaded speed of 16 knots. This engine has cylinders of 640 mm. diameter, with a stroke of 1,160 mm. Accommodation is provided for twelve passengers.—*The Motor Ship, Vol. 29, May 1948, p. 54.*

Problems Associated with Use of Diesel Fuels

This paper presents results of recent investigations dealing with the nature of exhaust products resulting from the combustion of Diesel fuels, particularly those products composing smoke. These findings, together with knowledge gained from the extensive research work in the field of combustion demonstrate the significant influence of chemical composition and physical properties of Diesel fuels on engine combustion. Engine power outputs, reliability, and durability are also affected. This is related to some of the properties used for defining the various classes of Diesel fuels with the object of emphasizing factors which appear to need further development. It is suggested that new standardized tests be evolved, one whereby the relative stability can be determined and another whereby the "Diesel-fuel combustibility" quality can be evaluated. Suitable inspection limits could be used for specifications. New additive-type lubricating oils must be made available for use in the medium- and higher-speed Diesels to combat the deleterious effects of sulphur contents in the fuels for these engines.—*Paper by W. H. L. Doyle and E. W. Landen read at the 1947 Annual Meeting of the American Society of Mechanical Engineers, No. 47—A-124.*

English Electric Magnetic Slip Coupling

An electro-magnetic slip coupling is illustrated in Fig. 3. The primary member is an exciting coil (1) magnetized through slip rings (2), magnetized North and South poles (3, 4) being arranged alternately around the periphery. The magnetic flux crosses the air gap

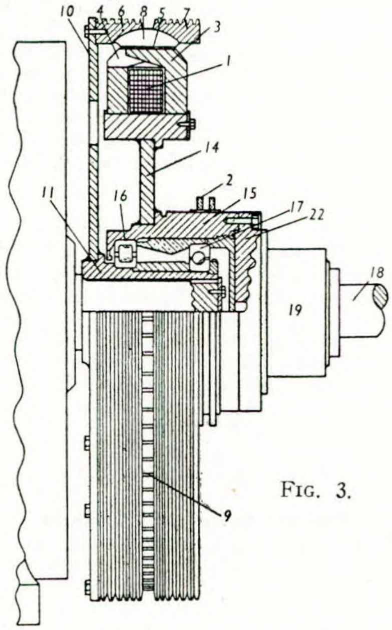


Fig. 3.

(5) and passes through the secondary member which consists of rings (6 7) connected by cross-members (8) which are separated by gaps (9). The secondary member (6, 7, 8) comprises the driving portion of the coupling and is supported from a hub (11) by a disk (10). The coil (1) and the poles (3, 4) forming the driven member are supported by a disk (14) from a hub (15) aligned with the hub (11) by a roller bearing (16) and a ball bearing (17). The driven shaft (18) is provided with a flexible coupling (19), and the driving member (22) of the coupling is secured to the hub (15). With this arrangement the driven member is maintained in exact alignment with the driving member and the air gap (5) always remains uniform. (British Patent No. 597,399. English Electric Co., Ltd., R. L. English and E. H. Hassler, Stafford).—*The Oil Engine and Gas Turbine, Vol. 16, May 1948, p. 36.*

A Capacitance Type Torquemeter

The torquemeter was designed originally for the measurement of friction torque due to the test bearing in a bearing testing machine in which the test bearing was subjected to alternating loads. The requirements call for an instrument which would respond to very small torques, of the order of a few lb.-ft., which would have a wide frequency response, which could be easily calibrated and could be used on shafts rotating at speeds up to 4,000 r.p.m. The measuring head is of the variable gap type and forms part of the tuned circuit of an electron coupled radio-frequency oscillator, to which it is connected by means of brushes and slip-rings. The instrument measures small dynamic torques of the order of 10lb.-ft. with an accuracy of ± 5 per cent.—*C. H. G. Mills, Journal of Scientific Instruments and of Physics in Industry, Vol. 25, May 1948, pp. F151-156.*

Developments in Marine Reduction Gearing

The author of this paper recalls that since the first successful use of toothed gearing for marine main propulsion, general development has been in the direction of reducing the tendency to noise production and increasing the load capacity or the life expectation for given overall dimensions. Recent developments have all had the same main aims, and the possible means of accomplishing them may be considered under the following headings:—

(1) Variations in tooth-form.
(2) Higher standards of accuracy in manufacture.
(3) Use of materials of higher load capacity.
(4) Refinement in mounting.
(5) Use of lubricants of higher load capacity.

It is shown that the involute helicoid tooth form, which has great practical advantages over any other, can give greater load capacity only if the depth/pitch ratio is increased, and there are practical limitations in that respect. Harder materials offer considerable scope for improvements but also tend to introduce difficulties in cutting. Profile grinding of large gears, expensive though it is, may therefore need to be considered in the future. Flame-hardening of teeth is successfully carried out on gears of medium and small sizes but does not seem to have been applied to large high-speed marine gears. It has the advantage of providing tooth flanks of harder material than can easily be cut with precision without any need for profile-grinding. Induction hardening offers the same possibility in the future, but except for small gears, it is at present far less advanced than is flame-hardening. Important characteristics of gear cutting machines are discussed, and the value of post-hobbing processes is examined. Comments are made on mountings, lubrication and load-testing of high-speed helical gears.—*Paper by Dr. W. A. Tuplin, Trans.I.Mar.E., Vol. 60. No. 4, May 1948, pp. 107-117.*

Strain Gauges

The author of this paper, who has since died, and who was chief engineer of a leading American manufacturer of strain gauges, gives an authoritative account of the developments leading up to the present type of strain gauge. The principles underlying the construction and manufacture are treated in some detail. Different types and their limitations are reviewed. Ways of measuring and recording the resistance differential are discussed, from the simple milliammeter to the costly multiple recorders. Possibilities of application extending beyond the field of measuring mechanical strains are shown. This includes the use in automatic limiting and continuous control.—*C. H. Gibbons, Metalen, Vol. 2, May 1948, pp. 187-193.*

The Brown Boveri Pressure Exchanger "Comprex"

This article describes a new "pressure exchanger" for gas turbines which is being developed in Switzerland by Brown Boveri. The function of the "Comprex" is to increase the pressure of the air passing through it. This is achieved by the action of pressure waves set up inside the helical compartments of a special rotor, the mechanism of which is described briefly and illustrated diagrammatically. The "Comprex" is driven preferably by a small electric motor, power for its operation being required only for overcoming the frictional losses that occur. The combustion gases which do not pass through the "Comprex" are expanded in an auxiliary turbine which can be arranged on the same shaft as the main turbine. The "Comprex" model which has been constructed has a supercharger which is driven by an independent gas turbine; this accelerates the circulation of the air and compensates also for the pressure loss in the combustion chambers. An experimental exchanger used with a 4,000 h.p. turbine, increased the thermal efficiency from 18 per cent to 22 per cent, with a maximum temperature of about 1,200 deg. F. for the turbine intake gases. *Abstract No. 1717, Journal of The British Shipbuilding Research Association, Vol. 3, No. 4, April 1948. Journal de la Marine Marchande, Vol. 30, 22nd January 1948, p. 131.*

Double-purpose Gearing for Motor Collier

Recently trials took place at the works of the Modern Wheel Drive, Ltd., Slough, of a set of oil-operated reverse double-reduction gearing for the North Metropolitan Gas Co.'s motor collier "Catford", now being fitted out by Messrs. S. P. Austin and Son, Ltd., Sunderland. This single-screw ship is to be propelled by a Ruston and Hornsby 6 V.O.X.M. oil engine, capable of developing 1,425 s.h.p. at 423 r.p.m., and 1,585 s.h.p. at 440 r.p.m. The reduction ratio of the reverse gear, which is claimed to be the largest of its type ever constructed, works out at 5·42 times when working ahead, and 5·28 times when driving astern. This means that when the engine is turning ahead at 423 r.p.m. the speed of the propeller shaft is 80 r.p.m. In this way the most efficient propeller can be used, and the use of a high-speed prime mover means that considerable saving in weight and space can be effected. Manœuvring with this gear is simple, and consists of moving a small lever, like an engine telegraph handle, through a three-notched positioning quadrant. When the machinery is fitted in the ship, it is intended to arrange for both wheelhouse and engine-room control. As starting the propeller from rest, stopping and reversing are all functions of this combination, it will be appreciated that not only is the reversing gear in the engine eliminated, but the provision and stowage of starting air become almost of secondary importance. Moreover, the manœuvring of the machinery, as was demonstrated satisfactorily, is speedy, smooth, and certain in its operation. Long periods of astern running on full load are possible if necessary without ill effects to the unit, and without risk of overheated. The unit is co-axial with the engine, but the input shaft from engine is about 2 feet above the output shaft coupling. This arrangement has an advantage, in that the tank top under the engine can be made deeper, thus keeping the crankcase clear of any bilge water. At the same time, it obviates the necessity of tilting the engine if it is necessary to obtain sufficient immersion for the propeller. The reverse-reduction unit consists of a gearcase containing, in all, fifteen machine-cut steel gearwheels. The ahead and astern wheels incorporate oil-operated couplings or clutches, each of which consists of two inner and two outer members. The two outer members are carried and are free to rotate on the sleeve or hub of the two inner members, which, in turn, are carried on longitudinal spline shafts. Engagement between them is effected by directing oil, under pressure, into the chamber between the two inner members. One of these is bronze, and the gearwheels are of steel, and the engagement takes place in the gear under test by seven circular grooves, each having a section similar to that of large size Whitworth thread. At the bottom of each groove a series of breathing holes ensure quick release when the pressure is taken off, and a single piston ring is provided, fitted at the outside edge to prevent any undue leakage of oil when the clutch is engaged. Disengagement after release of the working oil pressure which, in the unit under test, was 75lb. per sq. in., is further ensured by oil pressure on the opposite face of the inner member, which returns them to idling, or free position. The controlling oil system consists of a gear-driven pump, a by-pass valve, a control cock, an oil filter, and a suitable system of water-operated oil coolers in the circuit.—*The Journal of Commerce (Shipbuilding and Engineering Edition), No. 37514, 20th May 1948, p. 2.*

Powder Cutting

The powder cutting process has become well established during the past several years in the cutting of stainless steels and other materials difficult to process by standard oxyacetylene methods. The process consists in introducing a finely divided iron-rich powder into the cutting-oxygen stream. The powder unites with the oxygen and burns, liberating large quantities of heat and forming superheated molten particles of iron oxide. This additional heat supplied by the burning powder plus the fluxing action of the superheated particles keeps the refractory oxides, formed in the oxidation of the stainless steel, in a molten condition to be ejected in the slag stream. Experience has indicated that powder-cutting costs are lower than those for other methods. In considering the cost factor, the time element is outstandingly in favour of powder cutting since, with the exception, of course, of straight-line shearing, this is one of the fastest methods for cutting stainless steels. The labour component of the cost consequently is small compared with previous practices, such as nibbling, multiple drilling and electric arc cutting, where labour represents the major item.—*D. H. Fleming, The Welding Journal (New York), Vol. 27, March 1948, pp. 181-187.*

Welding Research

The first meeting of the members of the British Welding Research Association was recently held at Abington Hall near Cambridge, where a large condenser spot welder is installed and ancillary gear for sheet cutting and preparation and for making tensile tests of specimens is available.. At this meeting Dr. R. Weck referred to work in progress on fatigue-testing of structures. One line of research being followed at present was to determine the best method of joining angle stiffeners to ships' plating, and the other to ascertain the influence of internal stresses on fatigue strength. The former set of experiments, he said, was being carried out on sections of bulkheads or decks, to which angle stiffeners were attached by various forms of welding, the object of the test being to determine the method of welding that gave the highest fatigue strength. Five different types of joint were being tested, and four specimens of each type had been made. The specimens were being X-rayed by the Admiralty to determine the condition of the welded joints. The resonance method of testing was employed, since this was the cheapest, and gave very satisfactory results.—*Lloyd's List and Shipping Gazette (Shipbuilding and Engineering Section), No. 41,640, 27th May 1948, p. 6.*

Clinical Approach to Weldment Design

A clinical approach to the design of weldments is a study of the behaviour of welded structures, particularly failures of welded structures, during and after their service life, much in the same manner that a physician approaches a human ailment and learns from it. The need for such a clinical approach is the result of a combination of features peculiar to weldments, such as the frequently overlooked fundamental that a welded structure is one piece of metal and that for economical reasons that one piece of metal may have designed into it internal and, or alternatively external notches and incipient cracks. Such notches and cracks, as will be discussed later, may drastically affect the endurance limit of the welded structure. The greatest need for a clinical study of weldment lies therefore in the field of dynamically loaded structures. One of the numerous examples of failures of welded structures given by the author is the failure of a Diesel engine frame which has been produced in large quantities for a number of years. It is for a general-purpose engine used mainly for auxiliary power on shipboard. In 1943, failure occurred in this frame of a type which definitely indicated unusual service, something that was practically impossible for the designer to foresee. Of thousands of frames produced for these engines only approximately thirty showed distress. Thus, the design adequacy of the frame was proved most thoroughly. In further support of this statement is the fact that all failures occurred on engines in a particular type of service on a particular type of ship. Two things became apparent in the investigation of this failure: first, the nature of the service was such that the engine might be subjected suddenly to peak load conditions at full speed; second, the ship seemed to be of such class and in such service that it rolled and tossed violently. Trouble with foundation bolts bore out these conclusions; in addition, information on the conditions encountered at sea indicated severe inertia forces due to the swaying mass of engine. Another case is that of the frame for a Diesel for submarine propulsion. In this instance the submarine had been depth-charged many times, on one occasion so violently that she was blown to the surface. Some time following these experiences fractures were discerned in the engine frame, and no fewer than 126 cracks throughout the frame structure were counted. Many of these fractures started at stress raisers such as machined contours; others started at the edges of openings. Many cracks originated in the welds connecting secondary members in the structure, but none of the fractures occurred in either the welds or the parent metal of primary members.—*G. von Stroh, The Welding Journal (New York), Vol. 27, March 1948, pp. 207-216.*

Peening Weld Deposits for Stress Relief

The use of peening for stress relieving a welded joint and maintenance of dimensions embodies the principle of cold and hot working of metal. Cold peening is purely a surface-working effect and the depth of crystal deformation for a given tool will depend on the impact of the hammer and size and shape of tool. A small, spherically shaped peening tool will give more rapid crystal deformation than a larger tool which is more nearly flat on the face, and it will be conducive to greater indentation and deeper plastic flow. The author recommends the use of resistance wire strain gauges on members being fabricated, in order to apprehend dangerous states of stress and to be able to take corrective steps. With some experience the gauges could be placed at the most vulnerable points and used to direct the welding procedure or peening. Examples of frequent failure are: fixed plating, hatch corners, through members in decking and bulkheads, heavy casting attachments. Peening is not proposed as a "cure-all", since most structures or assemblies will not require it. However, there are conditions where the welding sequence will not adapt itself properly, and only then does a mechanical method of stress relief become a valuable tool.—*J. L. Morris, The Welding Journal (New York), Vol. 27, March 1948, pp. 148-s-157-s.*

Bronze-welding of Cast Iron

The bronze-welding of cast iron is a process in which the oxy-acetylene flame is employed to deposit a bronze rod on to prepared surface of cast iron at a lower melting point than that of cast iron to form an adhesive bond. When properly carried out the process will produce a perfectly sound joint. The surface of the prepared casting has to be heated to a temperature at which a small amount of molten bronze will flow freely over the surface of the casting in a manner similar to which soft solder will flow over the surface of a piece of clean copper. This free flowing of the bronze over the surface of the casting is called "tinning" or "wetting". Once the surface of the cast iron has been properly "tinned" bronze filler rod is deposited with a suitable welding technique to the required thickness and width. During the "tinning" the actual bond between the bronze and the cast iron takes place by surface alloying; this essential part of the process might be likened to a sure foundation for the completion of the weld. It is most important that the surface to be bronze-welded be perfectly clean and free from oil, grease, dirt, paint, oxide, etc. The welding flame for bronze-welding should be adjusted to a very slightly oxidizing condition, although some expert operators prefer to use a neutral flame. The smallest nozzle practicable should be used. The cleat method of bronze-welding is a technique which was first developed in Africa and has been found to be extremely useful for supporting molten bronze in the vertical and horizontal-vertical plane, particularly for operators of limited experience in controlling molten bronze in these positions. Pieces of steel in the form of "cleats" approximately 1 inch wide by ¼ inch or ⅜ inch thick are used; they should be cut long enough to overlap approximately ⅜ inch at each side of the V and slightly bent to give approximately a 5 per cent reinforcement of weld metal over the thickness of the casting. The bending of the cleats increases the accessibility of rod and blowpipe. It is important that these cleats be perfectly clean on the inside and the edges to facilitate easy "tinning" with the bronze rod and to ensure a strong sound weld (Fig. 6). The V surfaces at the bottom of the casting where welding is to be started should be brought to a dull red heat and "tinned". A steel cleat should then be placed across the front of the V, thus forming a cup or bath into which molten bronze deposit "tins" on the steel cleat. This cleat supports the molten bronze and keeps it under perfect control. Bronze can be rapidly deposited up to the level of the top edge of the cleat. Another cleat is then placed in position and bronze deposited, the operation being repeated until the joint is completed. The angle of the blowpipe for the "tinning" operation is 70 deg. from the surface of the casting. After the surfaces of the V have been tinned the blowpipe can be brought over so that it is pointing downwards into the molten pool, thus reverting to the technique for depositing from vertical to horizontal, so enabling the operator to deposit two or more filler rods at once if required. This considerably increases welding speeds. For metal thickness under 1 inch this method has little advantage, but for the operator of limited experience on metal thickness 1 inch and over, it has distinct advantages because, without the cleats, owing to the fluidity of the bronze and the size of molten pool, welding speeds are considerably reduced in order to control and prevent loss of molten metal.—*E. Ryalls, Welding, Vol. 16, May 1948, pp. 203-210.*

Fig. 6.—*Vertical bronze welding using cleats.*

Cold Welding

The cold welding of aluminium and aluminium alloys is a process whereby ductile metals are welded by pressure alone, the pressure being applied to the workpieces to be joined, by specially designed dies which are mounted in a suitable tool, such as a hand-press. Production of a satisfactory cold weld, however, depends upon two essential factors. First, the work-pieces must be so treated that two uncontaminated metal surfaces can be brought into intimate contact between the dies. In other words, the oxide film on the surface of the aluminium must be removed, and a substantial part of the work carried out in the G.E.C. Research Laboratories was concerned with determining the best means of performing this operation. Further, once the surfaces have been properly treated, the reformation of the oxide film, although it begins at once, is not rapid. Therefore, provided the surfaces are kept clean, satisfactory welds can be made within twenty-four hours of such treatment. Cleanliness of the surfaces is extraordinarily critical, however, as even the contamination conveyed by handling will invariably prevent a weld from forming. The second proviso is that the pressure must be applied over a comparatively narrow strip, and in such a manner that the metal can flow away from the weld at both sides. This desired state of affairs is achieved by applying the pressure between suitably constructed dies, and also imposes slight restrictions on the more complicated forms which these welds can take. A considerable displacement of metal is necessary to obtain a good weld. Normally expressed as a percentage of the combined thickness of the work, this displacement is conveniently measured by the reduction in thickness produced by the pressure. Obviously, a certain minimum reduction is necessary in order to produce a sound weld, but once this has been reached, it is clearly undesirable that it should be exceeded. The simplicity of cold welding arises from the ease with which ductile metals flow under pressure, while the limitations of the process also result from the same factor. This means that although nearly all ductile metals can be cold-welded, it is actually useful with only a few of them.—*Welding, Vol. 16, May 1948, pp. 193-194.*

Fighting Boiler Room Fires

In this article reference is made to the recommendations made by the Admiralty in 1946 regarding the methods to be adopted in fighting fires in machinery compartments. The recommendations envisaged two distinct phases in the development of fires in machinery spaces and in the methods of attacking them: (1) direct attack with hand foam extinguishers or spray nozzles before the fire has gained large proportions; (2) either steam smothering or foam from main appliances after evacuation of the compartment has become necessary. In the first phase. while direct attack is being made, it was considered inadvisable to close down ventilation owing to the need to maintain visibility and to enable the fire fighter to work initially without breathing apparatus. Separate reports of fires in the boiler rooms of two of H.M. ships, of a similar class, have since been received. Both fires occurred whilst "flashing up" boilers, and the similarity of the positions and intensity of these fires is so marked that a fair comparison can be made of the methods adopted in fighting them. Both ships were in harbour and steam was just being raised when the fires broke out under the boiler brick pans, where accumulations of oil had collected in the bilges. The following reports are necessarily much condensed. The first report stated that the initial symptoms were volumes of black smoke, although the boiler sight glasses remained clear. The fire was eventually discovered under the brick pans to the rear of the boiler. The following fire-fighting technique was adopted: (i) fire was attacked with two gas-water extinguishers, and the outbreak of fire was reported; (ii) fans were stopped (smoke was heavy in the boiler room, and flames increasing in intensity); (iii) an abortive attempt was made to shut the boiler main stop valve; boiler room was evacuated; (iv) boiler room hatches and air intake flaps were closed; (v) oil fuel supply was shut off by the emergency deck valve; (vi) one boiler room hatch was opened and the boiler room was flooded by hoses from the firemain. Additional hoses were played over the deck-head and bulkhead of the boiler room. (vii) After flooding to a depth of three feet, steam drenching was applied for five minutes. The fire was correctly assumed to be out and the boiler room was allowed to cool down before re-entering. The total time to fight the fire was just over one hour. The brick pan supporting frames and the electric light and degaussing control circuits were damaged; there were also slight buckling of the bulkhead between the boiler rooms. The second report stated that the initial symptom was the presence of smoke in the boiler room and the fire was discovered under the back brick pans, whence it spread rapidly under the whole of the boiler. The following fire-fighting technique was adopted: (i) the application of one two-gallon foam extinguisher and the outbreak of the fire was reported; (ii) the water gauge steam and drain cocks were opened whilst awaiting the arrival of extra portable foam extinguishers and the main foam appliances; (iii) the oil fuel sprayer was shut off and the fan eased. The fire could thus be fought from the floor plates without the use of breathing apparatus; (iv) foam was applied from fifteen two-gallon foam extinguishers together with ten gallons of foam liquid through the main appliances; (v) the fire was soon visually under control and finally extinguished in one hour. Damage was confined to the brickpan supporting frames. The author comments that the second of these fire-fighting methods was undoubtedly the more efficient. In the first method it was apparently ignored that liquid fuels will float upon the surface of the water and continue to burn; whereas in the second method the fire fighters always retained control of the fire and were able to direct the extinguishing agent directly at the seat of the fire.—*Commander(E) A. C. K. Laman, O.B.E., R.N., The Naval Engineering Review, Vol. 31, April 1948, p. 35.*

Organic Coatings for Corrosion Protection

This general discussion of the subject includes reference to an unusual coating developed during the war by the Bakelite Corporation for the United States Navy. This was an all-vinyl system for protecting ships' bottoms from corrosion and from fouling. The primer for this coating is Bakelite's washprimer, WP-E, which is applied in thin coatings about a half-mil thick. This primer is a combination of a vinyl resin, phosphoric acid and a zinc-chromate pigment; and it is of special interest because it will tolerate the presence of a film of water on the surface of the metal to which it is applied. When dried and aged, it develops excellent adhesion to all metals and has special merit as a primer for galvanized iron and for magnesium alloys.—*G. W. Seagren, Corrosion, Vol. 4, May 1948, pp. 219-226.*

Corrosion Research in Union-Castle Ships

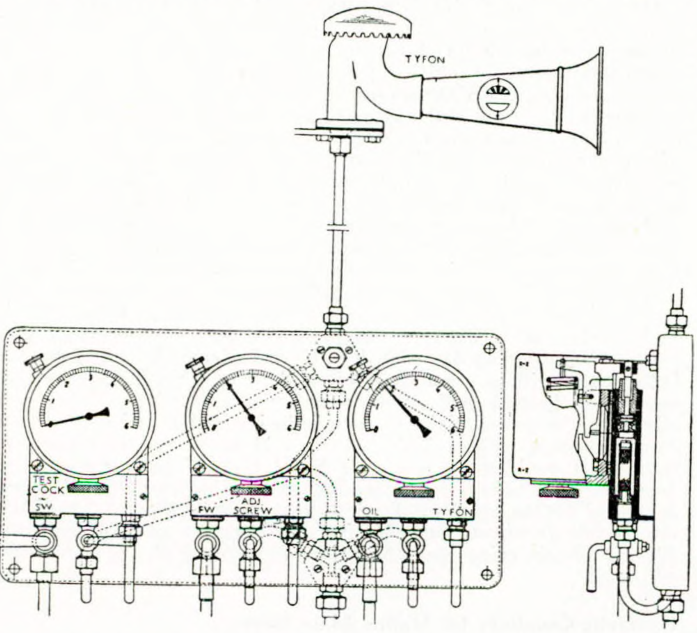
The activities of the Corrosion Committee of the British Iron and Steel Research Association were discussed at a recent meeting in Birmingham. The effects of internal corrosion in marine boilers, flame cleaning of ship plates and the corrosion of underwater surfaces of ships are but a few of the many fields covered by the various sub-committees. The Marine Corrosion Sub-Committee, with Professor J. E. Harris as chairman, has made a detailed study of the prevention of corrosion by sea water and the prevention of fouling. In the prevention of corrosion by sea water considerable advances are claimed in the development of efficient protective paints. As a result of a series of researches, a number of anti-corrosive compositions have been developed which are now regarded as setting up a reasonable standard of efficiency. One of these compositions has been used by the Admiralty with satisfaction, and it is of special interest to note that the outer hull plating of the "Pretoria Castle" and the "Edinburgh Castle", built by Harland and Wolff, Ltd., Belfast, for the Union-Castle Mail Steamship Co., Ltd., were painted on the stocks with compositions and paints to the sub-committee's specifications. The "Edinburgh Castle" has not yet been drydocked since fitting out, but the "Pretoria Castle" was drydocked a few weeks ago, seven months after fitting out, and the effect of these compositions noted. On inspection, 98 per cent of the bottom paint was found to be perfectly intact and unstained by rust.—*The Shipping World, Vol. 118, 26th May 1948, p. 517.*

Salt Water Corrosion of Ships

In this paper the authors review the fundamental principles applied in modern shipbuilding practice to minimize corrosion damage, and give examples of the consequences when these precautions are not observed. Improperly coated areas which sometimes occur are not normally troublesome, since under a periodic repainting schedule, they eventually become adequately protected before any significant damage occurs. However, these areas serve as focal spots for corrosion when abnormal conditions, tending to accelerate the corrosion rate, arise. Probably the most potent of these abnormal conditions is electrolysis caused by stray currents. Stray current corrosion is most likely to occur when insufficient attention is paid to the grounding of electrical equipment used aboard ship which is supplied with power from the shore. If insufficient ship-to-shore ground cables are used for the current involved, some of the current will flow from the ship, through the water, to the shore, carrying ions into solution. The electrical resistance of the paint film forces the current to leave the hull preferentially through scratches or other defects in the paint coating, thus concentrating the corrosion at these points. The paper refers to and illustrates an actual case of this type which was due to the improper grounding of rather heavy welding currents. Corrosion of this type is sometimes incorrectly attributed to some inferior quality of the material, but when the electrical conditions are corrected and the damaged area is properly painted, further corrosion ceases. Ground cables should have an area of at least one million circular mils for each 1,000 amperes current being supplied to the vessel from the dock. A typical satisfactory grounding system consists of three one-million circular mil cables attached to the ship, forward, amidship, and astern. Additional cables are run directly from the grounding point to the ship when the current load exceeds 3,000 amperes, in order to maintain the proper area-current ratio. Ground cables are made no longer than necessary and checked at regular intervals to ensure maintenance of good electrical contact. When ships are at a pier for extended periods of time, or when unusually heavy currents between ship and pier are involved it is the practice in some shipyards to take periodic voltage-drop readings between ship and water by measuring the voltage differences between the hull and a plate of similar composition suspended in the water near the hull. Experience with this method has shown that voltage differences greater than 0·25 volt call for further investigation of the electrical circuits. In this respect, attention is drawn to the fact that dangerous potentials are those in which the direction of current flow is from the vessel to the reference plate. It is necessary, therefore, that the direction of current flow or polarity be ascertained. One additional other precaution is that it is advisable that potential measurements of this type be made immediately after connecting the test plate to the vessel, since the flow of any considerable current from the ship to the plate may result in polarization of the latter, such that the original potential may be reduced below the level which indicates danger. A second type of accelerated hull corrosion may arise from a combination of circumstances involving the presence of mill scale on the hull plating in conjunction with inadequate paint protection. Under such conditions, galvanic corrosion will develop as a result of couples between the mill scale and exposed steel and between the mill scale and rivet heads or welds, unless the latter are definitely cathodic to the mill scale, which usually is not the case. In discussing galvanic corrosion the point is made that galvanic couples between dissimilar metals are the most amenable to control of all the corrosion accelerating factors, and premature failures due to this type of attack should not occur in a modern piping system. When dissimilar metals must be coupled, it is important to keep in mind not only their relative positions in the galvanic series of metals, but also the relative areas of these metals. When the area of the more noble metal is relatively small, the couple may be frequently made without an excessive increase in corrosion rate, but when the area is nearly equal to, or greater than the area of the less noble metal, the latter will be corroded rapidly. For this reason, threaded joints between dissimilar metals should always be avoided. The effective areas of the coupled metals in this type of joint are, for all practical purposes, equal, and the individual thread thicknesses are small as compared with the pipe wall thickness, so that premature failure is certain to occur. The preferred method is to braze the joint, thus excluding water and preventing the unfavourable galvanic arrangement. Galvanic corrosion may also be minimized or eliminated.—*Paper by R. A. Pomfret and L. M. Masher, presented at the Annual Meeting of the National Association of Corrosion Engineers, St. Louis, Mo., 5th-8th April 1948, Corrosion, Vol. 4, May 1948, pp. 227-243.*

Engine Pressure Alarm

The accompanying outline diagram shows the "Tyfon" alarm for indicating loss of pressure in the salt-water, fresh-water and lubricating oil circuits of marine Diesels. The smallest size of "Tyfon" siren is used for the purpose, and the warning instrument is mounted at an appreciable distance from the relays. The alarm has a sensitive control and begins to sound immediately the pressure in any relays falls below that to which it has been adjusted. The spring which determines this pressure is adjusted by a milled screw, which can be seen



A set of "Tyfon" alarms for sea-water, fresh-water or lubricating-oil circulating systems

immediately below each gauge. A plate shows the names and duties of the connexions. Behind the instrument there is a stainless-steel diaphragm with one side exposed to the pressure of the oil or water. A lever transfers this pressure to the adjusting spring. The range of adjustment is between 0·3 kg. per sq. cm. and 2 kg. per sq. cm. and the compressed air supplied to the "Tyfon" should not exceed 12 kg. per sq. cm. On the left of the gauge there is a testing valve. By closing the supply cock and gradually opening the valve, the pressure of the oil or water in the relays is gradually reduced to the figure at which the "Tyfon" should give the necessary signal. Only one air pipe is necessary for a complete set.—*The Motor Ship, Vol. XXVIII, No. 338, March 1948, p. 493.*

Friction-resistant Carbons

In recent years it has been found possible to produce carbons for use as bearings, glands, etc., having a low coefficient of friction and capable of withstanding extremely heavy loads. Because carbon is self-lubricating there is no risk of welding or seizure, even though a lubricant is not used. Manufacture can be carried out by moulding methods, and even intricate shapes can be produced with relatively high precision. Machined carbon parts can be made to tolerances as fine as 0·001 inch anl gland rings for turbines, for example, may be produced in segments designed to be interchangeable. Carbon bearings operate very efficiently when immersed in a variety of liquids, such as water, brine, petrol, etc., and this feature enables the bearings to be used with advantage for submerged pumps. Carbon seals em-

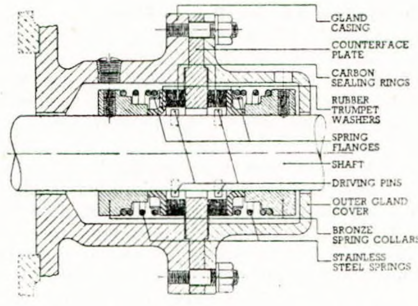


FIG. 1.—*Double-acting Morgan-Stewart gland internal drive*

ployed in pumps in the form of glands may be in two basic forms, a single seal where only pressure conditions exist, or a double seal where both pressure and suction have to be dealt with. A typical example of carbon glands used in a modern pump and made by The Morgan Crucible Co., Ltd., London, is seen in Figs. 1 and 2, showing respectively a double acting Morgan-Stuart gland for resisting pressure and suction, internal drive type; and the same type of carbon gland for external drive. The gland operates axially, a graphitic carbon ring providing a running seal against a fixed seating in the pump; while although the carbon ring is driven by the shaft, it is

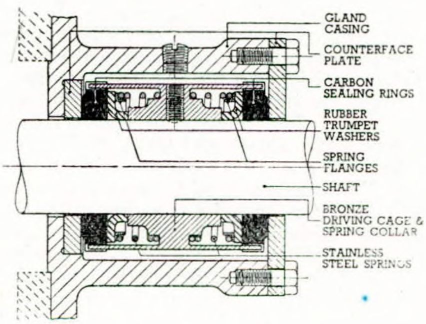


FIG. 2.—*Double-acting Morgan-Stewart gland external drive*

free to slide along the latter, the ring being sealed to the shaft by the synthetic rubber washer which forms a feature of this system. These washers are made from synthetic rubber and successfully withstand water or oil up to temperatures of 100 deg. C., also petrol and other solvents and chemicals. When the pump is in operation, the rubber washer which is initially flat, takes up a characteristic shape when sprung in position, with its sealing lip embracing the shaft and its flat surface making a flexible seal against the carbon ring, towards which it is pressed by the spring holding the working face of the carbon ring against the counterface which forms its seating. Under permanently wet conditions, the loading of carbon bearings can be several hundred pounds per square inch at speeds of several hundred feet per minute. In one instance where the bearings are in use on a fuel pump, there is a bearing load of 1,250lb. per sq. in. at a surface speed of 850ft. per min., the wetting medium being the paraffin fuel pumped.—*A. E. Williams, Cheap Steam, Vol. 32, May 1948, pp. 59-60.*

Operating a Geared-turbine Unit

This article presents the various steps involved in operating a geared-turbine marine unit. The main headings and the various items dealt with under each heading are: *procedure at sea*, adjust pressures, temperatures, nozzle openings, etc. to level required for standard speed, check lubrication system, the astern valves and vacuum, keep an accurate log; *coming to anchor*, measure axial clearances, switch to manœuvring combination, open high-sea suction and close low-sea suction, and place auxiliary condenser in operation; *securing engines*, close manœuvring valves, engage and start turning gear, shut down air ejectors, shut off gland-sealing steam, open turbine- and throttle-drains, shut down condensate pumps, close bulkhead valves in steam line, secure main circulating pumps, disengage and secure turning gear after the turbines have cooled down, secure lubricating-oil pumps, and drain water side of lubricating-oil coolers. —*Marine Engineering and Shipping Review, Vol. 53, May 1948, pp. 71-73.*

Design Trends in Modern Marine Power Plants

There is a tendency to increase both the cargo-carrying capacity and the speed of ships. Increasing the power and speed of a ship has a double effect. It not only decreases the number of ships required but also permits the adoption of more economical forms of propelling machinery in the other. As a general rule it does not pay to adopt extreme engineering measures for the attainment of high fuel economies in the low power steam field. The subject of fuel economy becomes quite involved in a marine power plant. It is really the result of a combination of factors rather than the effect of a single factor. Broadly speaking, minimum fuel consumption is attained when the maximum amount of steam is generated for the amount of fuel burned; the maximum amount of useful energy realized from the steam so raised: and the maximum amount of low heat conserved. Theoretically at least the application engineer can project any of the foregoing elements from the present day practical or economic spheres of application into impractical and uneconomic spheres, with an equal degree of mathematical accuracy in either case. It is the wise engineer who knows where to stop on these ascending scales. As an example, boiler efficiencies can be increased by regulating the air-fuel ratio down to an absolute minimum for perfect combustion, where no margin of safety against the formation of carbon monoxide exists; and also by reducing the stack temperature to a point where there is danger of flue gas condensation on the air preheater or economizer tubing. Obviously this would be a dangerous procedure in either case. In oil-fired boilers, such as those used in the deep-sea trade, automatic combustion controls are widely used to maintain high efficiencies and yet maintain the proper margins for safety. Automatic stokers and combustion controls have been applied to a limited extent on the Great Lakes, and this is a step in the right direction. As the power ratings are increased the tendency is to take advantage of higher initial pressures and temperatures. In the 10,000 to 20,000 s.h.p. range, an initial pressure of 600lb. per sq. in. gauge and temperature of 825 deg. F. may be considered normal, and in larger horse-powers 850lb. gauge and 900 deg. F. Two bulk freight carriers in the deep sea trade have adopted 1,400lb. per sq. in. gauge pressure, 750 deg. F. temperature, with two stages of reheat. As the steam consumption of the propulsion power plant is progressively reduced by adopting higher initial steam pressures and temperatures, it becomes increasingly difficult to apply non-condensing steam driven auxiliaries and still maintain a satisfactory heat balance. The exhaust from such auxiliaries, as a general rule, is in excess of that which can be absorbed by the feed-water heaters. Even in cases where such auxiliary exhaust can be utilized for feed-water heating, it cancels the fine effect of the extraction system. The tendency in all modern marine power plants is to obtain auxiliary power at the lowest possible rate from turbine driven auxiliary generators which operate condensing. This prevents the auxiliary power needs from becoming a burden on the main power cycle. Steam for miscellaneous heating purposes aboard ship is obtained from extraction lines provided in the main turbine wherever possible. This eliminates throttling or available energy losses and further reduces the quantity of steam entering the condenser. Another tendency may be noted in modern marine power plant design, and that is to utilize alternating-current auxiliaries wherever possible.—*F. V. Smith, Iron and Steel Engineer, Vol. 25, April 1948, pp. 92-97.*

Christiansen and Meyer Latest Designs

The latest type of totally enclosed propulsion steam reciprocator built by Christiansen and Meyer of Hamburg, Germany, includes a new arrangement of valve gear. This consists of a rotary valve shaft immediately below the two piston valves, the shaft carrying a "reversible" slip eccentric for the actuation of each valve. The valve shaft is enclosed in the crankcase, but is readily accessible for examination; it is driven by spur gearing from the crankshaft. Thermally the engine is unaltered with its neat duplicated arrangement of two Woolf-type compound cylinders employing a single piston valve. The lower pressure cylinder is of the semi-uniflow type. The cranks of the two cylinders of each pair are at 180 deg. and the forward pair of cranks are displaced through 90 deg. in relation to the after pair. The two separate cylinder blocks are supported from the crankcase on short steel columns which give good access to the stuffing boxes and crankcase wiper glands. The firm has also developed a quicker-running engine laid out to incorporate a Bauer-Wach exhaust steam turbine when required.—*The Marine Engineer, Vol. 71, Annual Steam Number, 1948, pp. 249-252.*

Marine Power Plants of the Future

Before entering upon a discussion of possible future developments the author points out that the inertia against the discarding of the old and the adoption of the new is nowhere more self-evident than it is in the marine field. The fact that the sum total of all ships in the world consists of all age groups in itself becomes a barrier against sudden change. But as fuel prices rise, the position of all antiquated types of propulsion plant becomes more untenable. However, a solution of the economic problem involved in a modernization programme affecting ships in the middle-age group is much more difficult of solution than the economic problems relating to new ships. The tendency in the past has been to hang on to any apparatus which has been bought and paid for as long as it will work. Even 50 per cent fuel savings have failed to make a dent in this knotty old problem. Considering that fuel reserves are steadily shrinking, "by force of necessity we may be compelled sometimes in the future to adopt the most economical forms of power-generating equipment whether we wish to or not". Fuel even may be rationed for essential services. In the steam turbine field the experiences made in land stations with steam conditions of up to 2,000lb. per sq. in. and 1,050 deg. F. are available to the marine field any time that such application can be justified economically. A thorough investigation is being made of turbine speeds with the object of further reduction in weight and dimensions. In the high-power field of marine application, turbine gear units have already been built with speeds ranging from 6,000 to 7,500 r.p.m. Turbine rotor speeds of 10,000 r.p.m. have become quite commonplace for auxiliary turbine generators. Marine turbines are now designed for furnishing both propulsive power and extraction steam for heating the feedwater and other miscellaneous heating purposes. With regard to trends in reduction gear design, the author points out that engineers are now speculating on the possibility of applying planetary gears to the high power field. Because of the compactness and light weight of planetary gears, they might be used not only in the straight mechanical forms of speed reduction, but they could also be placed between the turbine and generator in turbo-electric drives. A similar gear could be placed between the motor and propeller shaft. One of the main difficulties encountered in the application of high-pressure high-temperature steam in marine power plants is the proper co-ordination of the propulsive power and auxiliary power requirements within the same steam and feed cycle. The author therefore suggests that in a high-pressure power plant—850lb. per sq. in., 900 deg. F. and above—it would be much better to provide a secondary boiler plant to furnish lower pressure steam for heating and other miscellaneous services. This would eliminate the many high-pressure reducing valves with their attendant throttling losses. This boiler could be of the seperately fired type, or it could make use of a liquid type of heat transfer agent from the main boilers as the heating medium.—*Paper by F. V. Smith, presented before the New York Metropolitan section of The Society of Naval Architects and Marine Engineers on 30th March 1948; Marine Engineering and Shipping Review, Vol. 53, May 1948, pp. 64-68.*

Hydraulic Couplings for Marine Main Drives

Data are given for the design of Vulcan hydraulic couplings for use between engine and propeller. A set of standard dimensions are shown on a diagram, and design curves are given for both oil and water as the driving fluid. Tests have shown that welded couplings have less slip for the same power, diameter, and speed than cast couplings, because of surface smoothness. A formula is derived for the calculation of the slip in a coupling when all the engines of a multiple-engine drive are not in use. This type of coupling has been used to transmit power up to 30,000 h.p. at 450 r.p.m. and for speeds up to 2,000 r.p.m. It is not used for speed variation, and is not considered effective for vibration damping. The couplings are comparatively heavy, bulky, and expensive; they can be designed with an efficiency of about 98 per cent, with an oil emptying and filling time from 3 to 15 seconds.—*Abstract No. 1786, Journal of The British Shipbuilding Research Association, Vol. 3, No. 5, May 1948; B.I.O.S., Miscellaneous Report No. 67.*

Italian Diesels

Medium-powered Diesels are produced by the Italian firm of Ansaldo, Genoa, for generating sets and the propulsion of coasters and fishing vessels. These engines are manufactured in three types. The smallest of these develops 30 b.h.p. per cylinder at 430 r.p.m., while a larger type develops 50 b.h.p. per cylinder at 360 r.p.m. Both types are built as three-, four-, and six-cylinder units, the smaller also in a two- and the larger in a seven-cylinder unit. The third type develops 100 b.h.p. per cylinder at 275 r.p.m. and is made in six- and nine-cylinder models. All engines have a single-piece enclosed frame in cast iron, embodying the water jackets and a trough for the camshaft. Cast-iran cams are mounted on this shaft, which can be withdrawn sideways. Wet type liners are of centrifugally cast iron. Each cylinder has a separate head, carrying the single inlet and single exhaust valves in cast iron cages, a centrally disposed injector, starting and relief valves and a test cock. The cast iron pistons carry five pressure and two oil-control rings; the gudgeon pins are of case-hardened steel with bronze bush; the connecting rods are of I-section in the two smaller models, but a round section is used for the rods of the largest engine type. The one-piece crankshafts are of 28/32-ton steel, and of dimensions larger than those required by Lloyd's regulation, in order to take severe criticals out of the running range. Camshaft and governor are gear-driven from the flywheel end of the main shaft; lubricating oil and water pumps are gear-driven from the forward end. Lubrication is carried out under pressure from a gear-type pump, and the system is complete with cooler and two-section strainer; cooling is by sea-water through a reciprocating pump; a second pump is provided in the propulsion engines for bilge service. Fuel injection is by Bosch equipment with a separate pump for each cylinder; and in the largest type fuel oil is supplied to the injection system by a fuel feed pump. This engine also has a separate fresh-water cooling system for the nozzles, maintained by a separate pump directly driven by the engine. Engine starting is by air through valves in the covers controlled pneumatically by a rotary valve.—*Gas and Oil Power, Vol. 43, May 1948, p. 156.*

Bethlehem Reconditions a 108-ton Crankshaft

When the Navy Supply Ship, KA8, now known as the M.V. "Algorab", arrived at the San Francisco Yard in September 1947, her Sun-Doxford Diesel engine had been stripped to the bedplates and the parts stored in the vessel's cargo holds. Necessary re-conditioning was carried out before the engine was re-assembled. This article is, however, primarily an illustrated account of the re-conditioning of the 108-ton crankshaft of the vessel. The stub end and pins had shown signs of working loose, and they were built up by welding. They were then machined to fit the webs which had previously been re-bored. The webs were heated to a temperature between 600 and 700 deg. F. before the pins and stubs were shrunk in place. After the shrinking operation, each crank section was checked in the lathe for trueness. Main journals were re-machined, cranks were lined up and new coupling bolts fitted. The re-conditioned crankshaft was then put back into the "Algorab" section by section.—*Abstract No. 1788, Journal of The British Shipbuilding Research Association, Vol. 3, No. 5, May 1948; MacDonald, P., Pacif. Mar. Rev., Vol. 45, March 1948, p. 43.*

Notes on the Operation of the "Beavers"

This article recapitulates the salient features of the boiler installations in the "Beaver" class vessels of the Canadian Pacific Steamship Co. and in particular discusses the design and control of the Melesco superheater and reheater. The reheater damper is in one piece and extends for the full length of the reheater, allowing complete control of gas flow. The superheater damper is in two sections and partially controls the gas flow over the superheater surface. The by-pass damper is fitted so that the economizer can be isolated when raising steam. It is stated that the simplicity with which control of steam temperature can be obtained, notwithstanding the high working pressure and full-load temperature, has been demonstrated in service, experience which will doubtless interest owners and superintendent engineers having regard to the tendency during recent years to adopt the twin-furnace boiler in order to control steam temperature under varying conditions of load and operation. It is pointed out that the question of damper or furnace control of gas conditions is a controversial one: for the latter it is claimed that it is more efficient than the former, as the gas conditions over the superheater are controlled by the amount of oil burnt in the outboard or inboard furnaces, whereas with the simpler damper control the gas leaving temperature tends to increase due to the by-passing of the superheater surface. This, however, need not result in loss of efficiency, as the heating surfaces of economizers and air heater will maintain the funnel base temperature at an economical figure. As normally in merchant ships, control is only necessary when lighting-up and manœuvring in or out of port, the complication of twin furnaces, manipulation of burners, and air pressures may be considered superfluous, when the desired result can be obtained, as in the "Beaver" ships, by the simple operation of a damper. In service it has been demonstrated that the operation of the boiler and control of steam pressure and temperature do not present any difficulty. The procedure before lighting-up may be interesting to follow: the superheater by-pass damper is opened fully; the reheater balance and shut-off damper are shut; and the economizer by-pass damper fully opened. When the steam pressure has reached about 300lb. per sq. in., the turbine is started at idling speed and the boiler pressure gradually increased to 800lb. per sq. in. Just before full pressure is reached the economizer by-pass damper is shut; when the water in the boiler has reached the working level the centrifugal feed pump is started. When the vessel is ready and manœuvring can begin, the reheater balance and shut-off damper are opened slightly; it has been found by experience that the steam temperature can then be maintained steady at about 800 deg. F. When the "full away" order is received the remaining burners are lighted up, the superheater by-pass damper is shut, and the reheater balance and shut-off damper are opened sufficiently to give equal steam temperatures at the superheater and reheater outlets.—*The Marine Engineer, Vol. 71, Annual Steam Number, 1948, pp. 258-260.*

A Method for the Determination of a Ship's Stability at Sea

This paper gives the results of experiments made with a 20-feet model of a large vessel. The object of the tests was to determine the stability of the model from measurements of its rolling motion in irregular waves, without knowledge of loading conditions. The paper includes a graph showing curves predicated upon rolling data obtained by two instruments, namely (1) a roll recorder and (2) a recording roll analyser. The method of determination of the stability curves is based on the fact that, if the cross curves of stability are known, the stability curve can be found, if the displacement and location of centre of gravity are known. In an appendix to the paper it is shown how the centre of gravity can be located without knowledge of loading details, if the angle of heel of a ship (if any) and the slope of the stability curve at that angle are known. This slope can be found from the natural period of roll of the ship by equation. Thus the only information required to locate the centre of gravity is the knowledge of the ship's displacement, period of roll, and angle of heel, if any. It is assumed that the ship's displacement can be found with fair accuracy from draught gauges and that the angle of heel (average list, if the ship is rolling) can be determined by available or procurable means. However, for these experiments, displacement and list were determined in still water and only the natural period of roll was determined by measurements in a seaway. The determination of the natural period from the actual roll of the ship is the most difficult step in the procedure. At present the two aforementioned instruments are used. In the case of the roll recorder, the angle of roll of the ship is recorded and plotted against time. From this record, periods of successive rolls can be found. If the latter are tabulated and distribution curves plotted (percentage of rolls having a given period plotted against that period), the most often occurring period, the peak of the distribution curve is invariably close to the natural period. If a selection is made, tabulating only rolls of fairly good wave shape and not too large an amplitude (the latter being forced rolls in all likelihood), sharper distribution curves result. With the recording roll analyzer, the rolling of the ship is recorded magnetically on a steel tape and a spectrum analysis of the frequency components is made with a recording roll analyzer which will be described in a future paper. This instrument is fully automatic and the spectrum is drawn by a recording meter. The method described in this report assumes that the hull is intact and that the cross curves of stability apply. Dynamic measurements then give information which helps to locate the virtual centre of gravity. Thus, if free surface is present, the predicted stability curve does not include the effects of pocketing; in the case of free communication with the sea, considerable errors are possible at large angles. However, a fair approximation of the stability curve at small angles seems always possible. If the ship trims considerably, enough to affect the stability, then the amount of trim must be known and data must be available (either computed from the shape of the hull or measured from model experiments) to duplicate the cross curves of stability at all possible values of trim.—*Paper by Captain J. E. Kiernan, U.S. Navy (retired), read at the Spring Meeting of The Society of Naval Architects and Marine Engineers, New York, on 27th May 1948.*

Airport with Polaroid Screen

In what is believed to be the first peace-time application to marine service, pivoted escape-type airports are being installed in American Export Lines vessels now undergoing reconversion. Adjustable polaroid glass allows the occupant of a ship's cabin equipped with these airports to control the intensity of light entering through airports from a maximum to zero. In order to permit the use of this polaroid screen and still adjust the amount of outside air entering the cabin, a mechanism has been added which permits the glass to move out parallel to the plane of the port. The sides of the housing will keep any direct light from the outside entering the cabin and still permit privacy while ventilation is obtained.—*Marine Engineering and Shipping Review, Vol. 53, May 1948, p. 118.*

New Italian Railways Ferryboat

The first of two new ferryboats for the Italian State Railways, the motor vessel "Aspromonte", was recently launched from the Riva Trigoso shipyard of the Cantieri del Tirreno (Genoa). Both vessels will be in service on the Messina-Reggio Calabria and Messina-Villa San Giovanni ferryboat routes by the end of the year. The main particulars of the new vessel are as follows:—

Length of railway deck...	306ft. 4in.
Length, b.p.	296ft. 10in.
Breadth moulded ...	39ft. 4in.
Maximum width of railway deck	50ft. 6in.
Draught at full load	12 feet
Displacement at full load	2,735 tons
Maximum load ...	18 wagons*
Accommodation ...	500 passengers
Service speed at full load	12½ knots

The railway deck carries three standard-gauge tracks converging forward into one central track for loading and unloading vehicles over the bows. The main propelling machinery consists of two Tosi 7-cylinder Diesel engines, each developing 1,200 h.p. at 235 r.p.m. or 1,500 h.p. at 252 r.p.m. They are reversible, and have a cylinder diameter of 465 mm., and 500 mm. stroke. They are direct-coupled to the shafts. Electric power at 220 volts d.c. will be supplied by three 100 kW. dynamos, each driven by a type CNR T4, 4-cylinder Diesel engine of the 4-cycle direct injection type developing 135 h.p. at 650 r.p.m. All three generator groups are housed in the main engine room. Two will supply the current required for the auxiliary services on board, all of which will be electrified, while the third will be a standby. A Voith-Schneider bow rudder is fitted to facilitate berthing.—*The Shipping World, Vol. 118, 26th May 1948, p. 523.*

Passenger Steamship "President de Cazalet"

The twin-screw passenger steamship "President de Cazalet", which has recently been completed at the Neptune works of Swan, Hunter and Wigham Richardson, Ltd., is for the service of the Compagnie de Navigation Mixte, of Marseilles. The principal dimensions are:—

Length overall ...	402ft. 0in.
Breadth moulded ...	53ft. 4in.
Depth moulded to upper deck...	27ft. 3in.

The ship is designed to carry a deadweight of 2,030 metric tons on a mean draught of 19ft. 5in. The ship has a raked stem of plate construction and a cruiser stern. A combined poop, bridge and forecastle form a promenade deck and upper and main steel decks run all fore and aft. In addition there is a lower deck clear of the machinery space. The propelling machinery consists of two sets of Parsons type single-reduction geared turbines designed to develop 10,000 s.h.p. collectively in service at about 165 r.p.m. of the propeller shaft. This machinery was constructed in the builders' Neptune engine works. Each set consists of three turbines each driving its own pinion. The high-pressure turbine has one two-row impulse wheel followed by reaction stages. The impulse blading is made from Hadfield's Hecla A.T.V. steel, as are the vanes in the phosphor-bronze impulse nozzle casting. The reaction blading is of stainless iron and is on the end-tightened type. The i.p. turbine is of all-reaction type, with end-tightened blading. Incorporated in the same casing but separated from it by a diaphragm is the h.p. astern turbine, consisting of one three-row impulse wheel. The l.p. ahead turbine is also of all-reaction type, whilst the l.p. astern turbine, accommodated in the exhaust end of this casing, is composed of a two-row impulse wheel followed by reaction stages. The two astern turbines give a combined output of 70 per cent of the normal ahead power. The reaction blading throughout is built up in sectors with mild steel packing pieces and secured in grooves by side locking strips of Lowmoor iron. All parts of the turbine casing which are subjected to the action of superheated steam, namely the h.p. ahead, i.p. ahead, h.p. astern and l.p. astern turbines, are made of annealed cast steel, whilst the l.p. ahead turbine casing is of the close-grained iron. The turbine casings are rigidly bolted to the gearcase, whilst at the forward end the supporting feet are machined and free to slide longitudinally, to allow for expansion. Each turbine is provided with an adjusting block to control the axial clearance in the machine. The single-reduction gearing is of the double-helical type, the reduction ratio being about 20 to 1. The pinions, of normalized nickel steel, are connected to the turbine rotors through flexible claw couplings. A mild steel rim is shrunk on to the built-up main wheel, the whole gearing being housed in a fabricated steel gearcase. Weir's closed feed system is employed. The two main condensers are of the two-flow Weir regenerative type, and are slung underneath the l.p. turbines, the weight being carried by spring supports. Steam is supplied by two La Mont boilers manufactured under license by John Thomson Water Tube Boilers, Ltd., Wolverhampton. Each boiler is designed to operate under the following conditions:—

Evaporation, normal power	55,000lb. per hr.
Working pressure in drum	500lb. per sq. in.
Final steam temperature	734 deg. F.
Feed temperature	275 deg. F.
Maximum evaporation ...	80,000lb. per hr.

Steam for accommodation heating and ship's services generally, is supplied by a small La Mont forced-circulation boiler, designed for a working pressure of 50lb. per sq. in., and burning oil under cold air forced draught.—*The Marine Engineer, Vol. 71, Annual Steam Number, 1948, pp. 241-248.*

* Italian wagons measuring 32-feet overall and weighing 26.4 metric tons when fully loaded.

The Investigation of Dewpoint and Related Condensation Phenomena in Flue Gases

The first part of the paper describes two dewpoint instruments which have been developed for investigating the sulphur trioxide content of boiler flue gases. Both are based on the detection of the change in electrical conductivity occurring when a film of sulphuric acid condenses between two electrodes embedded in a glass surface. One instrument, referred to as the external instrument, involves the continuous withdrawal of the flue gases from the boiler and over the glass detector surface, while in the second, referred to as the internal instrument, the detector surface is inserted directly into the gas stream of the boiler. The second part discusses the different types of conductivity phenomena met with in studying the condensation of (a) water, (b) sulphuric acid, and (c) metallic salts, with the aid of the instruments described. These phenomena have been identified and explained by observing the effect of time, temperature, gas velocity and change of atmosphere on films condensed from boiler flue gases and by comparing the results so obtained with observations made in the laboratory.—*Journal of The Institute of Fuel, Vol. 21, June 1948, pp. 248-253.*

Latest Blue Star Single-screw Steamships

The recently completed "Uruguay Star" is the third of four similar single-screw vessels for the Blue Star Line's South American service ordered from the Birkenhead yard of Cammell Laird and Co., Ltd. The vessel is of the following main dimensions:—

Length overall ...	501ft. 0in.
Breadth moulded ...	68ft. 0in.
Depth to upper deck	39ft. 6in.
Maximum draught	30ft. 6in.
Gross tonnage ...	about 10,720 tons

The vessel has a raked stem, cruiser stern, well-proportioned streamlined funnel, and single-pole mast. There are three steel decks continuous all fore and aft, a bridge deck amidships, forecastle, poop, 135-feet passenger and boat decks, a navigation bridge and a docking bridge. The main propelling machinery comprises one set of three-casing Parsons type reaction turbines driving a single screw through double-reduction gearing. The set consists of h.p., i.p., and l.p. turbines of the all-reaction type, capable of developing 8,700 s.h.p. at a propeller speed of 104 r.p.m. when supplied with superheated steam at a pressure of 415lb. per sq. in. and a total temperature of 740 deg. F. at the turbine stop valve. Astern turbines of the impulse type are incorporated in the i.p. and l.p. casings and are designed to develop about 60 per cent of the ahead power. Connexions are provided from all turbine rotor glands to a common receiver which provides the glands with steam to prevent loss of vacuum; alternatively it can receive steam leak-off depending on the steam pressure in each cylinder. A gland evacuation system, comprising a vapour condenser with a steam ejector, is fitted to keep the engine room atmosphere free of steam and vapour. The gearing is of the double-helical double-reduction interleaved type. The primary gear teeth are of the all-addendum type and the gear teeth of the secondary train are of the deep involute type. The gearing is enclosed in a strong iron case. Steam is supplied by two water-tube boilers of the Babcock and Wilcox small-tube single-pass sectional type, designed for a working pressure of 430lb. per sq. in. with a temperature of 750 deg. F. at the superheater outlet. The boilers work under Howden's system of forced draught with tubular air heaters. The boilers are equipped with a Bailey combustion control unit and with electrically controlled steam blowers. The function of the Bailey automatic combustion control system is to maintain fuel and air input to the furnace in accordance with the demand for steam and to proportion the fuel and air supplies for maximum combustion efficiency. The soot blowers were supplied by Clyde Blowers, Ltd., and are electrically operated and controlled from a central control panel situated on the firing platform.—*The Marine Engineer, Vol. 71, Annual Steam Number, 1948, pp. 261-265.*

ENGINEERING ABSTRACTS

Section 3. Shipbuilding and Marine Engineering

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Studies on Anti-fouling Compositions

This paper forms part of a series of studies on anti-fouling compositions made by the Marine Corrosion Committee of the Metallurgy (General) Division of the British Iron and Steel Research Association. Following a discussion of the factors affecting the rate of release of cuprous oxide from anti-fouling compositions, consideration is given to the methods of storage of leaching slides in order to compare anti-fouling behaviour with leaching-rate determination. Sea storage is considered desirable when large numbers of compositions are to be tested. The relation between the loss on raft panels and that given by leaching-rate determinations has been investigated. By leaching-rate determinations and assessment data on replicate panels, the critical leaching rates necessary to prevent the establishment of some important fouling organisms have been determined for average exposure conditions. It is shown that a rate of 10 μg sq. cm. per day will prevent the settlement of forms other than algæ. Data are presented on the loss of copper from experimental compositions under varying conditions of service. It is shown that the loss in service is greater than that from the same composition when exposed on the raft.—*H. Barnes, Journal of The Iron and Steel Institute, Vol. 159, Part 2, June 1948, pp. 175-185.*

Fatigue Testing of Structures

At the recent meeting of the British Welding Research Association at Abingdon Hall, Dr. R. Weck gave a brief account of the work in progress on fatigue testing of structures. He added that at present two lines of research were being followed—one on the determination of the best method of making joints in angle stiffeners of ships' plating, and the other on the influence of internal stresses on fatigue strength. The structures that were being tested at the moment were sections of ships' bulkhead or decks, to which angle stiffeners were attached containing various forms of butt joints, the object of the tests being to determine the type of joint that gave the highest fatigue strength. Five different types of joint were being tested, and four specimens of each type had been made. A typical specimen was on exhibition in the fatigue testing machine; the remainder were being X-rayed by the Admiralty to determine the condition of the welded joints. The resonance method of testing was employed, since this was the cheapest, and gave very satisfactory results. Only light equipment was required to enable high stresses to be produced in large specimens. For example, with a specimen made from 10-feet by 2-feet by $\frac{5}{16}$-inch plate stiffened by two 6-inch by 3-inch by $\frac{5}{16}$-inch angles, it was possible, with the application of only a few horse-power, to attain stresses of over 14 tons per sq. in. on continuous running. This resonance method of vibration enabled the strain in the specimen to be maintained constant by controlling the amplitude; this control operated on the motor speed which vibrated the specimen at a point near resonance.—*Transactions of The Institute of Welding, Vol. 11, June 1948, p. 39r.*

Methods for Determining the Developed Blade Surface of Screw Propellers with Rake

The authors point out that the approximate method suggested by Holst and in current use for the determination of the developed blade surface requires a correction if raking of the blades is resorted to. Three methods available for the correct layout of the developed blade surface are described. Deviations from the old design are considerable, particularly in the case of screw propellers with large rake. These deviations do not, however, affect the relationship which exists between the developed and the projected blade surface. The corrections to be applied to Holst's method in the case of aerofoil profiles, which were given on a previous occasion by the authors, are still valid. As is also the special correction which has to be made in view of the increased curvature of the blade section near the hub boss.—*W. P. A. van Lammeren and J. A. van Aken, De Ingenieur, Vol. 60, 26th March 1948, pp. W.35-W.41.*

Equipment and Methods Used in Operating the Newport News Hydraulic Laboratory

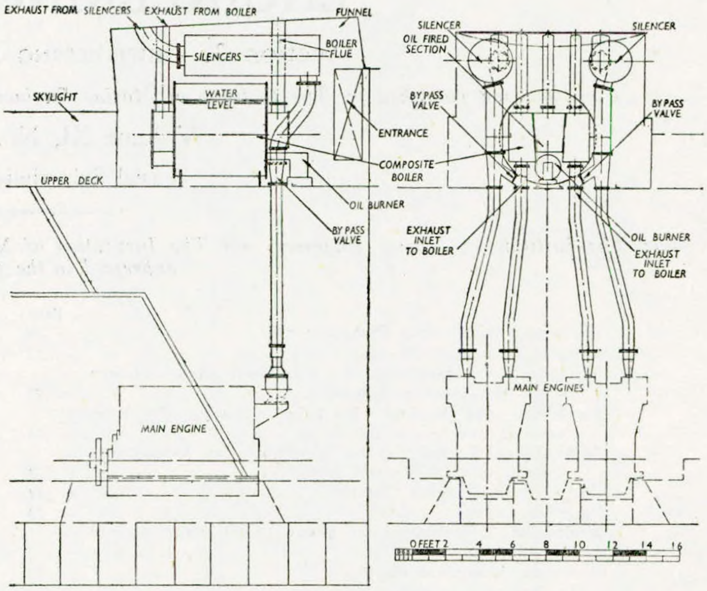
This paper describes the equipment and methods in use at the Hydraulic Laboratory and Ship Model Towing Tank of the Newport News Shipbuilding and Dry Dock Co., while three appendices give details of the technique discussed. The 56-feet tank available is one of the smallest now in existence which attempts to do serious resistance work. It is, however, believed that the small ship model will yield good, preliminary resistance results. The author explains that on important ships contracts the practice of his firm is to refine ship lines by testing a number of 5-feet ship models and then to have the David Taylor Model Basin tow a 20- to 30-feet model. This procedure was followed in the design of the S.S. "America" and the preliminary tests were extended to more than fifty different models. Among the numerous miscellaneous tests carried out there have been several launching tests, perhaps the most novel of which was that concerned with the first launching at the Wilmington, North Carolina, yard. Since there was not a sufficient length of deep water for the usual free run, it was necessary to alter the ship's course during the launching by means of a stern drag. The original plan was to fashion one end of a wire rope to the stern of the ship and the other end to a barge which was moored with a light, breakable line, upstream of the ways. The length of the wire rope and the position of the barge were such that the wire rope would take up taut immediately after the bow of the vessel came afloat. At this point the lines on the barge would break and the drag of the barge would swing the stern of the launched ship upstream in the channel. In model tests of this operation, it was required to know the path of the bow and the stern, the path of the barge, the force in the wire rope and the speed of the ship during the waterborne period of the launch. A photographic technique, involving interrupted light traces, was adapted to furnish the foregoing data. By means of various barge combinations, chain drop and anchor drags, sufficient information was obtained to reach conclusions on the quantitative items desired. At the actual launching of the ship simultaneous transit readings were taken and the actual path of the ship was plotted. A fairly accurate check was obtained.—*Paper by C. H. Hancock, read before The Society of Naval Architects and Marine Engineers at the Spring Meeting on 27th May 1948.*

A Study of Slotted Tensile Specimens for Evaluating the Toughness of Structural Steel

The cracking of deck plating of welded merchant vessels early in the war led to many American investigations into the causes of the fractures. As a result of numerous investigations the evidence obtained indicated that the cracks started at points of high strain and also that low temperature might be a contributing factor. An extensive programme of testing under the sponsorship of the War Metallurgy Committee of the National Research Council was planned, and various laboratories were assigned a part in the work in accordance with availability of equipment and personnel. One important part of the programme called for tensile tests of specimens made from flat plates ¾-inch thick, ranging in width from 6 to 72 inch and ranging in quality of the steel from rimmed to normalized fully killed. Slotted tensile specimens of rimmed- and killed-steel plate were tested at the David Taylor Model Basin to determine the effect of: (1) the temperature, (2) the sharpness of the notch at the ends of the slot, and (3) the ratio of the length of the slot to the width of the plate, on the tensile strength and on the energy for fracture, and also to determine the temperature of transition from shear to cleavage fracture. From these tests the authors draw the following tentative conclusions. (1) Slotted plates notched at the ends of the slot when tested at a range of temperatures can be used to determine a transition temperature for the particular geometry of plate and notch involved. Plates containing slots notched with a jeweller's saw are more sensitive for this purpose than plates containing slots notched with drilled holes. (2) Plates containing a slot equal in length to one fourth of the width of the plate, or greater, are satisfactory for the purpose of determining transition temperatures. (3) Plates containing diagonal slots and notches exhibit greatly increased values of energy absorption and greatly decreased values of transition temperature compared to plates containing slots perpendicular to the face of the plates. It is suggested that these effects are the result of a reduction in the degree of triaxiality of stress at the ends of the slot. In view of the greatly increased absorption of energy and the greatly decreased transition temperature found for the 45 deg. slotted plates, it is recommended that designers consider the possibility of using details at an abrupt change in section which takes advantage of this effect—*H. R. Thomas and D. F. Windenburg, The Welding Journal (New York), Vol. 27, April 1948, pp. 209-s-215-s.*

Composite Boilers for Coasters

The coaster collier "Fulham VIII" of the Fulham Corporation is equipped with a composite boiler which has an output of 700lb. of steam hourly, when passing about half of the exhaust gas from the Diesel machinery. This comprises two 820 b.h.p. Mirrlees four-stroke 12-cylinder V-type supercharged engines, running at 600 r.p.m. and driving a single propeller shaft through hydraulic couplings and reduction gearing. The propeller speed is practically 115 r.p.m. The boiler acts as a silencer, and the gas passes direct to the atmosphere after it has traversed the tubes. The makers are Spanner Boilers, Ltd. and the unit is known by the name of "Swirlyflo". Oil-firing equipment is provided, and the amount of steam raised by this means is the same as that obtained from the exhaust gas, so that the combined maximum output of steam is 1,400lb. per hr., the working pressure being 25lb. per sq. in. As the accompanying engraving shows, two separate exhaust gas tube nests are provided, each taking the discharge from one bank of cylinders. The oil-fired section is fitted with a Laidlaw Drew automatic pressure jet burner. When the vessel is at sea, the oil burner cuts in and out as necessary, meeting the full demand for steam. The capacity of the boiler using exhaust gas alone would, of course, be reduced at slow speed. It is stated that the boiler has given satisfactory results both on exhaust gas and with the automatic oil-firing system in operation, while the silencing is effective and there are no adverse results due to back pressure. The controls work well, notwithstanding the difficult problems presented in the operation of a boiler located close to the top of the funnel. As indicated in the illustration, the unit is installed on the upper deck. The boiler is a new design, and apart from the feature of automatic control, it has the advantage of limited dimensions for the output required, as the overall length is little more than 8 feet, the diameter being 5ft. 8in. An appreciable amount of welding is employed in its construction.—*The Motor Ship, Vol. 29, June 1948, p. 100.*



Propeller Losses

Apart from striking floating objects, there are several ways in which screw shafts may be broken. Exceptionally high stresses may be imposed on shafting from various causes; no more than continuous racing in a heavy sea may have serious consequences, and it is for this reason that automatic governing is now almost universal, and the unbalance resulting from a lost blade will obviously bear heavily on a screw shaft. In the first place, therefore, it is necessary to see that the propeller is securely fitted to the shaft, and for this, the shaft cone must be accurately fitted to the propeller boss, and the nut screwed up hard. Any initial slackness, either in the shaft cone or the propeller nut, must inevitably tend to a progressive increase in slackness, and a final loss of the propeller. The second danger is that the shaft may crack through the combined influence of fatigue and corrosion. At the propeller, the conditions are particularly favourable for corrosion, for the water there is well aerated, which stimulates the process. Cracks caused by corrosion fatigue, like any other cracks, start most readily at discontinuities, and the keyway in the cone provides a suitable starting point if the shape is not correct; many shafts in the past have cracked at this point, but nowadays, the advantages of having radius corners to the bottom of the keyway are so well known that trouble from this source should not be so frequent. Finally, stresses in the screw shaft may be increased through the influence of torsional vibration. It is apparent, therefore, that propellers may be lost from many causes, and an examination of the recent losses reveals two important indications of the reasons for the present casualties. In the first place, a large number of the ships affected were built in recent years, and secondly, the failures in "Liberty" ships have not been extended to ships of the same type built outside the United States. The first consideration seems to point to some reduction in the standard of workmanship in the fitting of propellers, for there has been no radical change in design since pre-war days. Force is added to this suspicion by the fact that the shafts and propellers of "Liberty" and other ships built abroad were produced on mass production lines, and the shaft cones and propeller bosses were machined to certain tolerances. The fitting of the propeller was, perhaps, not done with the exactitude which characterizes the hand-fitted job, as done in this country. On the second count, it has been officially stated that the failure of the shafts of the "Liberty" ships has been due to two causes, those due to cracks emanating from the forward end of the propeller keyway, and those due to corrosion fatigue. The incidence of corrosion fatigue was indicated by a circumferential groove round the shaft at the end of the liner, and this action was due to a defective seal at the propeller. This type of failure has now been practically eliminated. The cracking at the keyway is ascribed to torsional vibration, and torsiograph tests carried out on a "Liberty" ship have shown that there is a critical peak stress at about 78 r.p.m., when the ships are light, and 74 r.p.m. when they are loaded. Speeds approaching this range should, therefore, be avoided, and the American Bureau have recommended that the engines should not be allowed to run at more than 66 r.p.m., which means that the usual sea speed of about 11 knots is reduced to about 10 knots.—*Fairplay, Vol. 170, 20th May 1948, p. 1201.*

Evaluating Transition from Shear to Cleavage Failure in Ship Plate

During the early part of the last war certain welded merchant vessels developed fractures in the hull plating which, in many, instances, occurred with explosive suddenness and the fractures showed a degree of brittleness not ordinarily associated with the behaviour of normally ductile ship plate. This paper deals with the development of a laboratory scale test method capable of evaluating the susceptibility of ship plate to brittle or cleavage type fracture and with the correlation of the results of this method with those obtained from large-scale internally notched plate tests. The tear test, as the authors call it, utilizes a notched test specimen 3 by 5 inches by full plate thickness, which is asymmetrically loaded in static tension to complete failure under controlled temperature conditions. The load-extension diagram obtained for each specimen indicates the energy input required to (a) start initial failure and (b) propagate the fracture to completion. The latter was found to correlate with the mode of fracture, the energy value being roughly proportional to the percentage of shear in the fracture. The tear test method sharply defines the location of the transition temperature range of ship plate using either the absorbed energy to propagate tearing or the percentage of fracture in the shear mode as a basis of evaluating the change from ductile to brittle type failure.—*N. A. Kahn and E. A. Imbembo, The Welding Journal (New York), Vol. 27, April 1948, pp. 169-s-182-s.*

Repairing Aluminium Boats

The author, who is connected with a firm of builders of small craft with aluminium hulls, gives advice on the repair of tears or breaks in the hull. Arc welding is not recommended. However, the Heliarc (shielded gas arc method using argon) is highly recommended where available. In most cases the welding will be done with the oxy-acetylene gas welding torch. A good aluminium welding flux should be applied. It is not necessary to back up the seam during welding where the crack is more than 6-inch long; actual welding is preceded by tacking the seam at 1-inch intervals. Welding is done by the "puddling" method in which the parent or base metal is puddled with the filler rod. Care must be taken not to overheat the metal, as this could easily result in melting away a section of the hull. After welding, the outer weld surface should be ground off smooth with the hull surface. If the grinding does not remove all the surplus welding flux, it can be cleaned off with a 5 per cent solution of nitric acid, applied with a rag or a brush. This should be followed by rinsing with clear water.—*C. Bruno, The Welding Journal, Vol. 27, May 1948, p. 394.*

Leak Detection of Refrigerants

Leak detection methods now in use for refrigerating systems are as follows. (1) There is the soap bubble test in which leaks are detected by applying soap solution to the outside of the piping. The pressure of the escaping gas will cause the formation of soap bubbles. (2) By use of sound effects large leaks can be easily detected in a quiet space by the hiss of the escaping gas. Special electronic pick-ups are sometimes used. (3) The use of chemical swabs reacting with the escaping gas to form fumes is another method. With this method ammonia leaks are detected by the use of a sulphur taper. Leaks in sulphur dioxide systems are detected with a swab carrying saturated ammonia water. (4) The use of a halide torch is a device for reacting escaping refrigerant with copper in a flame, producing green colour if refrigerant is present. The halide torch is a very sensitive method and has gained wide acceptance in the refrigeration industry. The main objection is the use of an open flame which can be used only with halide refrigerants. (5) The other method is the colour tracer method. In a detailed description of the latter the authors state that attempts were made in the past to detect leaks by colouring the liquid refrigerant with various types of dyes. This method proved unsatisfactory and coloured tracing materials now in use are based on the mechanism of oil circulation in refrigeration systems, concentrated colour solution being made up in refrigeration oil. The material is prepared by purifying carefully the colouring matter so that it contains no constituents insoluble in the refrigerant. Some oil circulates at all times in refrigeration systems. Small amounts of oil are carried up with each piston stroke from the crankcase and with this oil is carried the colour. At any point where the coloured oil is in contact with liquid refrigerant the latter dissolves some colour and carries it along. Consequently, once colour has been introduced in a system, it continues to travel around during operation of the machine. As the leaks which are being sought are small ones there is time for a colour concentration to build up at the point of leakage although the colour strength inside the system may be quite low at the point of leakage. Oil separation will not stop the circulation of colour entirely. Apparently sufficient colour is carried along entrained with vapour to show up on the outlet side of the separator.—*D. H. Crampton and C. Winnefeld, Refrigerating Engineering (N.Y.), Vol. 55, March 1948, pp. 261-263.*

Sulzer Gas Turbine Fuel Control System

A gas turbine plant with a control system limiting the supply of fuel in relation to the air quantity is illustrated in Fig. 4. The installation includes a gas turbine (14) and there is a hydraulically actuated regulator for effecting the control. The free-piston power gas producer (10) has a combustion cylinder (13) working as a power unit and two compressor cylinders (12) to which air is supplied from the pre-compressor (1) through the pipe (15). The pre-compressor is driven by the gas turbine (4). The air, further compressed in the compressor cylinders (12), passes in the form of combustion and scavenging air through a pipe into the cylinder (13), in which it is further compressed and ignites the fuel, the quantity of which has been measured by the fuel regulating valve (3). After expansion the

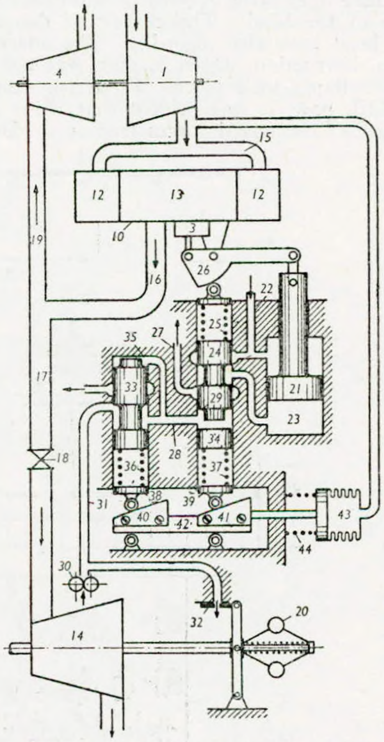


FIG. 4.—*Sulzer Gas Turbine Fuel Control System*

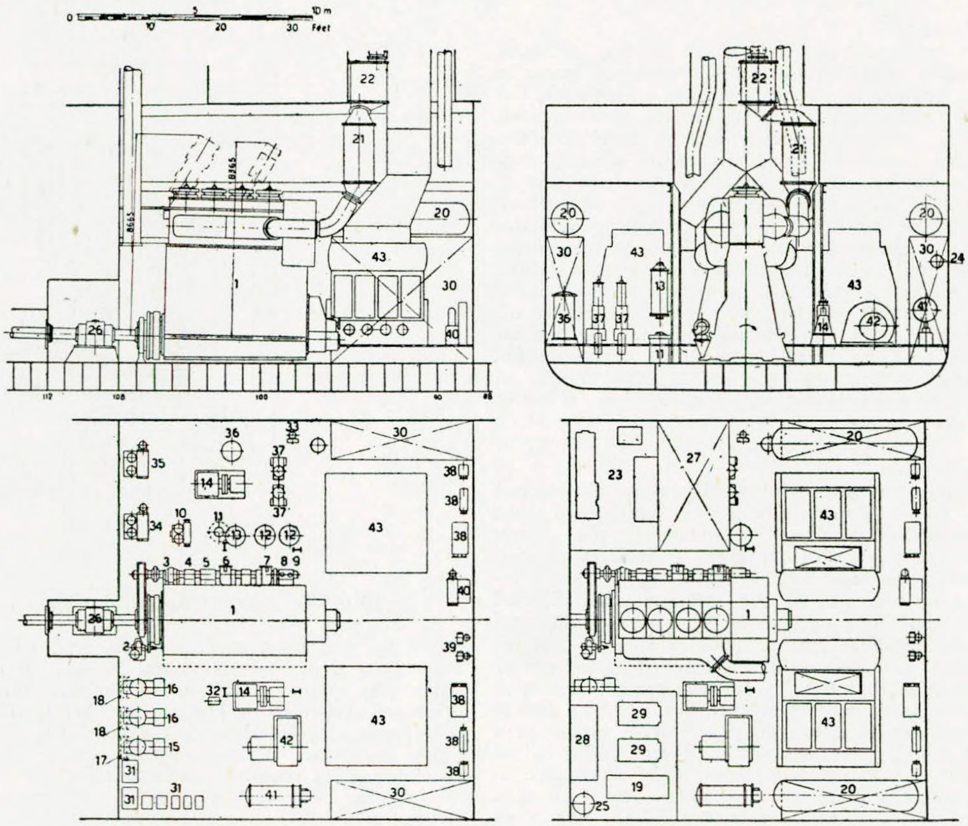
gas flows into the pipe (16) in the form of power gas, mixed with scavenging air. The gas passes through the pipe (17) and a throttle valve (18) to the useful output turbine (14), which may serve for driving a generator. The turbine (4) is also driven by the same power gas supplied through the pipe (19). The valve (3) for regulating the output of the free-piston engine (10) is operated from the governor (20) through hydraulically or pneumatically actuated mechanism. For this purpose a servo-motor is provided with a stepped piston (21) open on its upper side to the pressure in the supply pipe (22), while the supply and discharge of pressure to and from the space (23) is controlled by the valve (24). This valve (24) is connected through a spring (25) to the lever (26) and controls the pressure from the pipe (22) to the space (23) in the servo-motor cylinder and the discharge from this cylinder to the pipe (27). The face (29) of the valve (24) is under the pressure, adjustable by the governor (20) in the pipe (28, 31), supplied by the pump (30). The governor (20) controls the pressure in the pipe (31) by means of the throttle valve (32). In this regulating pipe (28, 31) is a shut-off valve (33) and a piston (34) opposite the control valve (24). The valve (33) is loaded on its upper side through the passage (35) by the pressure in the pipe (28), which also loads the piston (34) from above. The other ends of these members (33, 34) are loaded by springs (26, 37) with abutment plates (38, 39) adjustable by cams (40, 41), moved on the sliding bar (42), which is controlled by the bellows device (43) in opposition to the spring (44). The bellows device is connected to the pipe (15) and is adjusted by the pressure of the pre-compressed air.—(Patent No. 599,502, Sulzer Freres, Winterthur).—*The Oil Engine and Gas Turbine, Vol. 16, June 1948, p. 72.*

Pipe Bends

At the recent meeting of members of the British Welding Research Association, Mr. M. N. Gross explained that practical considerations had recently proved the need for further research work on pipe bends. During the late war it had appeared desirable to replace seamless imported pipe bends by the pipe bends manufactured in this country by welding. The British Welding Research Association undertook recently to carry out experiments so as to provide a comparison between welded and seamless bends subjected to internal pressure and to such external forces as would be produced by changes in temperature. Short portions of a high-pressure high-temperature pipe line, incorporating 90 deg. seamless and pressed welded pipe bends, were tested under internal pressure and under the action of external moments such as would be caused by an axial movement of the adjacent straight pipe when it expanded. The pipe bends were stress-analysed by means of brittle lacquer and electric resistance strain gauges, these later being applied on the inside as well as on the outside surface of the bend. The change of diameter and the deflexions of the bend were also recorded. The internal pressure tests were carried to destruction, whilst loading was applied in pressure-loss tests until collapse took place. From the results of the tests carried out up till now, it was evident that when a pipe bend was under the influence of external forces tending to decrease the radius of curvature, the dominant stress was a transverse stress located in the vicinity of what was thought in the past to be the neutral axis. That was borne out by theory and by a number of failures in service. The largest stress occurred at those points on the inside surface. Under the action of external forces alone and given static loading conditions, the pressed welded bend in the non-heat-treated state was found to be of equivalent strength to the seamless bend. The experiments had also shown that the load carrying capacity of pipe bends, seamless or welded, was not exhausted when the stress in a part of the structure reached the yield point, as was assumed by using limiting stresses as a basis for design. In fact, the investigated pipe bends carried about twice the load that produced the first permanent set, without suffering unduly large deflexions. As in other mild steel structures, the ratio (load causing failure)/(working load) was greater than normally expected.—*Mechanical World, Vol. 123, 4th June 1948, pp. 657-658.*

Liberty Ships with Diesel Engines

Several Liberty ships purchased by the Italian Government are being converted to Diesel-engined vessels. Of these the "Andrea C.", ex-"Ocean Virtue", has been transformed into a passenger liner and equipped with a 4,200 b.h.p. Fiat engine. Most of the conversions will, however, be carried out by the installation either of 2,400 b.h.p. or 3,350-3,600 b.h.p. Fiat engines. The plan for the 2,400 b.h.p. set to replace the Liberty steam engine is shown in the accompanying illustration. The Fiat engine installed has four cylinders and is of the single-acting type with cylinders 680 mm. bore and it runs at 125 r.p.m. It is believed that daily oil consumption will be reduced from 27 tons to 10·4 tons and that an average speed, loaded, of 11·1 knots will be maintained, and that there will be an additional cargo capacity of 900 tons on an 8,000-mile voyage. In addition to the "Andrea C." five more vessels will be converted, but in each of these a 3,600 b.h.p. Fiat eight-cylinder engine will be fitted to give a loaded



Engine room plan of the M.S. "Andrea C."

1.—Main engine. 2.—Turning gear. 3.—Generator. 4.—Fuel oil feed pumps. 5.—Lubricating oil pump. 6.—Fresh water pump. 7.—Salt water pump. 8.—Bilge-pump. 9.—Fuel nozzle cooling water pump. 10.—Lubricating oil pump. 11.—Lubricating oil filter. 12.—Lubricating oil coolers. 13.—Fresh water cooler. 14.—Air compressors. 15.—Lubricating oil purifier. 16.—Fuel oil purifiers. 17.—Lubricating oil heater. 18.—Fuel oil heaters. 19.—Diesel generator. 20.—Starting air vessels. 21.—Exhaust boiler. 22—Spark arrester. 23.—Workshop. 24.—Hot water tank. 25.—Fresh water pressure tank. 26.—Thrust bearings. 27.—Store room. 28.—Switchboard. 29.—Generators. 30.—Fuel oil tanks. 31.—Lubricating oil tanks. 32.—Drinking water pump. 33.—Sanitary pumps. 34.—Ballast and general service pump. 35.—Fire and bilge pump 36.—Evaporator. 37.—Boiler feed pumps. 38.—Manifolds. 39.—Boiler oil service pumps. 40.—Fuel oil transfer pump. 41.—Condenser. 42.—Boiler fan. 43.—Boilers.

service speed of 12·5 knots. About 750 tons additional cargo can be carried on an 8,000-mile voyage. The first of the engines intended for these conversions is now on the test-bed at the makers' works at Turin.—*The Motor Ship, Vol. 29, July 1948, p. 131.*

Chemical Descaling of Boilers

It has been known for some time that scale is removed from boilers by the alkali-phosphate system of internal boiler water conditioning. A typical case recalled by the author is that of a Babcock and Wilcox boiler with a capacity of some 20,000lb. per hour. This boiler had been purchased second-hand from a country district and the tubes were lined with a scale at least ½ inch thick, probably more in parts. After twelve months internal alkali-phosphate conditioning, a large proportion of the scale had been removed in suspension through the blowdown, and the balance was removed without effort by a turbine. Attempts to remove the scale by mechanical means prior to treatment had to be abandoned as the cutters had no effect. Descaling of evaporators in ships with alkali-phosphate mixtures has proved a reasonable proposition. The method is simple and involves filling the evaporator with water, adding a predetermined quantity of the chemicals and stewing for twelve to twenty-four hours at a gauge pressure of 5-10lb. per sq. in. Regarding the cleaning of evaporators, there are two schools of thought, one which believes in descaling the evaporator as a unit and the other which believes that only the coils should be descaled, and this is done by removal and submersion in a bath of inhibited hydrochloric acid. This same school believes that the shell of the evaporator should be left scaled up as a protective measure; of course there is a case for and against. At face value this theory might be applicable when fresh water is being evaporated; however, with sea water, bearing in mind the corrosion due to the breakdown of magnesium chloride, there is a strong element of doubt. The application of acid descaling is simple. The first step in the consideration of scale removal is an examination of the scale. Naturally the sample is important and should be representative of the hardest and most dense scale in the equipment. The simplest and most practical examination consists merely of submerging the section of tube or piece of scale in the solvent; observation will readily indicate whether or not it is effective. The concentration can be changed so as to obtain the lowest concentration consistent with dissolving or disintegration of the scale.—*W. J. Sinton, The Australian Engineer, 8th March 1948, pp. 51-54.*

Further Experiments with Bulbous Bows

A considerable number of passenger ships and fast cargo ships now operate at high speeds at which the adoption of a bulbous bow may possibly effect a coniderable reduction of the resistance. It is well known that for several ship projects a number of model tests have recently been conducted with various types of bulb designs. Previous investigations, notably those carried out by Taylor, have shown that very large bulb areas give the best results, but for various reasons there are strong objections to the use of such large bulb areas on merchant ships. In a few cases, however, bulbous bows with fairly large areas have been adopted also on merchant ships. This paper gives an account of a number of model tests in which the models were fitted with bulbs having an area between 5 and 10 per cent of the midship area. The belief is expressed that such moderate bulb areas might now be acceptable to owners and builders of modern ships. The models tested have dimensions and fullness corresponding to a modern twin-screw passenger or high-speed cargo liner of 400 feet length b.p. with a speed of about 18 to 20 knots. A cruiser stern of moderate size was used, its length being 2·65 per cent of the length between perpendiculars. The models were fitted with streamlined rudders, but had no other appendages. It is known that in several cases fairly large reductions in the resistance have been obtained by projecting the lower part of the bulb to form a "ram bow". There are of course some practical difficulties connected with the use of large protruding rams, but it seems possible that shipbuilders might be willing to approve a small ram. A second series of tests was therefore conducted with models having a ram bow of moderate size. In this series the forward ends of the water lines are rounded off with half circles to form part of a rotational body. The stem profile will thus have an outline of the same form as the half of the frame section at the forward perpendicular. The three models used in this series have the same bulb areas as in the first series, i.e. 5 per cent, 7·5 per cent, and 10 per cent respectively. The results of the two test series are summarized to the effect that with vertical stem even bulbs of moderate sizes such as of 5 to 7·5 per cent, undoubtedly yield considerable savings at higher speeds and may permit a ship to be driven at speeds which are very high compared with the fullness adopted. At all low speeds with the beam/draught ratio being 2·6, the model with the bulb of 10 per cent area exhibited a very large resistance. At 15 knots speed it gave 10 per cent larger resistance than the model with a bulb of 7·5 per cent area. In the case of the models fitted with a ram bow, large bulb areas were also found to exert an adverse influence at low speed but to be advantageous at high speeds. In the case of the 5 per cent bulbs and with a beam/draught ratio of 2·6 there was a rather larger reduction of the resistance due to the ram bow as compared with a vertical stem. At 19 knots the reduction amounted to 5·5 per cent and at 20 knots to 3·2 per cent. But with a beam/draught ratio of 3·0 the advantage of the ram was not so apparent as it amounted to only 1·8 per cent at a speed of 20 knots. With the 7·5 per cent bulb at beam/draught ratios of 2·6 and 3·0, the ram bow was found to cause a considerably larger resistance than the vertical stem at all speeds below 19 knots; but at higher speeds there was some gain due to the ram, amounting to 1·5 per cent at 20 knots with a beam/draught ratio of 2·6; with a beam/draught ratio of 3·0 the reduction in favour of the ram bow was 2·1 per cent at 20 and 21 knots.—*A. Lindblad, Publications of the Swedish State Shipbuilding Experimental Tank, Göteborg, No. 8, 1948. 20 pp.*

1,000 Miles with a Broken Rudder Post

At noon on October 22nd last year the S.S. "Heminge" of 3,229 tons gross, on passage from Halifax to the Bristol Channel, was experiencing very heavy weather, the wind blowing with hurricane force. In the afternoon the deck cargo of timber was lost and two hours later the vessel failed to steer. An inspection showed that the rudder post had fractured below the lower stuffing box in a completely inaccessible position. The vessel was then 800 miles west of the Irish Coast, and no further action could be taken that night; with the engines going at half speed she lay safely about four points off the wind. On the following day and under hazardous conditions, under the direction of the Chief Officer Mr. D. M. Jones, emergency repairs were undertaken. At first the idea of a floating rudder was conceived. This idea was abandoned, however, and it was decided to try to secure the ship's own rudder, and control it by means of chains. To make the rudder more accessible, the afterpeak tank was pumped out, and the forepeak tank flooded. A line was passed through the gap between the rudder and the sternpost by means of a long pole composed of four 15-feet lengths of 3-inch by 3-inch timber lashed together. It was found possible to thrust the end of the pole with the rope attached through the gap between the second and third pintles. This line was successively replaced by a wire and a ⅝-inch chain, the middle of which was brought against the rudder. The two ends were brought together at the stern, crossed and a large cargo shackle slid down around them to fetch up against the rudder plate. The two ends of the crossed chain were then led forward, one on each side of the stern. Derrick topping lift tackles with 2½-inch wire and 9-inch threefold iron blocks were shackled on to the ends of the chains and made fast to the protruding ends of the bunker derricks. The hauling part of these tackles was led from the derrick ends right aft to the stern mooring leads, then forward to the barrels of the mooring winch. Here they were secured on the barrels by small wire lashings, the wires being led over the port and under the starboard one. Thus by simple reversing the rudder could be moved to port or starboard as required. The work was completed on October 27th, five days after the initial breakdown, when the deep salvage tug "Bustler" arrived, which was requested to stand by until the rigging of the emergency gear was completed. The "Heminge" got under way at an initial speed of six knots with the "Bustler" in attendance. Unfortunately, a fresh gale sprang up on October 29th, and the gear was carried away. Renewed repairs were completed the following day and the voyage was resumed at a speed of nine knots. Further troubles were encountered both from chairs breaking and the wire stretching and jumping off the winch barrels. The process of passing a messenger between the stern and rudder posts by means of a long pole had to be repeated. This time proper 1⅛-inch steering chains were used instead of cargo chains. As a further precaution the main chains on each side were lifted on each quarter in the bight of a lighter chain. After two more breakdowns the "Heminge" made contact with tugs on arrival in Swansea Bay on November 5th.—*Merchant Navy Journal, Vol. 10, April/June 1948, pp. 12-13.*

Ease Down When You Blow Down

The Proceedings of the Merchant Marine Council, United States Coast Guard, report a recent fatal accident in which a second assistant engineer was scalded while clearing an evaporator blow-down line. Prior to the accident, the second and junior third assistant engineers were on watch, during which time it developed that the evaporator blow-down line was clogged up. The second assistant engineer first attempted to blow down the line by building up steam pressure on the evaporator to between 5 to 10lb. per sq. in. Since this did not clear the line, he decided to remove the blow-down valve and use a plumber's snake. He crawled under the floor plates to get into position to work on the valve. He then removed the reach rod and all bolts from the valve flanges, except two bolts which he left loose, and swung the valve off the line. He inserted the plumber's snake (the blow line was about 2 feet long) and began to work it. In a matter of seconds, the snake cleared the line, and steam and hot water gushed out on him. Because of his precarious position under the floor plates, he was trapped. He was finally released, but died within nine hours. If he had removed the floor plate in front of the evaporator, and had eased down on the pressure, he would have had an escape, and the casualty could have been avoided. In every case where there is pressure on a line—be it steam pressure, hydraulic pressure, fuel or lubricating oil pressure—it must be relieved before ever attempting to work on the line. This is a fundamental principle of marine engineering.—*Marine Engineering and Shipping Review, Vol. 53, June 1948, p. 82.*

Model Tests with a Small Ferry

This paper gives short account of tests conducted on the model of a small mechanically propelled ferry. The specifications called for equal efficiency when travelling in either direction, both forward and aft propellers being provided for this purpose. It was also specified that both propellers should be coupled with a single engine and that they should be operating simultaneously. The principal dimensions of the vessel were to be the following:—

Length on water line...	35·39 m.
Breadth on water line	8·40 m.
Draught	2·45 m.
Displacement volume	365 cu. m.
Wetted surface	338 sq. m.
Block coefficient	0·501
Ⓧ coefficient	0·785
Prismatic coefficient	0.638

The propellers were to be made exactly alike with symmetrical blade forms and lens-shaped blade sections, having a diameter of 1·60 m., a constant pitch of 1·55 three blades each and a ratio of developed area to disk area of 0·42. The propellers were estimated to absorb together a total of 400 h.p. at 275 r.p.m. The scale of the model was 1 : 8·5. The paper includes a table giving results of towed tests, and results of free tests with each propeller are charted. Somewhat different results were obtained for the two propellers, due to the respective conical bosses facing in opposite directions. Self-propelled tests were carried out with the propellers working together, and thrust and torque were measured both for the forward and aft propeller. In order to separate the respective effects of the two propellers, self-propelled tests were carried out with either of the propellers working alone. This arrangement was found to have low efficiency owing to the lone propeller. The value of the total thrust deduction coefficient was found to be large as compared with the mean wake fraction. This resulted in a low hull efficiency and, consequently, in a low propulsive efficiency. The thrust deduction coefficient was shown to be much greater forward than aft. The increase in resistance on account of an increase in pressure forward was evidently greater than the increase in resistance which resulted from the reduction in pressure due to the aft propeller. In relatively short vessels, such as the one investigated, it is probable that the slipstream from the forward propeller causes a reduction of wake around the aft propeller with consequent diminution of efficiency. Although not an ideal, yet in this case an acceptable measure of the suitability of the different alternatives, the expression $K=(N_s-N_{sA})/N_{sA}$ was used, where N_{sA} is the shaft horse-power when only the aft propeller is working, and N_s is the total shaft horse-power. It was found that K is of the order of 45 per cent with the forward propeller alone and 12 per cent with both propellers working.—*H. F. Nordström and E. Freimanis, Publications of the Swedish State Shipbuilding Experimental Tank, Göteborg. No. 7, 1947, pp. 14.*

Some Propeller Characteristics

The author recalls that in an earlier work giving the results of a study concerning the interaction between engine, screw propeller, and the ship, he had obtained characteristics for a special propeller form based on model results. The angle of incidence embraced all values from 0 to 2π. In other words, the characteristics cover all combinations of speed and revolutions, both positive and negative. The chief object of the investigation mentioned was to set out the common principles of such generalized characteristics and their application. The propeller then tested—of Schaffran type—had a diameter of only 12 cm. Later experiments carried out with a similar propeller of diameter 25 cm. gave results, however, which agreed surprisingly well with those for the smaller propeller. Subsequently the author has taken the opportunity to determine such general characteristics for a systematic series of propellers covering different pitch ratios. Nine propellers were tested. All had a diameter of 25 cm., and the pitch ratios were 0, 0·2, 0·4-1·4, and 1·6. The lower pitch ratios (0 and 0·2) have scarcely any practical value, but were included to complete the lower range of the series. Altogether, some 1,500 runs were made. The tests were carried out during recent years at the Swedish State Shipbuilding Experimental Tank in Göteborg. The author emphasizes that with general characteristics, suitably presented, one can, however, at least approximately, study the behaviour of a particular propeller during different manœuvres. The characteristics certainly refer to steady conditions but can also to some extent be used for unsteady conditions. It sometimes happens that one desires to know the torque of a propeller which will remain non-rotating during the motion of the vessel. This is the case during launching. With an ice-breaker the forward propeller is often kept motionless during progress in free water while the after propellers rotate. Such problems can be solved with the help of generalized characteristics. Numerous other examples can be given of the use of such characteristics.—*H. F. Nordström, Publications of the Swedish State Shipbuilding Experimental Tank, Göteborg, No. 9, 1948, pp. 20.*

Longitudinal Flexion of a Ship. Structural Investigations on the Occasion of the Launching of the Destroyer "Alava" and the Fitting of her Boilers

The author describes extensive structural investigations made in the new Spanish destroyer "Alava" on the occasion of her launching in June 1947 and the fitting of her boilers, with the object of measuring the deformations and stresses under different conditions, and of checking them against the results obtained by classical calculation methods. The paper is preceded by a brief recapitulation of the various similar investigations which have been carried out to date, and an instructive table gives the main particulars of the tests in the destroyers "Wolf", "Preston", and "Bruce", and in the tankers "Neverita" and "Newcombia" (see also B.S.R.A. Journal, 1 (May 1946), Abstracts No. 61 and 62, and 2 (April 1947), Abstract No. 804). It can be seen from this table that the longitudinal deformations and mean stresses in these ships as found by measurement are in good agreement with those obtained by beam theory, if Young's modulus is taken as 13,300 tons per sq. in. In the calculation, the moment of inertia of the section includes all longitudinal continuous elements, except thin plating in compression if the distance between the stiffeners exceeds a certain limit, and the longitudinal bulkheads in certain types of ship construction. Nevertheless, the structural investigations which were carried out in the past include a considerable number of cases where measurement and calculation disagreed quite substantially. The author recommends therefore as many further structural tests as possible, and considers those in the "Alava" as a valuable contribution. To simplify the comparison between experiment and calculation, the large openings in the main deck of the "Alava" left for fitting the boilers after launching, were covered with plates which were tightly screwed to the deck. The deck could thus be treated as a riveted structure. The measurements were carried out before and on the day of launching, and again after removing the plate covers. The measurements were repeated several times during the day, to take account of the considerable temperature variations from 72 deg. F. in the morning and evening to 135 deg. F. at mid-day. The mean values of the strain were used for the final analysis. The instruments consisted mainly of long-base gauges and dial-gauge strain indicators. There is a short description of the experimental set-up, and a plan of the ship shows the positioning of the apparatus. Conventional curves are constructed of the weights, loads, shear stresses, bending moments, moments of inertia, and deflexions over the length of the vessel, calculated for the following conditions: (1) after launching the vessel with the deck cover plates fitted to the main deck; (2) after removing these plates; (3) with the plates removed and on the assumption that there were waves 2·5 feet high. The value of the longitudinal stress as found in case (1) by calculation is surprisingly close to that obtained by measurement, the former being 4·25 tons per sq. in., the latter 4·28 tons per sq. in. The transverse stress, as a result of measurements, was 0·84 tons per sq. in., that is, nearly 20 per cent of the corresponding longitudinal stress. This confirms the experience obtained with the "Neverita" and "Newcombia", and contradicts Sir John Biles' assumption, on the occasion of his experiments in the "Wolf", that the transverse stress is negligible. The comparison of the values of the longitudinal stress in case (2), on the other hand, reveals considerable discrepancy between measurement and calculation (3·22 tons per sq. in. and 2·14 tons per sq. in. respectively). This proves that the simplified assumption of a continuous girder for the calculations is here no longer justified.—*Abstract No. 1,750, Journal of The British Shipbuilding Research Association, Vol. 3, No. 5, May 1948. A. V. Nuñez, Ingeniería Naval, Vol. 16, February 1948, pp. 65.*

New Indicator Device to Measure Roll and Pitch

A new and yet untried device is the pitching and rolling indicator in the Ship Division of the National Physical Laboratory, Teddington. Worked by gyroscopes, the device has three dials, on which by electronics can be shown (1) the roll; (2) the pitch; and (3) the yaw, of a ship. Later, the results will be continuously recorded on paper for more detailed study. It is intended to take the apparatus to sea in a ship, and by connecting it up with the mains of the ship to take necessary readings. When sufficient data has been obtained, it is proposed to build a model of a similar ship and, by fitting bilge keels and the like, to eliminate some or all of the causes of the erratic behaviour.—*The Journal of Commerce (Shipbuilding and Engineering Edition), No. 37,550, 1st July 1948, p. 2.*

Developments in High-speed Rotating Disk Research

The uniform circular disk, rotated at high speeds about its central axis perpendicular to the plane of the disk, provides a very useful and convenient means of studying the plastic flow and fracture properties of full size sections of a given material. At the centre of the disk and for an appreciable distance from the centre, a state of nearly equal bi-axial tension stresses exists in both the radial and tangential directions and this is applied uniformly over the plate thickness. It offers various advantages over its chief competitor, namely, the tube subjected to internal pressure and axial loads. In the latter, due to the local bulging of the tubes before fracture, not only does the calculation of the stresses become difficult (being essentially the problem of a curved plastic shell subjected to both membrane and bending stresses), but experience has shown that it is extremely difficult, if not impossible, to maintain a constant ratio of the true stresses up to fracture by controlling the high-pressure pump and the testing machine. The rotating disk, on the other hand, automatically maintains the radial and tangential stresses nearly equal (the most important ration of bi-axial stresses in relation to brittle fracture). It is also quite feasible to test thick disks at relatively small cost, thus making possible the testing of full-size sections. The cost becomes prohibitive to make tube tests on material of a comparable thickness, and even if carried out, the wall thickness would not be uniformly stressed. More important, however, the rotating disk can be used to investigate the flow and fracture properties under combined stress of the base plate material *without* welding, as well as with welding. The tube test is usually only feasible without welding in small sizes and wall thicknesses. Above this, it is necessary from a practical standpoint to weld the plate material after forming in order to fabricate tubes of large sizes and plate thicknesses. Further, it is relatively easy to subject the rotating disk to high or low temperatures. The whirl pit constructed at the Massachusetts Institute of Technology is capable of testing disks up to 8 inch in thickness and as large as 30 inch in diameter. For bursting tests, however, the minimum diameter is about 12 inch outside diameter for ship plate. A single-stage horizontal Terry-type G.E. steam turbine drives the disk specimens. The direction of rotation is reversible since the turbine wheel is provided with two sets of buckets machined in opposite senses. The top speed of the turbine is 35,000 r.p.m. Since 1st January 1948, the project is being sponsored under contract by the Ship Structure Committee and the Bureau of Ships of the United States Navy.—*C. W. MacGregor and W. D. Terry, the Welding Journal (New York), Vol. 27, June 1948, pp. 303-s-309-s.*

Organization of Shipbuilding in Holland

This paper describes the internal organization of the Netherlands Dock and Shipbuilding Co., Ltd., Amsterdam, giving a survey of the working of its different departments and of the way they co-operate. The author discusses in succession the design bureau, the calculation department, the purchasing department, the draughting room and the management bureau, including the preparation of work, planning, statistics, research, the wage tariff department and time check. Special attention has been given to welded ships, built in sections, thereby greatly eliminating climatic influences and furnishing many other advantages. The fluctuations in new building and repairing work can be used to neutralize each other, but its planning remains very difficult.—*A. A. Gaasterland, De Ingenieur, No. 26, 25th June 1948, pp. T23-T24.*

Vibration Problems in Gas Turbines, Centrifugal and Axial Flow Compressors

Failures due to vibration have occurred in the blading, impeller vanes, and combustion chambers of gas turbines. The scope of the problems involved in explaining these failures is illustrated, and the importance of the higher modes of vibration is emphasized. Stalling flutter in axial compressors is considered, and a simple rule to avoid it is given. The importance of investigating vibration in gas turbines by experiment is well established, and the technique developed is fully explained. The damping characteristics of duralumin compressor blades and steel turbine blades have been investigated. The results indicate that in the former aerodynamic damping is 60 per cent, whilst material and blade root provide about 20 per cent each; in the latter the blade root provides about 70 per cent, and the remainder is shared by aerodynamic and material damping. Heat-resisting alloys suitable for 650 deg. C. and above have low damping capacity. Experimental methods have been devised for fatiguing blades at resonance and have shown up weaknesses in blade and root design. The paper is fully illustrated and a list of references is given.—*Abstract No. 1,800, Journal of The British Shipbuilding Research Association, Vol. 3, No. 5, May 1948. J. F. Shannon, A.R.C., R. and M. No. 2,226 (1945).*

Testing Welds with Supersonic Waves

Rapid, accurate and positive tests of welds in tank walls, pressure vessels, plate and pipe of all kinds can now be accomplished using a newly developed "angle beam" transmission technique in connexion with a conventional supersonic reflectoscope. Welds in steel plate up to 5-inch thick and in thin walls (as thin as $\frac{1}{16}$ inch) have been successfully inspected with this new method. Indications from voids, inclusions or other defects in the weld are shown visually on an oscilloscope screen. Gas welds, arc welds and pressure welds lend themselves equally well to the supersonic method of inspection. Seam, groove and bevel welds, whether fused, beaded or full weave, can be tested so long as the weld surface is relatively uniform. Even small defects which are extremely difficult to locate by X-ray or other non-destructive test can be readily indicated on the oscilloscope screen. The supersonic reflectoscope is an instrument which operates upon the principle of echo-ranging. In its simplest form, it consists of a pulse generator which produces ultrasonic pulses of very short duration, usually in a range from about 1 to 3 micro-seconds. The instrument is so arranged that any of a wide range of frequencies from 0·5 to 5 Mc. may be produced. These pulses are sent out from a quartz crystal transducer which produces a series of vibrational pulses in the medium under test. The pulse generator then becomes inoperative and the same transducer acts as a receiving antenna upon which the return reflexions impinge. The searching unit employed in angle beam transmission consists of the usual quarts crystal, $\frac{1}{2}$- or 1-inch square, to which is cemented a special plastic member—the whole being enclosed in a suitable holder. This special transducer has the property of transmitting supersonic waves into a medium at such an angle that the waves travel in a direction generally parallel to its face. The material itself is an important aid in guiding the sound waves within it. The energy travels by successive reflexions between the surfaces of the material until it reaches an interface which presents a difference in homogeneity perpendicular to the beam. The weld metal will not constitute a reflecting interface. However, all flaws of a size to cause rejection will have a boundary, part of which will be in the correct direction to reflect some of the sound energy. When the beam impinges upon any interface, part of the energy will be reflected in the usual manner, received by the reflectoscope and indicated on the oscilloscope screen.—*B. Carlin, The Welding Journal (N.Y.), Vol. 27, June 1948, pp. 438-440.*

Measurement of the Combined Frictional and Thermal Behaviour in Journal-bearing Lubrication

Data were obtained in tests with a four-bearing friction machine which show that an increase in the load on a journal bearing produces a proportional increase in frictional torque, when other conditions of test are held constant. Under these same conditions an increase in load also produces a proportional increase in the fluidity of the oil in the bearings. These two effects are the result of the combined hydrodynamic and thermodynamic actions involved in journal-bearing operation with forced-feed lubrication. The increase in torque is influenced by the viscosity of the oil, the oil-inlet temperature, the oil-feed pressure, the shaft diameter, the clearance diameter ratio and the length-diameter ratio. The increase in fluidity is influenced by the same factors and also by the speed of the journal. Empirical equations are derived for the fluidity-pressure relationships for certain conditions. Also, a graphical method is given for the use of this relationship in estimating safe bearing loads. Data pertaining to the thermal behaviour of the bearings and apparatus are given in an appendix. These indicate that with forced-feed lubrication most of the heat generated in the bearings is carried away by the oil flowing through them.—*Paper by S. A. McKee, H. S. White, and J. F. Swindells, read at the 1947 Annual Meeting of The American Society of Mechanical Engineers. Paper No. 47-A-61.*

Magnetic Fluid Clutch

A new type of electromagnetic fluid clutch, said to have extensive applications and many unique features, has been developed at the

National Bureau of Standards. The development of this clutch is based on Rabinow's discovery that frictional forces between solid surfaces and certain types of fluid media can be controlled by application of magnetic fields. Characterized by ease of control, high efficiency, smooth operation, long life, and simplicity of construction, the new magnetic fluid clutch is reported to be particularly suitable to applications in servo-mechanisms, automatic machinery, automotive service, and many other fields where ease of control and constancy of characteristics are important. The magnetic fluid clutch operates on the following basic principle. When the space between two parallel magnetic surfaces is filled with finely divided magnetic particles and a magnetic field is established between the two plates, the magnetic particles bind the plates together against movement parallel to their surfaces. The magnetic particles may be finely divided iron which, for most applications, is mixed with a liquid such as oil, to prevent packing and to afford smoother operation of the clutch. When a portion of this mixture is acted on by a magnetic field, the iron particles are mutually attracted, bind together in the field, and the mixture seemingly "solidifies". As the magnetic field can be produced by an electric current, a simple means is thus obtained for the control of the binding force over a wide range. Preliminary results indicate that the electro-magnetic fluid clutch has numerous advantages over many other existing types. It is characterized by extreme smoothness of action because all contacting surfaces, both of the plates and of the iron powder, are coated by a lubricant. The clutch is easy to control and requires small amounts of electric power. The control is extremely smooth from the minimum which is determined by the viscous drag of the oil, to the maximum which is controlled by the magnetic saturation of the iron. Because it has no axially moving parts, the clutch is extremely easy to build, consisting essentially of a driving and a driven member which do not change relative position, except in rotation. As slipping occurs only between extremely fine iron particles and between the iron particles and smooth-face surfaces of the clutch, and as all surfaces are lubricated, wear is said to be practically non-existent. Moreover, if any of the surfaces are worn off, the iron dust thus generated simply adds to the iron powder already in the oil mixture. The gaps as normally employed, are fairly large: therefore any such wear will have negligible effect.—*Mechanical Engineering, Vol. 70, May 1948, pp. 442-443.*

Belgian Motorship "Albertville"

The single-screw motorship "Albertville" was recently completed by the Soc. Anon. John Cockerill for the Compagnie Maritime Belge. The leading dimensions of the vessel are:—

Length overall	504ft. 2in.
Length b.p.	467ft. 6in.
Breadth moulded	64ft. 3⅝in.
Depth to main deck	31 feet
Depth to upper deck	39ft. 10in.
Displacement	16,550 tons
Corresponding draught	27ft. 5in.
Deadweight capacity	9,460 tons
Cubic capacity of holds and 'tween decks	451,095 cu. ft. bale, including that of eight palm oil deep-tanks.
Gross tonnage	10,900 tons

British-made equipment is extensively used. The main engine is a Burmeister and Wain type two-stroke cycle double-acting engine of the latest coverless type, built by Cockerills. Certain modifications are incorporated in the design as a result of co-operation between Mesrss. Cockerill's engine works staff and the owners' superintendent engineer. The engine is of the 8-59 WF 125 type, the eight cylinders having a diameter of 590 mm. and a stroke of 1,250 mm. It is capable of developing 9,250 b.h.p. at 115 r.p.m. which power gives a contract speed of 18½ knots. The maximum mean speed reached on trial was 18·8 knots on 9,150 b.h.p. and 108 r.p.m. The majority of the engine room auxiliaries, like those on deck, are electrically operated, there being four 250 Diesel generator sets installed in the main engine room. These were supplied by W. H. Allen, Sons and Co., Ltd., each engine having five cylinders.—*The Marine Engineer, Vol. 71, June 1948, pp. 287-288.*

A Stability and Trim Experimental Tank

The stability problems confronting the ship's officer when either loading and unloading, and also under sailing conditions, are reproduced in the stability and trim tank at King's Point, N.Y., by the use of a model known as "Miss Calculation". The model is of merchant-ship form with an overall length of nearly 21 feet, and is divided into five compartments, three of which are fitted with plugs, which facilitate flooding conditions. Weights are used to raise or lower the metacentric height, and statical stability curves can be derived by the use of a dynamometer which measures the force of the inclining couple. The righting arm or moment for the condition is then found from the force measured. The centre of gravity of the model is found in the normal manner by moving known weights through a prescribed transverse distance and using the data in conjunction with the displacement. The centre of gravity thus found is slightly lower than in a comparable ship owing to the absence of superstructure on the model. "Miss Calculation" is also extremely useful in providing a clear conception of the effect of free water on the model's stability. A list is given of the nine main experiments which can be performed on the model, and the procedure adopted for a specimen experiment is also described.—*Abstract No. 1,747, Journal, The British Shipbuilding Research Association, Vol. 3, No. 5, May 1948. La Dage, J. H., Pacific Marine Review, Vol. 45, Feb. 1948, p. 49.*

A German Marine Gas Turbine

The F.I.A.T. Final Report No. 291 gives detailed particulars of a fully worked-out gas turbine for a Schnell boat, developed by Blohm and Voss. The project was never completed, although the turbine rotor and some of the compressor castings had been made, as also had a number of hollow air-cooled turbine blades. But the design of the unit was completed, and it is suggested that it is of sufficient interest to warrant further study. The turbine had a gross output of 20,000 h.p., with an effective power of 7,500 h.p., and it was intended that this should drive the centre shaft of the vessel through gearing, the outboard shafts being driven by Diesel engines. Particulars of the vessel are, however, not known. The turbine was directly coupled to its compressor, which absorbed 12,500 h.p., the speed of the unit being 5,400 r.p.m. The compressor comprised fourteen stages of axial flow blading, having a stage efficiency of 91 to 92 per cent with an overall efficiency of 85 per cent, the pressure at the compressor discharge being 5·15 kg. per sq. cm. (73·5lb. per sq. in.) at a temperature of 190 to 200 deg. C. (374 to 392 deg. F.). No particulars of the combustion chamber are available, although it is known that a model chamber had been tested. The turbine inlet temperature was to have been 900 deg. C. (1,652 deg. F.) at the nozzle outlet, which, it may be noted, is considerably higher than has been employed in any unit of which particulars have been made available to date; this, no doubt, being deemed possible in view of the adoption of air cooling for the blades. The turbine itself consists of a single two-row Curtis stage with about 10 per cent reaction in each blade row, and the overall efficiency, including the blade coling losses, was calculated as 82 per cent. The unit has two compressor journals, and two turbine journals, but the turbine rotor is overhung while there is a thrust bearing at the after end of the compressor next to the pinion coupling. The overall plant thermal efficiency was expected to be 15 per cent, giving a fuel oil consumption of 450 to 500 grams (0·99 to 1·1lb). per s.h.p. per hour. Aluminium was used for the compressor castings. As a consequence the estimated weight of the entire unit was only 11 metric tons, that is, 3·22 per effective horsepower. Particular interest attaches to the system adopted for air cooling the turbine blades. The air used for cooling the first row of blades is by-passed from the compressor just before the eighth moving row of blades, but the pressure and temperature of the air at this point are not given. The air is fed into the hollow shaft of the turbine, whence it passes through vanes in the rotor and slots in the blade root, up through the hollow blade and out into the clearance space. The arrangement for feeding the cooling air into the hollow shaft is quite ingenious and might, it is suggested, well have other applications. The air duct in the rotor is formed by plates bolted to the hub and welded to the rim. Short impeller vanes are provided at the air duct to increase the pumping action, and the cooling air for the second row of moving blades comes directly from the atmosphere due to this pumping action of the rotor.—*Shipbuilding and Shipping Record, Vol. 71, 17th June 1948, p. 725.*

An 86-feet Drifter-Trawler

The gradually increasing employment of aluminium alloy in ship construction is extending to the building of fishing boats, and in the drifter-trawler "Equity I", just completed by Brooke Marine, Ltd., for the Scottish Co-operative Society., this metal is utilized to a considerable extent in the wheelhouse, funnel and the casing. The casing of the engine-room and the funnel is of salt-water-resisting aluminium alloy, the plating being mainly $\frac{7}{32}$-inch thick with 2½-inch by 1½-inch angle stiffeners. It is of riveted construction and the wheelhouse casing is also of aluminium alloy up to the windowsill level.—*The Motor Ship, Vol. 29, June 1948, pp. 116-117.*

ENGINEERING ABSTRACTS

Section 3. Shipbuilding and Marine Engineering

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Diesel Engine Experiments—A Study of Injection Phenomena

This paper gives an account of a systematic experimental study of mechanical and hydraulic phenomena bound up with the injection process. The experiments were carried out on a test plant consisting of a fuel injection pump and a specially designed injector assembly. The fuel injection pump was operated by a variable-speed motor through a specially devised actuating mechanism suitable for the operation of different types of injection pumps. The experiments described were, however, made throughout with the use of a Bosch pump. The fuel pressure on the intake side of the injection pump was measured by means of a piezo-electric gauge consisting of a pile of 18 quartz disks subjected to the prevailing fuel pressure through the medium of a diaphragm which in turn exercised a thrust upon a mobile plunger resting on top of the pile. This gauge was suitable for a maximum pressure of 20 atmospheres. The pressure in the fuel line at the injector was ascertained by a second piezo-electric gauge which consisted of two quartz pieces; it was capable of registering rapid pressure variations at pressures up to 800 atmospheres. In this device the fuel line pressure was transmitted to the piezo-electric part by a thin diaphragm with a maximum deflexion of 0·03 mm. at 100 atmospheres pressure. The volume displacement caused by the pressure gauge was correspondingly small and amounted to only 3 cu. mm. In consequence the resultant static pressure drop in the fuel line was limited to some five per cent. Valve lift at the injector was measured by a variable electric capacitance device indicating the valve position with an accuracy of 0·05 mm. The sprayer was contained in a chamber equipped with observation windows, one test series being conducted at atmospheric pressure and another with a chamber pressure of 35 atmospheres. Comparative tests were carried out with various types of check valves in the fuel injection line; these valves were (1) ordinary check valves at the injection pump outlet; (2) check valves at the injection pump outlet of the type which by closing produces a variation in the volume of fuel contained in the injection line and (3) delivery valves at the injector. From the test results obtained the author concludes that the employment of a delivery valve at the injector is preferable to that of a check valve at the pump discharge.—*Paper by M. Aragou read before Association Technique Maritime Aeronautique at the Session of 1948, on 28th May 1948.*

The Donaldson Liner "Cortona"

The single-screw steamship "Cortona" which has been built and engined by R. and W. Hawthorn, Leslie and Co., Hebburn, for the Donaldson Line, Glasgow, has a turbine installation which has been evolved as a result of research carried out by Pametrada. The "Cortona" is of the complete superstructure type with bridge and forecastle and has been specially designed for carrying meat from the River Plate. The insulated holds and 'tween decks are divided up so that they form separate compartments. All cargo spaces are insulated and subdivided for the carriage of every type of perishable cargo from frozen meat to those commodities which require accurate temperature control. The principal particulars are:—

Length b.p.	425ft. 0in.
Breadth moulded	62ft. 6in.
Depth moulded to upper deck	30ft. 11in.
Depth moulded to shelter deck... ...	38ft. 10½in.
Mean draught	27ft. 3¼in.
Gross tonnage	8,289 tons
Net tonnage	4,919 tons
Deadweight	8,394 tons
Chilled meat capacity	377,000 cu. ft.
Frozen meat capacity	408,900 cu. ft.

Rapid loading and discharging of cargo is effected by twenty derricks, each served by an electrically driven winch, for 7- or 3-ton lifts. The steering gear is of the electric-hydraulic 4-ram type, and is situated on the shelter deck with access from a deckhouse on the weather deck. The propelling machinery consists of a single-screw double-reduction geared-turbine installation, developing in normal service 6,800 s.h.p. at 115 r.p.m., with a maximum power of 7,400 s.h.p. Steam at 450lb. per sq. in. pressure and a temperature of 750 deg. F. is supplied by two water-tube boilers of the Yarrow type with Melesco superheaters. The main turbine unit, designed in conjunction with Pametrada, consists of one h.p. turbine of the all-impulse type exhausting to an impulse-reaction l.p. turbine. An astern turbine consisting of two impulse stages is incorporated in a cast steel casing inside, but separate from the l.p. ahead turbine casing. Gearing is of the articulated type, the h.p. and l.p. primary gears driving their respective secondary pinions through a long flexible internal shaft. Couplings of the latest small tooth design are used for the primary and secondary pinions. As a result of these flexible connexions, the gearing can be regarded in effect as two sets of single reduction gears in series. A single massive gear case of fabricated construction maintains all the wheels and pinions in correct alignment, and the main thrust block is incorporated as an integral part of the gear case at the forward end. Provision is made for running, in emergency, with any one turbine out of action. In the design of the turbine, one of the basic considerations has been the avoidance of distortion due to high steam temperature, and this led to the adoption of the all-impulse principle for the h.p. turbine. Special precautions are taken in the design of the astern element, and the system of dampers in the boiler uptakes whereby the furnace gases can be by-passed quickly from the superheater, enables relatively low temperature steam to be used for manœuvring. A new design of high efficiency nozzle, accurately machined to the correct profile, is used throughout the h.p. turbine and results in a large number of stages being accommodated in a short casing of small diameter. The earlier stages of this turbine have partial admission in order to avoid the small and less efficient nozzle and blade sizes associated with the use of high pressure steam for comparatively low powered units. This special design of the h.p. turbine has the outstanding merit that it permits a two-turbine arrangement being adopted without any sacrifice of the small dimensions and light construction of rotor and casing so desirable where high temperature steam is used in marine work. A two-turbine unit possesses distinct advantages compared with a three-turbine arrangement, being more efficient owing to the smaller parasitic losses and involving less trouble in service maintenance. All turbine glands are of the labyrinth type and are connected to a gland condenser and ejector which prevents any leakage of vapour into the engine room. The main condenser is of modern regenerative design and maintains a vacuum of 28½ inch of mercury with a 75 deg. F. sea temperature. The two main boilers are of the latest Yarrow three-drum type with fusion welded steam and water drums and burn oil fuel under open stokehold forced draught conditions. Superheaters of the Melesco type are fitted in one "leg" of the tube banks, and this feature enables close and rapid control of steam temperatures being obtained by the use of dampers in the uptakes. Large air heaters are fitted above the boilers and any one of the two motor driven forced draught fans is capable of delivering air to either or both boilers.—*Shipbuilding and Shipping Record, Vol. 71, 3rd June 1948, pp. 675-680.*

Note on the Construction of Ship Models for Towing Tests

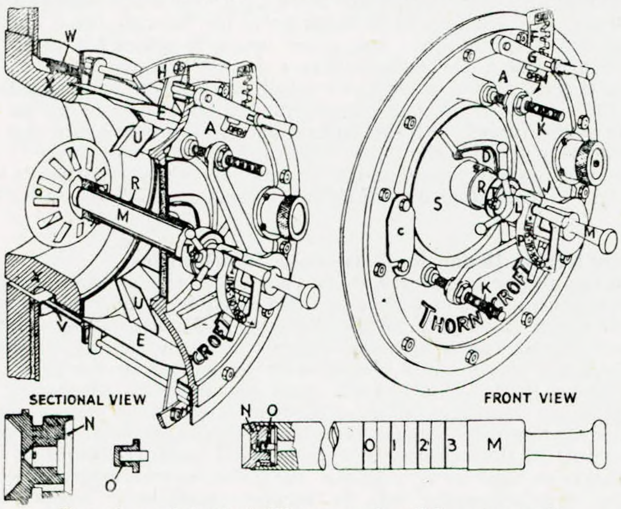
In this article, which is accompanied by photographs taken at the Ship Division of the National Physical Laboratory a description is given of the making of ship models for towing tests. The models, which are from 16 to 20 feet in length and weigh 700 to 1,000lb. when finished, are made of paraffin wax with a small admixture of stearine and beeswax. In the first stage china clay is moulded by means of wooden sections to the approximate form of the outside of the model, about ½ inch being allowed for subsequent shaping. At the same time, a second series of sections is made, to lines approximately 2½ inch inside the moulding sections, and covered with battens and canvas, this second series forming a core. When this core is turned over and correctly located in the mould, there is a clearance of about 2¾ inch between the canvas and the clog, and into this space is poured molten wax from electrically heated vats, the core being laid down by large weights and also by warm water, added as the wax is poured. This water both prevents the wax from forcing the canvas between the battens (and so hindering the later withdrawal of the core) and obviating the unduly rapid cooling of wax, with consequent risk of cracking. The moulding operation takes from two to three days, according to the difference in shape between the new model and the one previously cast in the same moulding bin; while casting occupies one day, during which it is necessary to feed the casting as the wax cools and contracts. When the model is cold, the core is removed and the top of the model dressed level. Beams are then added at definite intervals, being centred by a template. To remove the model from the mould, the clay is cut away at some point adjacent to the hull, a hose inserted, and water turned on. The water makes its way down between the wax and the clay, and when the model floats, it is girdled by slings and lifted clear. The model is next inverted and placed in the model-shaping or cutting machine which has two tables, one carrying the model, and the other the drawing of the level lines, both tables being moved longitudinally by a common motor, which drives them by means of screwed shafts and nuts. The knives are mounted at the lower ends of two vertical spindles, the driving motors being at the upper ends. A pantograph arm carries a feeler at one end, and, as this is moved over the drawing, a mechanism at the other end causes the knives to move in and out together, in accordance with the transverse movements of the feeler. The knives are first set to the correct vertical height of a particular waterline, and the operator controls the feeler transversely, so that, as the drawing moves slowly past him, the feeler follows faithfully the particular waterline on the drawing. Simultaneously, the knives cut this line on the model. The surplus wax left intact between successive cuts has now to be removed by hand "scraping", spokeshaves being used in the early stages, and thin flexible steel scrapers, with ground edges, in the final stages. After being weighed the mould is taken to the tank where it is turned over in the water and left filled until required for test.—*The Shipbuilder and Marine Engine-Builder, Vol. 55, June 1948, pp. 392-393.*

The Radiography of Welds

This paper opens with a brief theoretical résumé of the working of X-ray tubes and then describes in some detail the selection of types of X-ray equipment for various duties. Particular emphasis is laid by the author upon the selection of the best suited equipment for the examination of welded joints in the works and on sites. Reference is made to the use of radium and radon and their particular spheres of usefulness. This is followed by an account of the technique for the X-ray examination of welds. A detailed account is given of the interpretation of weld radiographs describing the types of faults found including lack of penetration, porosity, slag inclusions, lack of fusion and cracks. This section is illustrated with a large number of examples taken from development and production work. The methods of finding the depths of faults are described and the methods employed for the examination of filet welds, nozzle and manhole connexions and pipes are considered. A discussion of the causes of faults and differences in design and fabrication methods to avoid them is also entered into. The concluding parts of the paper deal with radiographic acceptance standards and the uses of radiography in development and inspection.—*R. F. Bishop, Trans.I.Mar.E., Vol. 60, No. 5, 1948, pp. 131-139.*

Boiler Installations in "Commandant Queré"

The Thornycroft water-tube boilers in the recently completed "Commandant Queré" are equipped with oil burning units of the latest Thornycroft type. During recent years the characteristics of boiler fuel have undergone a considerable change. A larger percentage of the lighter constituents are now being removed from the crude oil, leaving in consequence a heavier, more viscous, and less volatile residue. Although the calorific value of present-day fuel is practically unchanged as compared with pre-war fuel it has become more difficult to burn oil efficiently and smokelessly and without using an abnormal amount of excess air. To meet the difficulty two main requirements are indicated. (1) The oil must be more finely atomized prior to mixing with air; (2) the air must be more thoroughly and uniformly mixed with the oil spray particles at the point of ignition. Laboratory tests have shown that with pressure type atomizers the fineness of the oil spray particles improves as the oil pressure is



Drawing of typical Thornycroft oil-burning unit

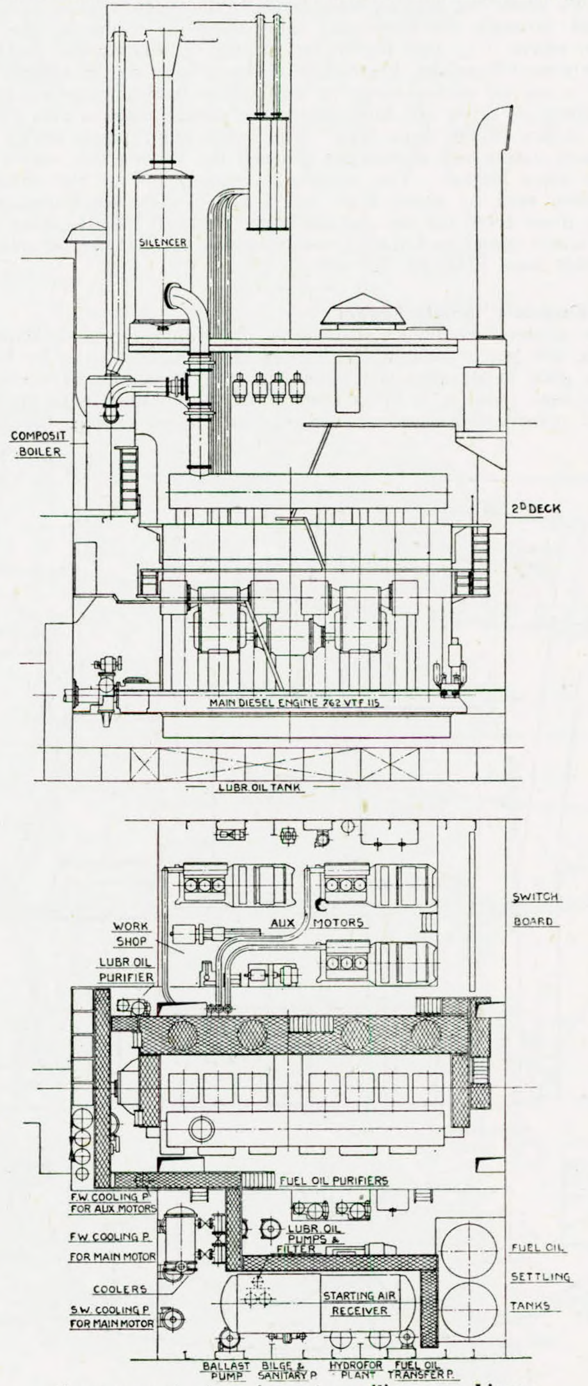
Boiler installations in "Commandant Queré"

A—Furnace front.
B—Sight window.
C—Lighting up door.
D—Inspection and cleaning door.
E—Air door.
F—Air door adjusting catch.
G—Air door operating handle.
H—Air door operating ring.
J—Sprayer carrier.
K—Sprayer carrier adjusting studs.
L—Sprayer clamp.
M—Sprayer body.
N—Sprayer cap.
O—Sprayer plug.
P—Oil shut-off cock and quadrant.
Q—Air deflector.
R—Air deflector tube.
S—Air deflector guide plate.
T—Gripcollar for deflector tube.
U—Air cone with radial vanes.
V—Brick sleeve.
W—Brick ring.
X—Throat bricks.

increased. Spray particle records obtained with specially devised apparatus have been of great value in facilitating the making of precise comparisons between atomizers of different sizes and proportions, and serve to show that the Thornycroft oil sprayer and oil burning unit as fitted in these boilers fully meets the abovementioned requirements for the efficient burning of present-day fuel oils. Each unit has six air doors linked to one quick-operating handle. The arrangement of air doors and air guides ensure that most of the air is made to swirl rapidly in its passage through the refractory-lined throat towards the furnace. Some of the air which enters the doors is caught by radial vanes and directed towards the centre portion of the unit, from whence it flows in approximately an axial direction through the openings in the cone which surrounds the burner tip. This central air suffices to maintain a steady primary flame from which the main combustion originates and, in addition, it avoids the risk of the main flame being blown out or drawn too far into the furnace before full ignition has taken place. Optimum results and good burning under widely varying outputs demands correct positioning of the flame within the furnace throat, and to this end the axial positions of the burner nozzle and cone have been made adjustable while in use. A safety shut off cock with an interlocking device obviates all risk of accidental oil escape during the burner changing operation.—*The Shipping World, Vol. 118, 30th June 1948, p. 620.*

The Cargo Motorship "Venezuela"

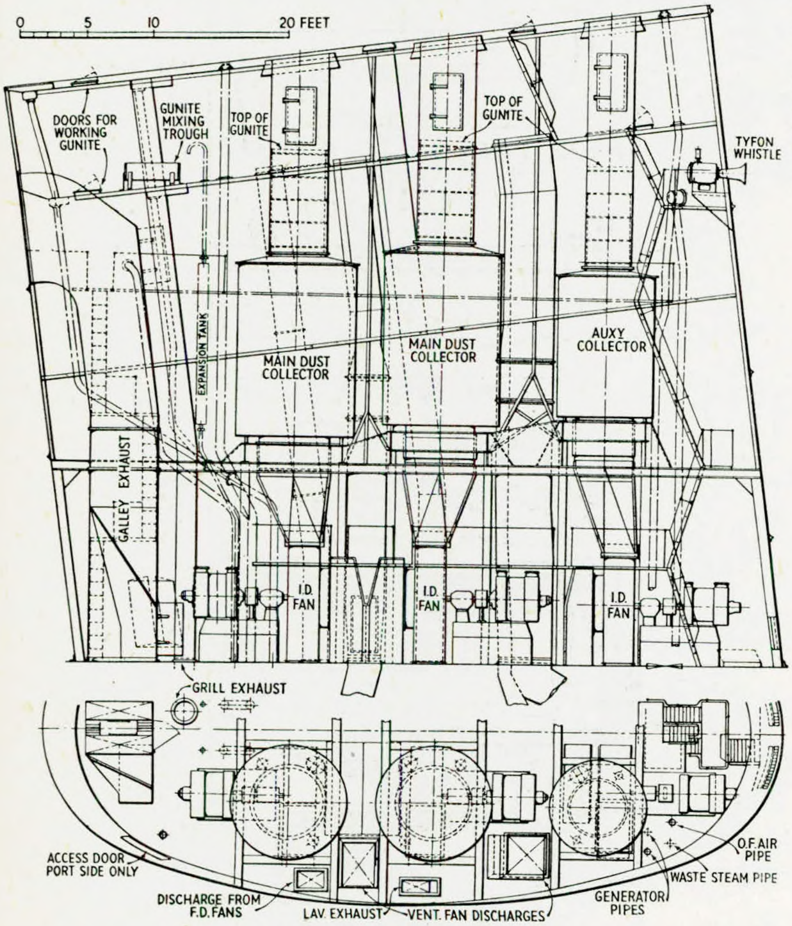
The cargo motorship "Venezuela", recently completed by Burmeister and Wain for Det Forenede Dampskibsselskab has an overall length of 439ft. 9in., a moulded breadth of 57 feet, and draught on summer load line of 25ft. 0¼in. and a deadweight of 9,200 tons. Speed on trials was 13½ knots. The "Venezuela" has two continuous decks and is built with a raked stem and cruiser stern. The propelling machinery has been built to Lloyd's Register Special Survey. The main engine is a Burmeister and Wain direct reversible, single-acting, two-stroke, seven-cylinder crosshead engine with airless injection, with cylinder diameter 620 mm. and stroke 1,150 mm. Normal output is 4,725 i.h.p., corresponding to 3,850 b.h.p., at 135 r.p.m. This engine type is one of the results of the development which took place before the war in regard to B. and W. two-stroke engines, and the engine, which essentially corresponds to the B. and W. standard designs, has been in two principal points a model of the single-acting, two-stroke crosshead engines. In accordance with B. and W. practice



Arrangement of main and auxiliary machinery the rotating scavenging air pumps are fitted on the rear side of the engine, which arrangement gives the shortest possible engine. The engine is built with short pistons and cylinder liners giving the least possible height and retains the pure crosshead principle that cylinders and crankcase should be kept apart. Three single-acting, four-stroke, three-cylinder trunk piston engines with airless injection are provided, each being direct coupled to a generator of 120 kW. at 220 volts. The Diesel cylinders have a diameter of 245 mm., a stroke of 400 mm., and an output of 180 b.h.p. per engine at 500 r.p.m. All large pumps are of the vertical centrifugal type, direct coupled to electric motors by resilient couplings. There are two lubricating oil pumps, each having a capacity of 140 cu. m. per hr. at a pressure of 3·5 atmos., two sea-water cooling pumps, each having a capacity of 150 cu. m. per hr. at a pressure of 2·1 atmos. and a fresh-water cooling pump having a capacity of 150 cu. m. per hr. at a pressure of 2·1 atmos. The auxiliary engines have a common sea-water and a common fresh-water pump, each of 22 cu. m. per hr., for use in port. The lubrication oil is drawn from the bottom tank beneath the main engine; it is discharged through the filter and lubricating oil cooler to the main engine, where it is used partly for cooling of pistons and partly for lubricating of bearings, whereupon it flows back to the bottom tank. There is an oil cooler made of steel plate having cast-iron covers, tube plates of brass and tubes of yellow metal; there is also a fresh-water cooler of the same type. The fresh-water pump draws from the main engine and discharges through the fresh-water cooler back to the main engine. The system is closed, and in the casing an expansion tank of about 1 cu. m. is fitted. The sea-water cooling pumps draw from the sea and discharge through the oil cooler to the fresh-water cooler and thence overboard.—*The Shipping World, Vol. 118, 30th June 1948, pp. 627-629.*

The "Caronia's" Single Funnel

In modern passenger steamships, the funnels are an important feature and much thought is given by the designers in order to provide a good appearance combined with the maximum of usefulness. The present trend is to fit as few funnels as possible, with the result that a considerable amount of gear is housed inside. A typical example of the modern funnel is that of the Cunard White Star liner "Caronia", now fitting out at the yard of John Brown and Co., Ltd., Clydebank. A section and half plan of its funnel are shown in the illustration. The outer funnel is designed to conform with what is thought a good appearance of the ship as a whole rather than in accordance with the size required to take the products of combustion to the atmosphere. Inside this outer funnel there are six small funnels or smoke uptakes, one from each boiler. The four uptakes from the main boilers are somewhat larger than those from the auxiliary boilers. On each of these individual funnels at casing top level there is an induced draught fan and above this, between the casing top and the funnel top, a wet type Howden dust collector is installed. Certain other ventilating trunks are accommodated in the outer funnel, the exhaust vents from the boiler room and a galley exhaust trunk, for example. This galley exhaust trunk is at the after end and is directed aft before it reaches the top of the outer funnel by an opening on the fore and aft axis of funnel. About 8 feet from the top of the funnel there is a flat from which repairs to the gunite linings of the dust collectors can be made. The small funnels project through this flat where there are doors on each for access, but in projecting through the flat the hole in the flat is greater than the diameter of each individual funnel and any air from the ventilating system which has come up to the hatch independently of the exhaust trunks will tend to press up through these annular spaces and help to direct the gases upwards somewhat after the ejector principle. The dust collectors are of the wet type, i.e., the soot is trapped on wet walls and washed into hoppers and from there over the side at or about the load draught line. All the piping for this is in the funnel. Access ladders and platforms are provided for the staff to get inside the outer funnel. Even the main body of the Tyfon whistles are inside, and it is only the trumpet portion which projects.—*Shipbuilding and Shipping Record, Vol. 72, 1st July 1948, p. 8.*



The "Caronia's" single funnel

Injector Nozzle Design for Two-stroke Diesel Engines

When the design of the Allen two-stroke engine was in course of development, the importance of rapid ejection of the exhaust gases and thorough scavenging of the engine cylinder led to the adoption of two exhaust valves arranged symmetrically in the cylinder head. The injector nozzle could consequently be located in the centre of the cylinder head. This had the great advantage of eliminating all complications associated either with twin injectors or with a single injector not centrally located. It also permitted an even distribution of the fuel in the combustion chamber and ordered control of the association of fuel spray with the air. The injector nozzle selected for this type of engine was of standard multi-hole "closed" type (Fig. 1), so called because the nozzle is closed with a valve after

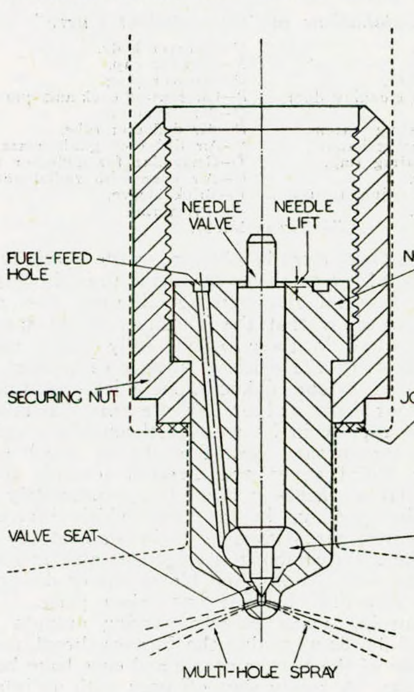


FIG. 1.
Multi-hole "closed" type injector nozzle

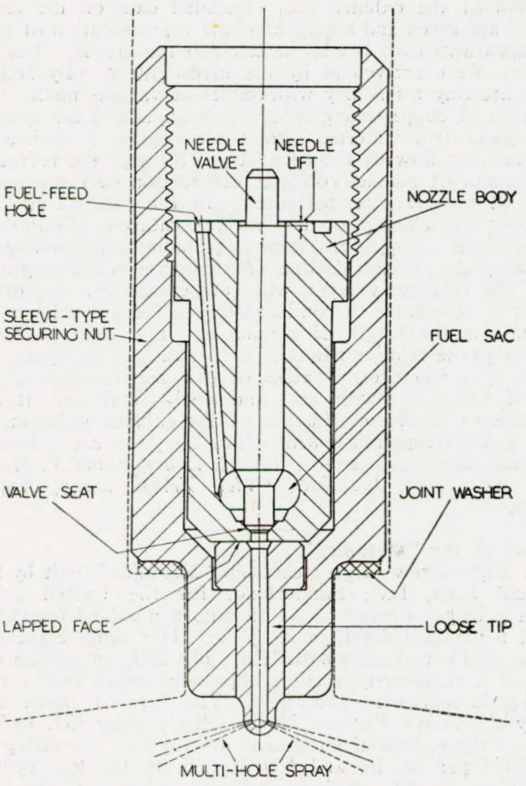
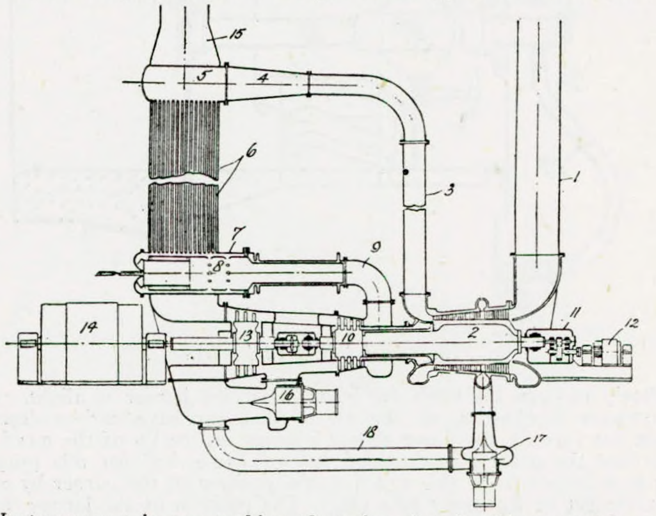


FIG. 2.
Injector nozzle with loose tip and valve body.

each injection of fuel into the engine combustion chamber and because the "dome" or "teat" is drilled with a number of holes of diameter and angle determined by the combustion chamber size and shape. As the valve stem and seat are in close proximity to the combustion chamber and, being located between the two exhaust valves, they are therefore subject to high thermal conditions. The temperature in the region of the two-stroke engine nozzle valve seat and the lower end of the valve stem approached 600 deg. F. when the engine was on full load. In comparison with this figure, the temperatures recorded on four-stroke engines were in the region of 250 to 300 deg. F. The effect of this higher temperature on the nozzle is two-fold. Firstly, it tempers or reduces the hardness of both components and thus renders them less resistant to fuel pressure seat loading, and secondly, the additional heat to be dissipated carbonizes the fuel within the sac of the nozzle body. The first gives rise to valve seat wear and deformation, and the second causes the valve to stick. Having determined that temperature conditions were responsible for the increased maintenance required on the two-stroke engine nozzles, the question of oil-cooling the nozzles was investigated, but this was considered undesirable. It was therefore decided to concentrate on methods of protecting the exposed end of the nozzle, or alternatively, of moving the needle valve and its seat further away from the heat of the combustion chamber. Various designs were considered and tested, and finally, a design incorporating a loose top and valve body was adopted. The principal features of this design are illustrated in Fig. 2, from which it will be seen that the nozzle tip is separate from the valve body and is of small proportions. The loose tip and valve body are secured to the main injector body by a special sleeve nut which shrouds the loose tip, forming an easy path for heat flow to the upper cooled part of the injector and allowing the loose tip to remain comparatively cool. Although the uncontrolled volume of fuel between the valve seat and the multi-spray holes is greater than in the original nozzles, this volume is only a small percentage of the quantity injected during each cycle, and running experience has shown no tendency for carbonization or dribble to occur due to this increased volume.—*The Allen Engineering Review, No. 19, June 1948, pp. 8-9.*

Improvement in Gas Turbine Plant for Electric Ship Propulsion

This invention relates particularly to gas turbine plants for electric ship propulsion using alternating current, but it is applicable to other cases where the gas turbine plant drives an alternator, and variable speed is required—obtained by varying the frequency. According to this invention the gas turbine generating plant includes an alternator, an exciter for the alternator, a gas turbine rotor which drives both the exciter and a compressor, and a further gas turbine rotor which drives the alternator. This has lower inlet pressure than the first mentioned rotor, the two rotors being mutually independent mechanically, but arranged in series with one another with regard to the gas flow. A further feature of the invention resides in the use of the exciter as starting motor for the gas turbine plant. Referring to the illustration, air from the air intake duct (1) enters the compressor. The compressed air passes through the delivery pipe (3) with a cone shaped diffuser (4) to the heat exchanger inlet drum (5) and then through the heat exchanger tubes (6) to the outlet drums

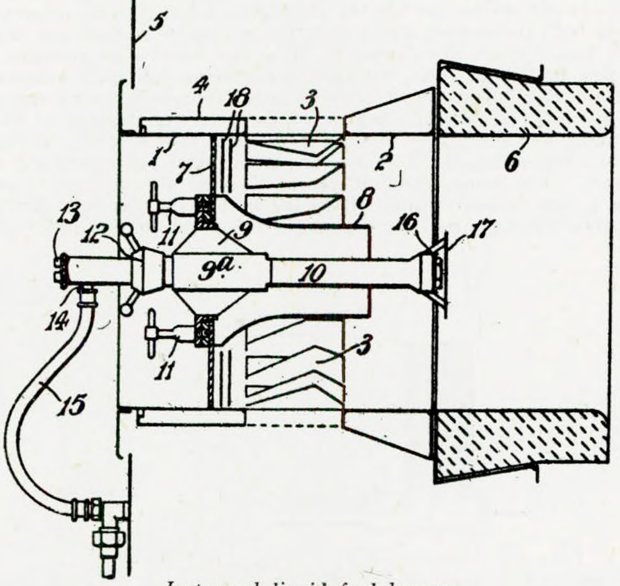


Improvement in gas turbine plant for electric ship propulsion

(7) in which are incorporated combustion chambers (8). Here, part of the air serves as combustion air the rest as diluting air. The gases, i.e., the mixture of combustion products and diluting air, pass through a short pipe (9) to the h.p. turbine (10) driving the compressor (2) and through speed reducing gears (11), the exciter (12). From the h.p. turbine (10) the gases pass directly to the l.p. turbine (13) driving the alternator (14), which, in a ship propulsion installation, produces current for the propelling motor (not shown). The l.p. turbine is in line with the h.p. turbine, but the two turbine rotors are mechanically independent. After leaving the l.p. turbine (13) the gases pass through the heat exchanger, flowing outside the tubes (6) to the atmosphere through the funnel (15). The heat exchanger is not essential. It reduces the amount of heat to be supplied in the combustion chamber, and therefore the fuel consumption. To facilitate starting and rapid manœuvring in ship propulsion, the layout includes a by-pass valve (16) for passing gases from the exit of the h.p. turbine (10) direct to the exit of the l.p. turbine (13), and a relief valve (17) for blowing off air from an intermediate stage of the compressor to the atmosphere. This is accomplished by connecting the valve (17) to the exit of the l.p. turbine by means of a pipe (18).—*British Patent No. 599,775, issued to the British Thomson-Houston Co., Ltd., and Bengt Erik Custav Forsling. Complete Specification accepted 19th March, 1948; The Shipping World, Vol. 18, 16th June 1948, p. 582.*

Improved Liquid Fuel Burner

This invention relates to apparatus for firing furnaces with liquid fuel as employed, for example, in steam boiler plant. The object of the present invention is to provide improved apparatus to ensure thorough mixing of liquid fuel and air and enable a burner with a stable flame to be adjusted for efficient combustion and protected against damage through overheating when not in use. The apparatus as shown comprises a register made in two axially spaced cylindrical parts (1) and (2), the space between which is bridged by inwardly inclined vanes (3) defining between them main air inlets which can be closed by a cylindrical axially slidable shutter (4) carried by the front part (1) of the register and movable by means of slide bars. The register extends between a screen plate (5) and the month of the refractory quarl (6) lining the furnace throat. Near the front end the register has a radial wall formed by an annular plate (7) on which is mounted an open ended central air supply tube (8) and a radially webbed sprayer carriage (9) for a sprayer tube (10). In using the apparatus the shutter (4) is positioned either to close the main air inlets completely when the burner is not alight, or withdraw com-



Improved liquid fuel burner

pletely to open the main air inlets when the burner is alight. For complete combustion of the oil so that excessive carbon deposits are not formed, the flame should impinge on the lip of the quarl (6) so that the quarl is maintained full of flame, and for this purpose it is necessary to be able to adjust the position of the burner by axial movement of the spray tube (10). The position of the burner when in use is so far forward that if left in that position when not in use, but with other burners alight, the sprayer cap and tip plate would be damaged by overheating, so provision is made for retracting the sprayer tube into the sprayer cap and tip plate inside the central air supply tube (8), which the tip plate almost completely closes. In this way admission of unwanted air to the furnace is cut off, but enough inward air leakage can take place past the tip plate in the tube (8) to maintain the sprayer cap and tip plate cooled, as well as shielded by the tube (8) from the heat of the other burners.—*British Patent, No. 599, 811, issued to Sir Frederick Richard Gordon Turner, K.C.B., O.B.E., Engineer Vice-Admiral, Engineer-in-Chief of the Fleet, of the Admiralty, and Colin John Grey, D.S.O., Engineer Captain, R.N.(ret.), of the Admiralty Fuel Experimental Station, Haslar, Hants. Complete specification accepted 22nd March 1948. The Shipping World, Vol. 118, 23rd June 1948, p. 598.*

Catalytic Combustion of the Exhaust Gases of Internal Combustion Engines

The combustion of gas-air mixtures in which the gas concentration is below the ignition limit or the temperature of which is below the ignition temperature cannot take place in the form of a flame. There are many cases in which the gases contain noxious and toxic constituents (mainly carbon monoxide). It has been proposed by M. B. Ravitsh that the problem be solved by the employment of a catalyst which permits the complete combustion at high speed at temperatures of 500 to 600 deg. C. The practical solution of this problem, however, requires the discovery of catalysts which are highly effective, do not deteriorate and are low in cost and easy to manufacture. Investigations of the combustion of hydrogen and also of carbon monoxide and mixtures of hydrogen and methane passed through both ordinary and activated refractories have been carried out at the Institute of Energetics of the Soviet Academy of Science under varying conditions of temperature and pressure; they have shown that activated refractories are well suited to serve as catalysts for the combustion of gases. Particular interest is attached to experiments conducted with fire clay activated by a mixture of oxides of iron and manganese as suggested by B. A. Zaharov. These experiments were conducted with the exhaust gases of a petrol engine. In the tests referred to in the present article a mixture of exhaust gas with air was passed through a refractory layer at atmospheric pressure and at temperatures of 300 to 500 deg. C. respectively. The velocity of flow ranged from 0·15 to 6 metres per second and the contact speed varied from 1,000 to 20,000 litres of gas mixture per litre of refractory per hour. The efficacy of the refractory as a catalyst was assessed on the basis of the degree of completeness of combustion of the exhaust gas. Detailed data on the experiments conducted are given and a diagrammatic representation of the experimental apparatus used is also included in the article. The following conclusions were arrived at by the investigators. By activating an ordinary fire clay refractory with oxides of various metals (palladium or mixtures of copper-manganese, iron-manganese) the combustion of exhaust gases from internal combustion engines is assisted. In the case of laminar flow of the exhaust gas through the refractory with a short length of contact complete combustion of the exhaust gas is obtained at moderate temperatures. In the case of unstable, turbulent flow the efficacy of the various catalysts diminishes in the following order: copper-manganese, palladium, iron-manganese, the last showing the greatest decline. An increase in the length of travel through the refractory layer will compensate for the drop in the degree of completeness of combustion with the gas velocity, and such an increase in the length of contact will also tend to diminish the differences in the relative efficacies of the various catalysts. Fire clay activated by a mixture of oxides of iron and manganese represents a catalyst which is low in cost and easily obtainble. It is capable of producing complete combustion of the exhaust gases at high flow velocity at the temperature with which the gases are exhausted from the internal combustion engine.—*B. A. Zaharov and T. N. Nicolaev, Izvestia Ak. Nauk. U.S.S.R., Otdel. Techn. Nauk, No. 1, 1948, pp. 79-86.*

Machinery of the "Matadian"

The single-screw cargo steamship "Matadian" built by Sir James Laing and Sons, Ltd., Sunderland, for the United Africa Co., Ltd., has a length overall of 431ft. 3in., a moulded breadth of 56ft. 6in., and a moulded depth of 39ft. 3in. Her deadweight tonnage is 9,210 tons, and her draught 26ft. 1⅜in. The main propelling machinery consists of a reheater-type triple expansion steam engine developing 2,200 i.h.p. in service at 84·5 r.p.m. This type of engine was introduced by the North Eastern Marine Engineering Co., Ltd. in 1934. Dry steam throughout the engine is obtained by admitting steam at about 210lb. per sq. in. and 600 deg. F. to the h.p. cylinder; the exhaust from the h.p. at about 70lb. per sq. in. pressure is reheated in the reheater from about 425 deg. F. to about 575 deg. F., and enters the m.p. cylinder at this temperature, this cylinder like the h.p. being fitted with poppet valves. The m.p. cylinder exhausts to the l.p. chest at about 10lb. per sq. in. and 340 deg. F., and steam at final exhaust to the condenser retains a few degrees of superheat. The heat for reheating is obtained by generating steam in the boilers at 220lb. per sq. in. and 750 deg. F., and this steam, on passing through the h.p. side of reheater has its temperature reduced by about 150 deg. F., the h.p. exhaust is the cooling medium and has its temperature correspondingly increased by about 150 deg. F. Similar installations have demonstrated a specific fuel rate per i.h.p. for all propelling purposes of 0·80 to 0·85lb. oil and 1·0 to 1·1lb. of coal; feed water loss under proper conditions has come out at about 1½ tons per day per 1,000 h.p. Internal lubricating oil consumption has proved to be no greater than for a normal superheated job, viz., not over one pint per 1,000 i.h.p., although many reheated engines are running with less than this quantity. The cylinder diameters are 23 × 38 × 65 inch, and the stroke 45 inch. Steam is supplied by three main boilers having an external diameter of 16ft. 0in., an external length of 12ft. 6in., and a total heating surface of 8.868 sq. ft. The working pressure is 220lb. per sq. in., and oil burning equipment of the Wallsend-Howden type is fitted. In earlier installations superheaters were fitted in all combustion chambers, that in the centre chamber being arranged higher up than those in the wings and so exposed to cooler gases. In many cases this proved quite satisfactory, but in others—and particularly in oil burning ones—there was under certain conditions a tendency to oxidation of the elements. This tendency has been completely overcome by a re-arrangement of superheaters, so that in a three-furnace boiler no elements are fitted in the centre combustion chamber, the centre furnace being used for raising steam, banked fires and low loads; the wing furnaces are not lit up until the load is beyond the capacity of the centre furnace. The modified superheater retains its former features of self drainage, freedom for expansion and interchangeability of all elements. Detail modifications to superheaters include the use of heat resisting steel for screwed parts and certain joints, and the disuse of any expanding of tubes. As a result of this modification, the main boiler has proved suitable for harbour services, and auxiliary boilers, which were fitted in most of the earlier reheat ones, are now very seldom fitted. Other modifications to the boiler design include the adoption of welded back stays to the combustion chamber which eliminates any necessity for access to stay nuts behind elements and also allows the superheater to be located nearer the back plate with reduction in quantity of gas by-passing the superheater and increases latitude in design.—*Shipbuilding and Shipping Record, Vol. 71, 17th June 1948, pp. 731-734.*

Integrated Towing in the U.S.A.

On the Mississippi for many years the practice of moving freight in barges has been to load into barges which are rigidly tied end to end, the whole length of barges being again rigidly attached to the forward end of the tug. The tug is no longer a tug, but is in effect a push-boat. In the old days it depended for its power of manœuvrability and pushing upon multiple rudders and a split stern wheel. Today it still depends upon multiple rudders but, in order that the Diesel engine may be employed, screws working in tunnels or semi-tunnels, and sometimes with Kort nozzles, are employed. The whole "push" which may be as much as 1,200 feet in length, depends in turn for its manœuvrability upon the driving end or locomotive portion's ability to flank or twist round often severe bends in the river. This is partly due to usirg direct rudder action and partly due to a system of moving backwards and forwards, while flanking. Designers are now integrating a series of barges of different shapes and fitting a false bow, making the whole into one large ship, greater in length than the largest ocean going ship, and in width equivalent to that of a large cargo liner. The power unit which is inevitably attached to the "stern" is a development of the modern push-boat, and the ships of this kind which are being built today are fitted with every device known to ocean-going navigation, e.g., radar, ship-shore telephone, air-conditioning, electric galleys, searchlights, automatic helmsman, and in the case of one unit, even with deep-freeze refrigeration. The recently commissioned integrated tow "Harry Truman" consists of eleven sections: a long spoon-shaped bow, three small barges 26ft. in length with a capacity of 250 tons apiece, one medium sized barge 83ft. in length and with a capacity of about 900 tons, five large barges 167ft. in length, each with a capacity of 1,900 tons, and the push-boat itself. The complete unit is 1,200 feet in length, with a beam of 54 feet, and has a cargo capacity of approximately 12,000 tons. When fully loaded the tow, or "push", can make a speed of ten miles an hour. The locomotive portion of this "push" is one of the most powerful push-boats on the Mississippi river, and is powered by two 1,600 h.p. General Motors, single-acting two-cycle Vee-type high-speed oil engines, each driving a 9-feet diameter propeller through a 4/1 reduction gear. Control, which is centred in the pilot-house, is by means of Airflex couplings. Each main engine is a 16-cylinder non-reversing unit, rated for 1,600 h.p. at 750 r.p.m. This push-boat differs slightly from normal practice in craft of this kind in that the bow is of greater length. This, however, is a false detachable bow, and the locomotive portion itself is a square shaped structure with a draught of about 6 feet. There are two deck houses, the deck house on the main or "weather" deck being somewhat longer than the superstructure deck, and this again is surmounted at the forward end by a large pilot house.—*A. C. Hardy. The Shipping World, Vol. 118, 23rd June 1948, pp. 600-602.*

An Analysis of General Cargo Handling

This is the title of a paper presented by L. H. Quackenbush before the New York group of The Society of Naval Architects and Marine Engineers. This paper aims at presenting a résumé of the relationship of the problem of cargo handling to the economics of vessel operation and a detailed description of these problems. The paper includes a reference to the influence of terminal facilities, vessel hull subdivision and shape, hatch openings and side ports, and cargo gear limitations. The author concludes that improvements in the handling of general cargo can be more easily developed if the problem considered is particular to any single trade, operation, or method of shipment and packaging. However, the most difficult problem, that of improved general cargo handling when considered in conjunction with tramp or the like operations with the need of retaining maximum flexibility, is most challenging and most complex. The author is firm in his conclusion that improved general cargo handling for the tramp operation retaining flexibility will not be obtained by radical modification or replacement of the present vessel arrangements and gear. Rather, it is felt that to obtain improved handling with flexibility, the developments made will and must progress conservatively step by step from today's conventional methods, equipment, and vessel design through variation in new construction and alteration of vessels now in operation. The author lists the following obvious sources of improvement in the stowage phase of the cargo operation:—(1) closer proportion between cubic capacities of holds and single- or double-rigged shipboard handling equipment; (2) squaring off holds by modification of vessels general arrangement (engine aft); (3) provision of spotting ability by hatch openings and by modification of shipboard cargo so as to incorporate the fore and aft movement of the hook as well as the athwartship movement—this without additional resetting of booms and guys and preferably under load; (4) mechanically operated hatch covers; (5) topping lift winches to reduce detentions occasioned in resetting booms while working cargo and opening and closing hatches; and (6) improved winches—hydraulic, steam, etc.—*Member's Bulletin, The Society of Naval Architects and Marine Engineers, Vol. 3, May 1948, p. 19.*

Propulsion of Passenger and Cargo Liners. Potential Influence of the Gas Turbine

Discussing American developments, the author of the article points out that the shipowner of the future who wishes to employ gas turbines will be confronted with the necessity of choosing between a closed or an open cycle of operation, just as in his new ship today he selects either a two-cycle or a four-cycle engine. Advocates of the open cycle system suggest that it provides the greatest possibility of weight and space saving. Westinghouse has produced, for example, a 2,000 h.p. oil-burning gas turbine generator set to advance technique on three primary elements—compressor, "combustor", and turbine. A major point in the development of the marine gas turbine is still to reduce the combustor side which like the boiler in a geared turbine equipment occupies space at the expense of the pure turbine side. Sets of about 2,000 h.p. output are of prime interest from the marine point of view, but not if they occupy too much space in the fore and aft sense. The Westinghouse unit for propulsion reveals what is really an inherent weakness of all gas turbines—the power required to drive itself. Thus a turbine developing 6,000 h.p. requires 4,000 h.p. to drive the compressor. It turns at 8,750 r.p.m. at full load speed. It is claimed that with 35 kW. it can be started in $2\frac{1}{2}$ min., with 80 kW. in one minute, but with only 20 kW. the time is increased to eight minutes. This allows latitude for electric power, and in no case is the time required excessive, even though not as instantaneous as the oil engine. A Westinghouse unit has been on tests since 1st August 1946, and has operated over 1,000 hours. An overall fuel rate, burning boiler oil, of 0·78lb. per b.h.p. per hr. is claimed.—*A. C. Hardy, The Journal of Commerce (Shipbuilding and Engineering Edition), No. 37,538, 17th June 1948, p. 5.*

Some Essentials in Oxy-acetylene Pipeline Welding

This article considers in detail the preparation of pipes of varying diameters for welding. Methods of matching, alignment and clamping are described as well as the attachment of branches. Referring to butt welds, the author points out that the matching of the bores of the pipes to be joined is a prime requisite to the production of satisfactory welds. This match should be absolute or as near as it can be achieved; and this applies to all pipes not accessible from within, i.e., at least up to 20-inch diameter. A small step in the bore at the weld is just as fatal to a good quality weld in a 20-inch pipe as in a $\frac{1}{2}$-inch pipe. Such steps should definitely not exceed $\frac{1}{32}$ inch; or, in other words, the pipe ends either must match or they must be made to match. In practice, pipes up to 3-inch diameter will be found to match reasonably well, provided that they are of the same wall thickness. Slight differences can readily be rectified by driving in a simple taper drift. The provision of an 80 deg. V for the leftward welding of small pipes up to 1-inch bore is achieved after matching by a simple hand tool, of which a detailed illustration is given in the article. If a normal three-roller parting tool is used for cutting the pipes to length, a slight bevel is automatically produced in parting off, so that little metal has to be removed by the bevelling tool. For pipes from $1\frac{1}{2}$-inch diameter upwards the bevelling becomes a much more tedious operation, and it is one of the great merits of the all-position rightward technique that bevelling is not essential for thicknesses up to $\frac{5}{32}$-inch. Slightly greater skill is required as compared with bevelled ends, but the difference is indeed slight and not a major consideration, as is the case with leftward welding. This means that practically all pipes in the range of $1\frac{1}{2}$- to 3-inch diameter for pressures up to 350lb. per sq. in. can be welded as taken from stock with perhaps a minimum of drifting. The attachment of branches is as important as the making of butt welds. On branch welds which are in essence mainly fillet welds, gas welding is a very slow and unsatisfactory process. It should certainly be avoided for branches from 4-inch upwards, except in the electric-on-oxy form which is satisfactory for thick-walled tubes. A description of the electric-on-oxy technique was given by the author in the October 1945 issue of "Welding". Sloping branches should be avoided, as they are difficult and expensive to prepare satisfactorily, involving the use of templates and requiring considerably more skill in marking out and preparation than 90 deg. branches.—*E. Fuchs, Welding, Vol. 16, June 1948, pp. 236-248.*

Pitting of Boiler Shells

Oxygen dissolved in feed-water is a fruitful cause of pitting in boiler shells. This pitting occurs on the roof or upper portion of the shell or in any pocket where air bubbles can collect. The solubility of oxygen varies considerably with the temperature and pressure of water. As the temperature rises, any air which the water is holding in solution is thrown out and rises in bubbles; owing to the confined character of the boiler shell or steam drum, these attach themselves to the under side of the metal or accumulate in any convenient pocket. In general, it is not the presence of the oxygen in a boiler shell which leads to pitting, but the electrolytic action that it causes starts the corrosion. According to a recent Admiralty publication dealing with boiler corrosion, the electrolytic action is first initiated between the cathodic surface under the bubble, which is rich in oxygen, and the surrounding water areas, which are less rich. The products of electrolysis combine to form compounds of iron, and these products settle over the bubble as a film or ferric hydroxide. In time this forms a semi-permeable membrane, which allows the passage of ions, but interferes with the ingress of oxygen. Ultimately a stage is reached, where the oxygen under the membrane is exhausted by the oxidation of the products of electrolysis and the flow of current is reversed. This phenomenon is often accompanied by partial collapse of the membrane, which has now increased considerably in thickness so that, finally, the areas most deficient in oxygen are in the centre of a small heap of ferric hydroxide. Thus, hemispherical isolated pits, covered with a cap of loose soft corrosion products appear, red on the outside and black on the inside. The remedy is to ensure a supply of well-heated and properly deaerated feedwater to the feed pump.—*The Journal of Commerce (Shipbuilding and Engineering Edition), No. 37,538, 17th June 1948, p.6.*

Cargo and Passenger Steamship "Duquesa"

The cargo and passenger steamship "Duquesa" recently launched from the yard of R. and W. Hawthorn, Leslie and Co., Ltd., Hebburn-on-Tyne, is built for the Furness Houlder Argentine Lines, Ltd. for the United Kingdom-Spain-River Plate trade. Leading particulars are: 479ft. 6in. overall and 460ft. b.p., by 65ft. 6in. moulded, by 30 feet moulded to upper deck and 37ft. 10in. moulded to shelter deck; insulated cargo capacity 560,000 cu. ft. Service speed is 15 knots. The vessel is of the closed shelter-deck type, with plate stem and cruiser stern and has a cellular bottom and peak tanks. The propelling machinery consists of a set of double-reduction geared turbines developing 6,800 s.h.p. at 115 r.p.m. in normal service, with a maximum power of 7,400 s.h.p. Steam, at a pressure of 450lb. per sq. in. and a temperature of 750 deg. F. is supplied by two Yarrow water-tube boilers. The main-turbine unit, designed in conjunction with Pametrada, consists of one h.p. turbine of the all-impulse type, exhausting to an impulse-reaction l.p. turbine. An astern turbine, consisting of two impulse stages, is incorporated in a cast-steel casing inside, but separate from, the l.p. ahead-turbine casing. The gearing is of the articulated type, the h.p. and l.p. primary gears driving their respective secondary pinions through a long flexible internal shaft. Couplings of the latest small-tooth designs are used for the primary and secondary pinions. As a result of these flexible connexions, the gearing may be regarded in effect as two sets of single-reduction gears in series. A single gearcase of fabricated construction maintains all the wheels and pinions in correct alignment, and the main thrust block is incorporated as an integral part of the gear-case at the forward end. Provision is made for running, in emergency, with any one turbine out of action. In the design of the turbines, one of the basic considerations has been the avoidance of distortion due to high steam temperature, and this led to the adoption of the all-impulse principle for the h.p. turbine. Special precautions have been taken in the design of the astern element; and, in addition, th system of dampers in the boiler uptakes, whereby the furnace gases can be diverted quickly from the superheater, enables relatively low-temperature steam to be employed for manœuvring. A new design of high-efficiency nozzle, accurately machined to the correct profile, is used throughout the h.p. turbine, and results in a large number of stages being accommodated in a short casing of small diameter. The earlier stages of this turbine have partial admission, in order to avoid the small and less efficient nozzle and blade sizes associated with the use of high-pressure steam for comparatively low-powered units. This special design of the h.p. turbine has the outstanding merit that it permits the adoption of a two-turbine arrangement, without sacrifice of the small dimensions and light construction of rotor and casing, so desirable in a high-temperature marine installation. The turbine glands, which are of the labyrinth type, are connected to a gland condenser and ejector, thus preventing leakage of vapour into the engine-room. The main condenser is of regenerative design, and maintains a vacuum of 28½ inch of mercury with a sea temperature of 75 deg. F. A closed-feed system, incorporating Weir extraction pumps and feed pumps, is installed. During its passage from the condenser to the boilers, the feed water is heated in no fewer than six seperate stages, viz., air ejector, gland condenser, drain cooler, exhaust-steam feed heater, heater supplied with l.p. turbine-inlet steam, and, finally, heater supplied with steam bled from the h.p. turbine. The temperature finally attained by the feed water is 320 deg. F. The two main boilers are of the Yarrow three-drum type, with fusion-welded steam and water drums, and burn fuel oil under open-stokehold, forced-draught conditions. Melesco superheaters, fitted in one "leg" of the tube banks, afford close and rapid control of the steam temperature, by the use of dampers in the uptakes. Large air heaters are installed above the boilers, and either of the two motor-driven forced-draught fans is capable of delivering air to one or both boilers. A correctly proportioned supply of air and fuel oil to the furnaces is maintained automatically by means of a Bailey combustion-control system, so that maximum combustion efficiency is obtained at all loads. An auxiliary boiler of thimble-tube type is installed for harbour use, the feed system for this unit being entirely independent of the main water-tube boiler system.—*The Shipbuilder and Marine Engine-Builder, Vol. 55, June 1948, pp. 427-428.*

Waste Heat Recovery

It is far from certain that the full possibilities of the utilization of the heat of the exhaust gases from the main engine or engines in a modern motorship have yet been explored. By choosing an engine of suitable type, mean effective pressure, horsepower, and speed of rotation, there is no reason why a completely new heat cycle should not be evolved, which might reassert the value of the internal combustion engine for certain types of ship at a time when its prestige is being challenged by the fuel consumption and space requirements of the modern geared-turbine installation. Quite recently a United States shipyard delivered to the French Government a group of six ships 372 feet in length overall, intended for service between Algiers and Northern French ports. They are twin-screw ships, the machinery, placed aft, developing 7,200 h.p. Each shaft is driven by three engines through gearing and couplings, and two of each set of three may be used in port to drive generators as required for auxiliary purposes. At sea the exhaust from the six engines is discharged through a special forced-circulation waste-heat boiler built by the Combustion Engineering Co. of New York. The steam raised is used for a set of turbo-generators supplying power for various essential auxiliaries. This plan represents a return, upon more advanced lines, to the old idea of the single-screw tramp with Diesel propulsion in which the exhaust gas from the Diesel engine raised enough exhaust steam for auxiliary purposes. The drum of the forced-circulation stand-by boiler is used by the waste-heat boiler, an arrangement made possible by the forced circulation feature of the two units. The waste-heat boiler, high up in the funnel of the ship, is divided into three sections allowing steam control by hand valves. There is an oil-firing unit which cuts in or out through automatic controls according to the fluctuation of the steam demands. Both the waste-heat and the oil-fired stand-by boiler have superheaters to supply steam to turbo-generators, though for their necessary auxiliaries, desuperheaters are fitted. The waste heat boiler has a rated capacity of 2,780lb. of steam per hr. at 171lb. per sq. in., and 617 deg. F. The oil-fired forced-circulation boiler has a capacity of 5,800lb. of steam per hr. at 171lb. per sq. in. and the same temperature. The use of waste heat in these French ships affords some indication of its possibilities in a modern installation.—*Lloyd's List and Shipping Gazette (Shipbuilding and Engineering Section), No. 41,658, 17th June 1948, p. 7.*

Lubrication of Main Propulsion Power Plants Aboard Ship

In this paper, which was read at a meeting of the Northern California Section of The Society of Naval Architects and Marine Engineers, E. F. Griep and F. J. Hanly discuss the lubrication of reciprocating steam engines, steam turbines, Diesel engines and gas turbines. The lubrication of reciprocating steam engines is well known and the only problem normally existing is to select the proper grade and type of lubricant for the application desired from a reliable supplier. The lubricating oil used in a modern steam turbine is required to lubricate in the presence of water, cool the bearings, and act as a hydraulic oil to actuate the governor. Therefore, stability is of great importance, but the oil must also possess oxidation and rust inhibiting characteristics. Additive turbine oils possessing these characteristics are being widely accepted and are rapidly displacing straight mineral turbine oils for both severe and mild service. Straight mineral and detergent type Diesel engine lubricating oils are being used for the lubricating of large Diesel engines in marine service today. Where this service is mild, straight mineral oils can be used satisfactorily. However, where service is severe, the additive type Diesel engine lubricating oils are required. Gas turbines present no particular problems from the standpoint of lubrication at the present time. However, gas turbines of future design will probably operate at higher temperatures and due to space and weight limitations aboard ship, very compact units will be constructed. Bearing temperatures will probably be relatively high in these turbines and special lubricants may be required. However, these oils will be available when required. As dirty lubricating oil systems and subsequent contamination of the lubricating oil is a major problem aboard ship, two methods of cleaning oil systems are given; one is a simple flushing procedure for the removal of extraneous material, while the other consists of a complete chemical and mechanical cleaning procedure.—*Member's Bulletin, The Society of Naval Architects and Marine Engineers, Vol. 3, May 1948, p. 21.*

Turbine Electric Propulsion

In this paper, read at a recent meeting of the Philadelphia Section of The Society of Naval Architects and Marine Engineers, Mr. H. C. Coleman of the Westinghouse Electric Corporation gave an analysis and expression of opinion on details of turbine electric propulsion plant. The author stated that unless special characteristics are desired, such as for hopper dredge operation, alternating current is selected for turbine electric propulsion because it is smaller, lighter, more efficient, and lower in first cost. The use of integral turbine-generator-condenser or package power plant simplifies installation, foundations, connexions, and conserves space. Lubricating oil pumps directly connected to the turbine are desirable but must be supplemented by motor-driven pumps because the direct-connected pump, the capacity of which is a function of the turbine speed, will not have sufficient capacity at the low turbine speeds involved when manœuvring. Forced lubrication with heat exchangers appears to be the only practical way to remove the heat generated by friction losses in high-speed bearings. Totally enclosed water-cooled synchronous propulsion motors and generators are most often used. The entire system of motor, generator, exciter, and control must be carefully co-ordinated to provide sufficient torque margin for weather and manœuvring conditions. Control for turbine electric alternating current drive is usually manual and from the engine room only; however, automatic synchronizing with pilot house control is in successful operation and can be provided. Stability regulation is a simple, dependable means of obtaining torque margin and offers an attractive saving in weight and dimensions of the propulsion motor and generator. Although great care should be exercised in their application, it is believed that fuses, which will protect against short circuit only, should be used in propulsion control circuits. When space restriction makes it necessary to use top mounted coolers on rotating machines, as is often the case in marine applications, it is recommended that double-tube type coolers be used in order to protect against leakage. On ships having turbine-driven auxiliary sets with a.c. auxiliary generators, a saving in fuel consumption can be obtained by motorizing the auxiliary generator from the propulsion generator when operating for long periods at fairly uniform speeds. While the number of d.c. turbine electric applications have not been large, they have been important and have fitted their special fields in an excellent manner. Such installations have been made on fire boats, ferries, river towboats, and seagoing hopper dredges. The question of choice of optimum steam conditions is an important one, although there seems to have been considerable variation in experience in this respect.—*Member's Bulletin, The Society of Naval Architects and Marine Engineers, Vol. 3, May 1948, pp. 24-25.*

Fuel-injection Equipment Research

In a recent paper on fuel-injection equipment research Mr. A. T. Priddle refers to the fact that the most important factors in fuel-injection equipment are the physical disposition of the fuel injected, its state of subdivision and its disposition in time; further, any fundamental approach to the problems of Diesel combustion also requires a knowledge of at least the order of magnitude of the fuel drop sizes. It is usual to observe sprays from nozzles delivered into atmospheric air. Although this method is adequate for many purposes, such as the verification that a nozzle conforms to manufacturing specification, the behaviour of sprays is greatly affected by the density of the gas into which the spray is delivered. For any fundamental investigation, therefore, it is desirable to make observations with the nozzle delivering in gas approximating in density to that of an engine's combustion chamber. An apparatus for carrying out this function is now available. In most direct-injection engines the air into which injection takes place is in rapid motion, so that if successive parts of the injection can be thought of as taking place in air which, so far as the spray is concerned, is undisturbed, the penetration under such conditions will be somewhere between the value for still air with the full fuel quantity and the theoretical curve for a single drop. Arrangements are in hand for making observations of sprays in air at high density in the presence of air movement approximating to the turbulence of the working combustion chamber. It has been established in the development of oil engines that the rate at which the fuel is injected into the engine cylinder is of a paramount importance and has a decided bearing on the combustion efficiency and "Diesel knock". The cause of this knock has been described by several authorities and it has been established that by obtaining control over the injection rate, knock can be eliminated with little effect on efficiency. One of the methods of eliminating knock is the use of a pilot injection system, the remainder of the fuel required for power development being injected during the second phase. Another method is that of using a non-interrupted injection, whereby the initial rate is low until burning has been initiated, when the rate is increased to that necessary for maximum efficiency. This latter system would appear to have an advantage, as the injector closes only once per cycle, so that the possibility of dribble at the injector is minimized. With the object of establishing a relationship between the pump and nozzle rates an apparatus has been developed which enables the actual rate of injection at the nozzle to be determined in cubic millimetres of fuel discharge against pump camshaft angle.—*The Oil Engine and Gas Turbine, Vol. 16, June 1948, pp. 68-69.*

Diesel Electric Tugs

Some interesting comparative data on the performance of two Diesel-electric and two direct-driven tugs is given in an article in a recent issue of the American journal "Marine News". The Diesel-electric tugs are each 87-feet long by 21-feet beam by 9-feet deep, having a displacement of 232 tons, and are driven by a direct current shunt wound motor delivering a constant 375 s.h.p. to the single propeller at all speeds from 140 down to 107 r.p.m. Electricity is obtained from two Diesel-driven generators, the engines being of the four-stroke type developing 225 b.h.p. at 275 r.p.m., the generator having an output of 155 kW. at a pressure of 225 volts. One of the tugs is fitted with a propeller designed on the circulation theory while the other is of the Dyson or true-screw type, but it is stated that the differences between the performances of the propellers are no greater than the errors of observation. The tests comprised speed tests with and without tow, and tow rope tests in dock when running ahead and astern. The direct Diesel tugs were not sister vessels, one being of 550 and the other of 320 s.h.p. The results, it is stated, show the superiority of the Diesel-electric drive in straight pulling, in tow, running light and quick manœuvring, the average towing efficiency based on s.h.p. being 45 per cent for the electric drive as against 31·8 per cent for the direct drive. It is claimed that the electrical machinery and switch gear on these tugs is so simple that the crew includes no members with training as electrical engineers or electricians.—*Shipbuilding and Shipping Record, Vol. 71, 3rd June 1948, p. 663.*

Alternating Current Auxiliaries

In the many high-powered 26,000-ton tankers which are to be built in America, an alternating current electrical auxiliary installation is to be provided. In view of the discussion in this country of the system to be employed, it is of interest that the generating plant in these ships will comprise two 400 kW., 450-volt, 60-cycle, 3-phase units, but that for heating in the galley and for the lighting, direct current is to be employed. Two motor generators will be fitted for this provision. The emergency generator will also be an alternator of the same voltage.—*The Motor Ship, Vol. 29, June 1948, p. 83.*

Modern Marine Combustion Controls

The first marine installations of modern metering-type controls were made jointly in January 1936 by the Hagan Corporation and the Mason-Neilan Regulator Co. aboard the Standard Oil tankers "Resor" and "McCobb". These were followed in the same year by a Bailey Meter Co. installation on the U.S. Army dredge "Goethals". In succeeding years prior to the last war, the economy available through automatically controlled firing became well recognized, particularly in the large tanker fleets. The wartime shipbuilding programme gave tremendous impetus to this gradual development until today there are more than 1,600 ships equipped with Hagan, Bailey, Mason-Neilan, and General Regulator controls. Each of the control systems has four basic components, the master sender or controller, an oil-flow controller, an air-flow controller, and the air-oil ratio controller. Apart from the power used to operate these units, all of the controls fall into two broad classifications depending upon the sequence with which these units affect the firing rate as the boiler demand varies. One is the "series system" as characterized by Hagan and Mason-Neilan and the other is known as the "parallel system" as used by Bailey and General Regulator. In all of the combustion controls, the master sender performs the same primary function; namely, to convert steam pressure changes into air-loading or electrical impulses. In the "series system", as developed by Hagan, the master impulse actuates the airflow controller and thus changes the air flow to the furnace to compensate for the steam pressure change. The change in air flow is measured immediately by the air-oil ratio machine and a compressed air impulse is sent out to position the oil-control valve for an oil flow in exact proportion with the new air flow for best combustion efficiency. In the "parallel system", as characterized by Bailey, the master impulse is fed directly to the air-flow and oil-flow controllers, changing both quantities simultaneously. The new oil flow is then measured by the air-oil ratio machine and a correcting impulse is sent out to the airflow controller to readjust the excess air for maximum combustion efficiency.—*J. W. Westburg, Marine Engineering and Shipping Review, Vol. 53, June 1948, pp. 50-51.*

Gas Turbine Propelled M.G.B. "2009"

This article gives further information recently become available about the gas turbine propelled M.G.B. "2009". Among the ultimate advantages expected from the use of gas turbines as compared with the reciprocating internal combustion engine and steam turbine machinery are: reduction in weight and space for a given horsepower—it being suggested that the reduction in space will be more noticeable in installation of greater power; gain in overall efficiency; less time in starting machinery from cold and working up to full power—the time taken to start from cold and attain full power in the boat is under a minute and a half; less complication and vulnerability; less maintenance—it is visualized that maintenance on board between major overhauls will be of a very minor character and limited to the ancillaries and it is of interest to note that during the first fifty hours' running, no maintenance work whatever was carried out on "Gatric"; high torque—a feature of the gas turbine plant with a free power turbine is the high torque available at low speeds which is of particular value when towing, in the event of hull damage or failure of other propelling machinery. The present disadvantages are: short life—the life of "Gatric", i.e., the time between major overhauls, is as yet unknown. Deposits of dust and salt may affect the performance of the compressor but such fouling could probably be overcome by fitting suitable air filtering arrangements; this is already under investigation. The erosion and creep effects of the hot gases on the turbine blades may be the limiting factor determining the life of this type of propulsion unit. Vigorous investigation into this problem is proceeding. A possible solution is to accept a reasonable period between major overhauls, when the unit would be lifted out and rebladed. Modern foundry methods make possible the accurate casting of blades, which require no further machining and large stocks of these could be accumulated in preparation for an emergency. Another disadvantage is high fuel consumption. The present unit suffers from a very high specific fuel consumption but, as already mentioned, this was known and accepted when designing the unit; the aim of future designs will be to obtain a specific fuel consumption comparable with that of a Diesel engine. Referring to the future programme, it is stated that a replacement unit capable of the full designed power of 2,500 h.p. will be fitted together with new propellers to all three shafts to suit the revised performance of the boat. Silencing equipment will be fitted to the air intake and the exhaust uptake. An extensive programme of trials will be carried out with the new unit, probably taking up to the end of 1948. The trials are designed to obtain performance figures of "Gatric" under sea conditions. Periodic opening-up is catered for in order that the life of the unit may be determined.—*The Engineer, Vol. 185, 25th June 1948, pp. 621-624.*

Shaft and Rudder Bearings

During the last few years SKF spherical roller bearings have been introduced for shafting in ships and for the suspension of rudders. The spherical roller bearing is claimed to be particularly suitable for shafts where misalignment and displacement are to some extent inevitable, and where the forces are variable in magnitude and direction. Such cases occur with ship's tunnel shafting which is influenced by the movement of the vessel afloat as well as by the distribution of the cargo. SKF tunnel shaft bearings consist of a spherical roller bearing mounted on a tapered sleeve in a housing with split or solid covers on either side. As a general rule the housings are solid as shown in Fig. 3, but a split housing with the top half removable is also available. Tunnel shafts on which spherical roller bearings are to be mounted differ slightly from those for plain bearings. Since the bearing rings are not split, one flange of the shaft must be detachable. In the installations hitherto made, a flange coupling with a tapered seating on the shaft has generally been used for shafts of small diameter and split couplings for heavier shafts, but both flange and split couplings are heavy and unwieldy. The new SKF OK coupling is made of high-quality steel and is therefore small and light; it can transmit very high torque loads, and the absence of keyways not only prevents weakening of the shaft but also simplifies manufacture; moreover, the ends of the shaft do not need to be provided with integral flanges. Fig. 3 shows a section of a coupling placed between a tunnel shaft bearing and a propeller thrust bearing. The actual coupling consists of two parts, a thin inner sleeve with a slightly tapered outer surface, and an outer sleeve with a correspondingly tapered bore. The outside diameter and the length of the couplings are roughly 1·5 times and 2·5 times the diameter of the shaft, respectively. The coupling is based on an SKF invention, by means of which the frictional resistance between the active elements in a pressure joint during mounting and dismounting, is reduced by injecting oil at high pressure between the fitting surfaces. With special tools of simple design, the coupling can be mounted or dismounted in a very short time. The same tools can be used to force the bearings on and off, which is a great advantage, especially on twin-propeller vessels, where the space in the stern is often limited. Another application is a rudder bearing arrangement with a spherical roller bearing. This bearing is so designed that it can deal with both radial and thrust loads. It can thus carry the weight of the rudder and the vertical dynamic forces as well as the radial forces which arise when the rudder moves.

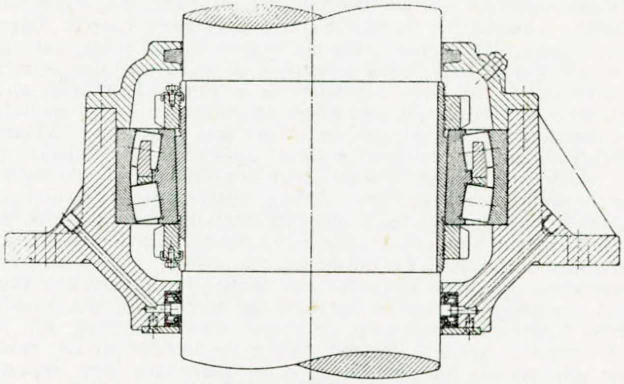


FIG. 6.—*Rudder bearing with special seal*

The spherical roller bearing is mounted on the rudder stock in the same way as the propeller shaft bearing. On the rudder stock, a recess is provided in which a split sleeve is placed. The bearing is then forced up on the sleeve by means of the mounting nut. If the rudder bearing is mounted on deck well above the waterline, ordinary felt washers can be used as seals or a simple stuffing box. If the bearing is placed near the waterline, the seal should be more efficient, e.g., made as in Fig. 6. The actual bearing housing is filled with grease, but oil is used for the seal. From a tank, situated at a suitable height, oil is led down below the housing and in between two leather or synthetic rubber washers placed round the rudder stock, and then through another channel to a drain cock. The seals are thus always under oil pressure, and the fact that no water has passed through them can be checked by draining off a certain amount.—*G. Astrand, The Shipping World. Vol. 118, 30th June 1948, pp. 630-632.*

Application of the Hydraulic Coupling to Diesel-driven Trawlers

Two Diesel-driven trawlers were recently fitted with hydraulic couplings by Messrs. Barclay, Curle and Co., Ltd. The first to be equipped in this way was the trawler "Dauntless Star" to the order

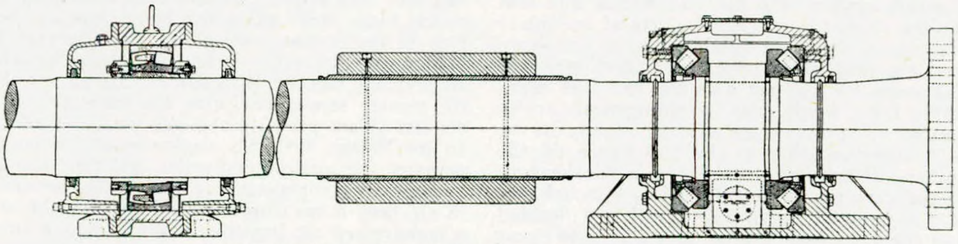
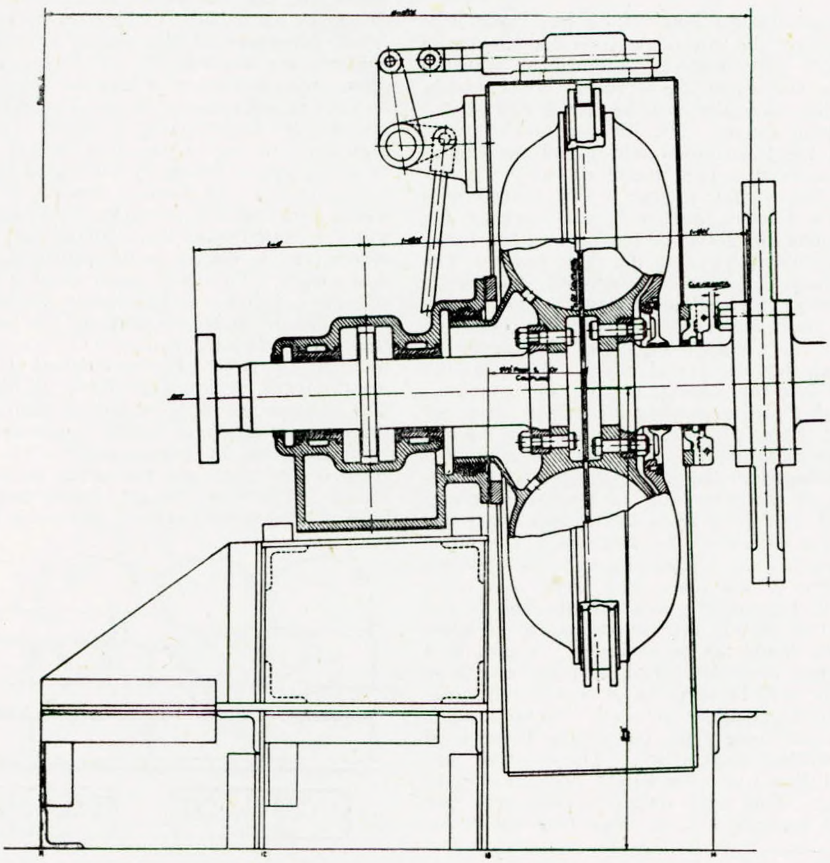


FIG 3.—*Tunnel shaft bearing, coupling and thrust bearing*



Application of the hydraulic coupling to Diesel-driven trawlers.

of Messrs. Hepton Brothers of Hull for Messrs. Star Drift Fishing Co., Ltd., Lowestoft. The machinery consists of a Crossley Diesel engine used both for propulsion and to drive the electric generator for the trawl winch forward. The coupling (see illustration) is fitted aft between the engine and propeller. The Crossley Diesel engine develops approximately 350 b.h.p. at 340 r.p.m., and this power is transmitted through the coupling to the propeller with about 3½ per cent slip. The hydraulic coupling is fitted with a ring which covers the oil outlet valves and these are placed on the periphery of the wheel. This ring is controlled by hand gear so that the coupling can be filled and emptied with oil at the discretion of the navigating officer on the bridge. The main engine also drives, through gearing, an electric winch for hauling in the fishing nets, and it is while this operation is in progress that it is necessary to keep a slight forward movement of the vessel and thus take the heavy strain off the nets and gear. This is of enormous advantage to the deck crew when manœuvring the vessel during this operation. To obtain this delicate forward movement of the vessel the emptying ring of the coupling is operated so that the outlet valves are uncovered, the coupling being allowed to have excessive slip between engine and propeller. The engine revolutions being about 200 with the propeller turning about 40, it can be readily seen that by this method the propeller speed can be arranged with the opening and closing of the outlet valves.—*The Shipyard, Vol. 22, January-March 1948, p. 40.*

Elliott Electromagnetic Slip Couplings

The six 372-feet twin screw motor cargo vessels built by the Tampa Shipbuilding Co., Tampa, Florida, for the French Supply Council are each equipped with six Nordberg 6-cylinder Diesel engines, each engine being equipped with an Elliott-Buchi turbocharger. All six engines are connected to the two propelling shafts through Elliott electromagnetic couplings and Farrel-Birmingham reduction gears. Although the six engines are all of the same power, four are considered main propulsion engines and are reversible, while two are considered auxiliary engines and operate in the ahead direction only. The non-reversible engines have a dual function. Each engine is directly connected to an Elliott 600-kW., 240-volt, direct-current generator for auxiliary power, and in tandem with an Elliott electromagnetic slip coupling and gears for connexion to gear drive shaft. When it is desired to operate the ship at full power, or for emergency in the ahead direction, the generator fields are de-energized and the coupling fields energized and the engine then becomes a propelling unit. The engine controls are so arranged that it is impossible to energize the generator fields and the electromagnetic coupling at the same time. Although the vessels will be at sea for more time than in port, rapid loading and discharging of cargo is an important factor. Large electric capacity was therefore installed for this reason and no additional generators would be required if refrigeration for preserving the perishable cargoes is installed at a later date. In order to keep a rigid sailing schedule, a reserve of power and speed is necessary. These problems were solved by the unique machinery arrangements. At sea, when all six engines are employed for propelling the ship, electric current is furnished by a 250-kW. turbine-generator set, steam for which is supplied by a waste-heat boiler. A stand-by, oil-fired boiler is provided for use in port. Propulsion engines operate at a full-load normal speed of 320 r.p.m., driving the two shafts through the reduction gears at 200 r.p.m. The Elliott electromagnetic slip couplings offer a number of advantages which recommend them for use in the larger multi-engine installations. They consist primarily of two elements—an outer element or field, and an inner element or armature. Since there is no mechanical contact, there is no wear. The torque is transmitted entirely by electromagnetic means, and the capacity is independent of speed. An important feature is their ability to dampen torsional vibrations in the propulsion system and to cushion the gears from torsional shocks and the relatively high-frequency torsional vibrations sometimes found in engines. The couplings also serve as disconnect clutches. In the event of the failure of an engine, it can be separated from the system by simply de-energizing the coupling field. The ship can then progress on the remaining engines while repairs are being made. If a slow ship speed is desired, only engines sufficient to give the necessary power need to be running. The others can be disconnected and shut down, thereby saving fuel. The control levers may be placed anywhere, even on the bridge. In this case, they are incorporated in the control stands. Manœuvring is simplified since it is possible to run two engines in reverse and two in forward speed. Propeller reversals are accomplished by energizing the appropriate couplings. Time and starting air are saved as the engines run constantly in the selected direction.—*Powerfax, Vol. 26, No. 2, 1948, pp. 16-18.*

Slip Couplings

The slip couplings supplied for the new Dutch passenger liner "Willem Ruys" were supplied by the Allmänna Svenska Elektriska A.B. Each of these "ASEA" couplings is designed to transmit 4,000 h.p. at 215 r.p.m., or the corresponding torque at lower speeds, down to about 100 r.p.m. They were designed to run at full excitation throughout the above speed range. The slip measured on test amounted to 0·8 per cent of the transmitted power and the excitation consumed another 0·8 per cent The maximum torque transmitted was 170 per cent of the normal torque, which agreed with the calculated values. The total losses were very small, amounting to 1·6 per cent. This corresponds to about 60 per cent of the losses in a hydraulic coupling capable of transmitting the same power. The external diameter of the couplings is 2,790 mm. (about 9ft. 2in.), while the axial length of the coupling, from engine flange to gear flange, is 990 mm. (about 3ft. 3in.). Both halves of the coupling consist of rigid, massive steel castings. An adequate supply of cooling air is ensured by letting the inlet air for the Diesel engines pass through the couplings. This method has the advantage that the couplings are always supplied with fresh clean ventilating air, which simplifies the care and maintenance, and it also provides highly effective cooling of the coupling. As the makers of the Diesel engines had stipulated that the slip coupling-half connected to the engine flange should have very small flywheel capacity, it was necessary to employ couplings of the outer pole, i.e. the field coils were fixed to the outer half and the short-circuited winding was placed in the inner half, the latter being bolted to the shaft flange of the Diesel engine. The specified limits on the flywheel capacity of the inner half were very close indeed, +0 to −3 per cent. In view of the fact that the hub of the inner half was made of cast steel, certain precautions had to be taken in order that these close limits should not be exceeded. A simplified design of smaller couplings has been developed, and six couplings rated at 3,500 h.p. at 215 r.p.m. will be supplied to two Dutch yards for installation in vessels for the Compagnie Génerale Transatlantique. These couplings are of the inner pole type, but unlike those used in the Willem Ruys are of welded construction. The external diameter is 2350 mm. (about 7ft. 8½in.) and the length between flanges is 820 mm. (about 2ft. 8¼in.). The total weight is 13·6 tons per coupling.—*H. Arnemo, ASEA Journal, Vol. 21, May 1948, pp. 47-53.*

Risk with Automatic Devices

Automatic devices can add substantially to safety on board ship, but they may also prove a source of danger. The "Proceedings" of the American Merchant Marine Council recently contained the story of a pleasure motor boat which exploded in port, destroying itself and three other boats as well as damaging three others. On the morning of the explosion it was found that there was petrol in the bilges due to a leak in one of the fuel tanks, and after the leak had been stopped, the bilges were flooded with fresh water and the mixture siphoned into the harbour, this procedure being repeated several times until the bilges seemed to be clear of petrol. In the late afternoon an explosion occurred in the engine compartment and instantly flames were sprayed throughout the immediate area with the consequences stated above. At the subsequent investigation it was revealed that the boat was equipped with an automatic electric bilge pump which under normal conditions came into operation with a rise of bilge water in the suction pipe. In the opinion of the investigating officer, it was the automatic starting up of this pump which produced the spark which ignited the petrol vapour accumulated between the floors. The report concludes:—"It is all well and good to install mechanical contrivances to ease the burden of daily routine, but it must be remembered that they increase the burden of responsibility when that routine is interrupted."—*Shipbuilding and Shipping Record, Vol. 72, 15th July 1948, p. 63.*

Torque Characteristics of Steam Turbines

In applying steam turbines the speed-torque relationship is considered only in a few special instances such as reversing of ships' propellers. Thus it is not surprising that there is an erroneous general impression that the starting torque of a turbine is low. If turbines were applied widely for the many applications served by motors, knowledge of their torque characteristics would be general. A multi-stage steam turbine supplied with steam at the designed inlet pressure and temperature and with exhaust pressure constant at the designed value develops slightly more than double its full-power torque at zero speed. Also, if it were mechanically strong enough, the turbine would run at a little more than double its rated speed at no load.—*J. S. Newton, Westinghouse Engineer, Vol. 8, July 1948, pp. 119-121.*

Dual Blowers for Pressure-charging

In the Buchi duplex turbo-charging system two blowers are employed, one of which is mechanically driven and the other is driven by an exhaust turbine, so calling for no mechanism for rotational connexion to the engine or other power source; likewise no controls are needed—the whole system functions automatically. A most important point is that the design can be used with two-stroke as well as four-stroke units. The difficulty usually experienced with air supply for starting a blown two-stroke engine is overcome. Referring to Fig. 1, the first blower, preferably of the centrifugal or axial type, is driven by the engine itself or from some other power source such as an electric motor. It is built as simply as possible, like a fan, and serves as the first stage of the air-charging system. For the second stage there follows an exhaust-gas-driven turbocharger which can be, thanks to the principle, of relatively small dimensions and weight. To ensure good starting of the engine, also to improve running conditions at light loads, the mechanically driven blower furnishes its air during starting and low-load running through non-return flap valves directly to the cylinders. At higher loads, however, the mechanically driven blower delivers its compressed air to the exhaust turbocharger, which then feeds all the charging air to the engine. The change-over from direct to series working of the mechanically driven compressor is wholly automatic, the flap valves (see Fig. 1) being actuated by pressure-difference conditions as between the air chest or chamber and the outlet from the primary or low-pressure blower. The low-pressure blower exit is constantly connected to the inlet of the turbocharger. Once the latter has, after the start and

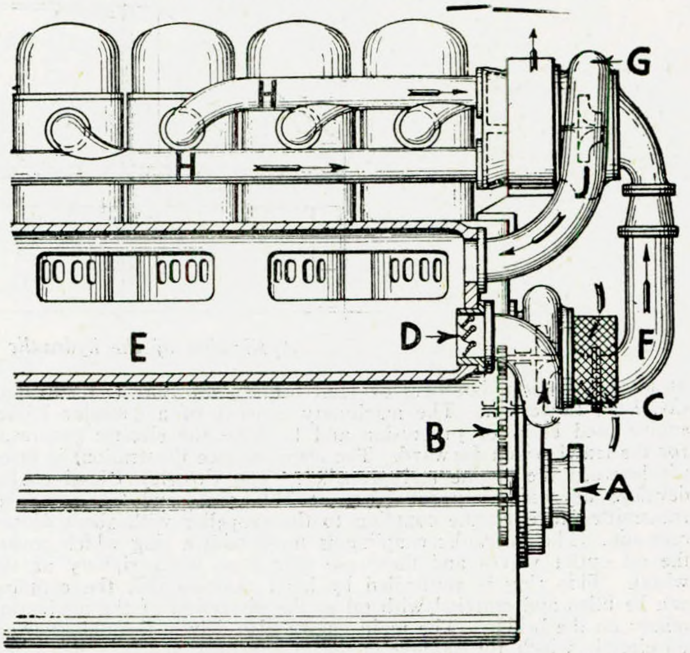


FIG. 1.—*Diagram of the layout of the Buchi Duplex turbocharging system applied to a two-stroke engine*

A.—Crankshaft. *B.*—Gearing driving blower (*C*). *D.*—Flap valves which are open when pressure from (*C*) exceeds that in the air chamber (*E*). They are closed when the pressure in (*E*) exceeds that in (*C*). *F.*—Air duct from (*C*) to exhaust turbo blower (*G*). *H.*—Exhaust manifolds leading to turbine.

take-up of load by the engine, been accelerated to a speed at which it produces a higher air pressure than the mechanically driven blower, then the simple flap valves close automatically. All the air is then compressed in series by both blowers acting as air-compounded units. This system offers the following advantages. (1) It works without attention, employing simple and reliable elements, from the start of the engine up to its maximum load, also at all engine speeds. (2) With the two blowers, both having simple single-stage runners, substantial charging pressures can be obtained. Even if an engine is assumed working without pressure fluctuations in the exhaust manifold and with quite low exhaust temperatures, a four-stroke engine can attain a normal continuous output of more than 200lb. per sq. in. b.m.e.p. when working with a high charging-pressure ratio. Cooling of the charging air is assumed, but no scavenging of the engine cylinders. Increased scavenging by the use of exhaust-gas-pressure fluctuations and divided exhaust manifolds can here be applied. This augments the output and improves the reliability to an appreciable extent. (3) The duplex system has the further advantage that during starting and at light loads there is always a substantial charging and scavenging pressure. This is especially advantageous for engines which must run during extended periods at low loads. (4) The higher the charging pressure the higher also will be the admissible back pressure behind the turbine. (5) If the mechanically driven blower is designed with radial runner blades and a blade-less diffuser, the Diesel engine can be reversed without needing any reversing device on either of the two blowers. (6) The exhaust-driven blower is relatively small and light in weight because it receives already precompressed air. Both factors facilitate its attachment to or mounting near the engine, keep its cost down and improve reliability. (7) This system is applicable not only to four-stroke but also to two-stroke engines; for the latter it offers many possibilities for further development and power increase.—*The Oil Engine and Gas Turbine, Vol. 16, July 1948, pp. 78-79.*

Experimental Compound Diesel Engine

In the experimental compound Diesel engine tried out in Japan by the Mitsubishi Heavy Industry Co. of Nagasaki, the compound processes were divided into two stages of the different cylinders such as high-pressure and low-pressure cylinders. The cylinder element of the engine consisted of one two-stroke low-pressure cylinder and two four-stroke high-pressure cylinders, and achieved remarkable working by making a special cycle. The working process is shown diagrammatically in Fig. 1. The gas transfer valves on both high-pressure cylinders as shown in Fig. 1A, open at the dead centre of the piston; that is to say, at the end of suction of one high-pressure cylinder, and all the fresh air that remains in the gas transfer ports is poured into the high-pressure cylinder on the suction side. The incipient advantages of this engine are an increase in output by taking advantage of this gas effectively for its combustion and working. The particulars of the experimental engine are: diameter of cylinder 100 mm., stroke of piston 200 mm., r.p.m. 1,500; b.m.p. 8 atmos.; b.h.p. 210; weight 0·6 tons; length 600 mm.; height of engine (from crank centre) 920 mm.; width 580 mm.; overall height 1,150 mm. Data for the low-pressure cylinder is the same as above except for cylinder dimensions of 200 mm. diameter and piston stroke of 250 mm. The engine inspected by Allied technical intelligence investigators was the second of a series, the first of which ended in failure. It was, however, of a larger type, and for the year previous to the visit of the Allied investigators Mitsubishi had concentrated on a smaller size which they hoped to use in fast patrol craft to replace high-

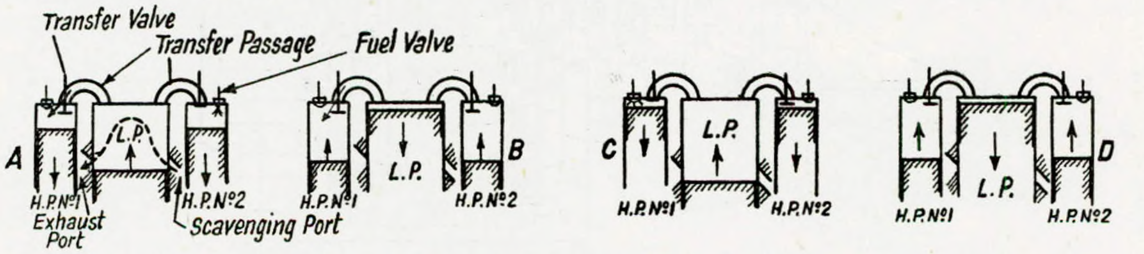


FIG. 1.—*Diagram of principle used by the Japanese for the experimental compound Diesel engine*

FIG. 1.—*Diagram of principle used by the Japanese for the experi-*
speed petrol engines. From information given, it was strongly indicated that it was not possible to develop over 150 h.p. on account of combustion difficulties. A Gray Diesel engine captured in Shanghai had had the blower removed, and no doubt a study was being made of the G.M. blower to discover means of forcing additional air into the low-pressure cylinder. The transfer valve was a source of trouble because of the high exhaust temperatures of 1,200 deg. to 1,300 deg. F. In order to produce the designed horsepower of 210, the fuel injection adjustment was set at a duration of 60 deg. Injection started at 40 deg. before t.d.c. and closed at 20 deg. after t.d.c.—*Gas and Oil Power, Vol. 43, July 1948, pp. 206-207.*

Discussion of Transmission Systems for Marine Propulsion Gas-turbine Power Plants

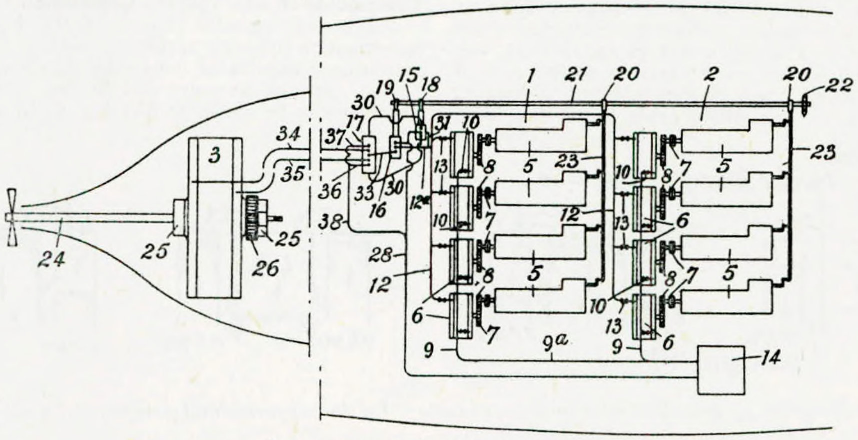
This paper discusses the various transmission systems available today to determine which might offer the most attractive prospects in connecting the gas turbine to the marine propeller for merchant vessels. According to the paper, the following points are some of the requirements that a marine transmission system should possess. (1) It must be capable of reducing the revolutions from those required by the prime mover to those required by the propeller; (2) it must be reliable and simple in operation within the capabilities of the crews that are available; (3) the transmission losses should be a minimum; (4) the first cost and maintenance should be commensurate with those of the prime mover so that the advantages of the prime mover will not be nullified by the transmission system; (5) the weight and space required should also be commensurate with that required of the prime movers for the reason just given; (6) if the torque characteristics of the prime mover do not coincide with the requirements of the propeller for all conditions of operation, then the transmission system must be capable of making suitable adjustments to meet these requirements; (7) if the prime mover is not reversible then the transmission must provide this feature; (8) should it be possible to disconnect accidentally the propeller from the prime mover while under load, then it must be possible to re-establish the connexion immediately. If this cannot be accomplished the consequences can be extremely serious and result in totally wrecked machinery; and (9) it is preferable that the transmission system selected for the merchant marine should have a wide application to reduce development cost, simplify manning problems, and reduce maintenance. There are available today many arrangements of marine transmission systems in successful operation with steam turbines which may be applied to the gas turbine. However, there is one important difference in the two prime movers, i.e., the steam turbine as it is known today is reversible and the gas turbine is not. Many suggestions and proposals have been made to provide a reversible gas turbine, but to date a reversible gas turbine has not been developed. The following transmission systems, presently available, might be considered as possible solutions to the problem: (1) electric drive, direct current; (2) electric drive, alternating current; (3) mechanical geared drive with controllable pitch propeller; (4) mechanical geared drive containing reversing features; and (5) mechanical geared drive with reversing gas turbine. The mechanical reduction-gear transmission with a controllable and reversible pitch propeller represents the best solution of the problem. For limited application, the alternating current electric drive and the mechanical reversing gears both offer acceptable solutions, in addition to the mechanical reduction gear with controllable pitch propeller.—*Paper by W. E. Hammond read at the Annual Meeting of the American Society of Mechanical Engineers, No. 47-A-69 (1947).*

Combustion in Gas Turbine Combustion Chambers

The experimental station of the Etablissement Indret for the investigation of gas turbine problems is equipped with a turbo-compressor capable of delivering 30,000 kg. of air per hour at 7 kg. per sq. cm. abs. pressure and 50 deg. C. temperature. The air temperature can be raised to 350 deg. C. in a tubular air heater consisting of an old marine boiler adapted to this purpose and heated by the combustion products of the gas turbine plant. The fuel used is no. 1 boiler fuel atomized at 30 kg. per sq. cm. pressure and 100 deg. C. in a mechanical sprayer of conventional design. The combustion chamber consists of an outer envelope made of 2 per cent nickel, 0·35-0·6 per cent chromium and 0·35-0·6 per cent molybdenum steel. The air distribution is made of 18-22 per cent nickel, 23-27 per cent chromium alloy and is equipped with guide vanes which impart a whirling action to the combustion air; a deflector for stabilizing the flame front is provided. The flame tube, which is arranged concentrically in the combustion chamber is also made of a high-chromium austenitic material. After operating for some sixty hours at theoretical combustion temperatures between 1,300 and 1,600 deg. C. no scaling of the flame tube was observed, and this in spite of the fact that the total pressure drop in the combustion chamber did not exceed 350-400 mm. wg. which is two to three times less than the pressure drops allowed in the best combustion chambers built outside France. As it is not possible to avoid uneven temperature distribution in the metal of the flame tube, there exists the danger of deformation by warping, but this was successfully avoided by appropriate design of the flame tube, it is stated. Two different types of pyrometer were used to measure the flame temperature. The two pyrometers indicated temperatures which were identical within ± 10 deg. C. By appropriate location of the air admission openings the temperature over the burner section was kept constant within ± 10 deg. C. at an air rate of 80 kg. per kg. of oil. This compares with a figure of ± 25 deg. C. in foreign installations, it is claimed. In order to study the influence of various operating factors upon the flame length, the fuel rate was varied between 125 to 450 kg. per hr., the air inlet temperature between 250 and 350 deg. C., the combustion chamber pressure between 1·5 and 5·5 kg. per sq. cm. and the air/fuel ratio between 95 and 55 kg. per kg. The test results confirmed that flame length decreases with increasing pressure and increasing excess air; it increases with increasing air velocity at the air distributor outlet. Burner efficiency was established by thermal balance for various operating conditions and the following conclusions were drawn. For a given firing rate the burner efficiency is solely a function of the flame length, and it increases up to a certain flame length and then decreases if the flame length is further increased. Combustion chamber efficiency for varying firing rates can be expressed as a function of the firing rate as defined by the amount of fuel burned per furnace volume occupied by the flame in unit time. In the case of a cylindrical combustion chamber the efficiency therefore is inversely proportional with the flame length.—*Paper by M. Pascal read at the 40th Annual Session of the Association Technique Maritime et Aeronautique, 28th May 1948.*

Improvements in Ship Propulsion

This invention has particular reference to improvements in and relating to the propulsion of ships, the primary object being the provision of a propulsion installation showing saving in dead weight of the propelling machinery and a considerable saving in cargo space. The propulsion installation according to the invention comprises, in combination, a number of high pressure, hydraulic pumps of piston type; an equal number (or a multiple or sub-multiple thereof) of Diesel engines adapted to drive the pumps; a high pressure, hydraulic motor of piston type to which the pumps are connected so as collectively to supply live liquid to it; a ship's propeller adapted to be driven by said motor; and speed control means adapted to control the rate (and if desired the direction) of rotation of the said propeller, the full power rating of any pump representing a fractional part of the full power rating of the motor. The method of speed control preferably acts on the engines. To avoid the use of an inconveniently large high pressure hydraulic motor a number of smaller high pressure motors may be provided for driving the propeller. In ship propulsion installations according to this invention it is preferred to use a pressure of the order of 2,000lb. per sq. in. The pumps and the motor or motors are preferably of the radial cylinder type. In Fig. 1 each of the batteries (1, 2) comprises four Diesel engines (5), and four radial cylinder high-pressure pumps (6), the engines being connected to the pumps by means of couplings (7) and reduction gear (8). The pumps are connected to inflow pipes (9) by branches in which are stop valves (10) and are connected to pressure pipes (12) by branches in which are stop valves (13). The pipes (9) branch from a main (9a) leading from a suction tank (14); the pipes (12) deliver into a common main (12a). The motor (3) drives the propeller shaft (24) directly, but the drive may be through reduction gearing.—*Brit. Pat. No. 598,654, issued to B. F. Baxendale, M. G. R. Petty and G. F. Jones. Complete Specifications accepted 24th Feb. 1948. Reproduced by permission of the Controller of H.M. Stationery Office. The Shipping World, Vol. 119, 7th July 1948, p. 12.*



Improvements in ship propulsion

The Nordberg Radial Engine

A new engine with cylinder arranged radially about a vertical crankshaft has been built and successfully tried out by the Nordberg Manufacturing Co. The Nordberg radial engine is built as a spark-fired gas engine with a patented system of spark ignition, as a Diesel engine and as a dual fuel engine. Its patented features of design are not found in conventional Diesel engines and they offer certain advantages that merit the serious attention of marine engineeers, it is stated. Built with eleven cylinders of 14-inch bore and 16-inch stroke, this engine developes 1,800 h.p. or 1,250 kW. at 400 r.p.m. The scavenging blower motor requiring approximately 100 kW. input is connected directly to the leads of the generator making a self-contained unit automatic in its operation, leaving a net capacity of 1,150 kW. The compact design of this engine provides for direct connexion to the generator which is mounted at the lower end of the vertical crankshaft in the coolest zone. This arrangement requires headroom of less than 20 feet measuring from engine foundation, and little more than 12 feet laterally. On board ship where a saving in space is generally reckoned a saving in money, the relatively small space requirements of this 1,800 h.p. unit recommend it for motorships using Diesel-electric drive. A further consideration in the matter of space-saving is the fact that cylinder parts can be serviced from the floor eliminating the necessity for clearance above the engine to pull pistons and doing away with the usual heavy crane and supports. The Nordberg radial engine operates on the simple two-cycle principle with port scavenging and port exhaust. Power is transmitted through connecting rods to a master gear mounted on the single crankpin of the shaft. The master gear assembly with its eleven bronze bushed knuckle pins is kept constantly aligned through pinion gears meshing with the master gear and a stationary gear attached to the heavy cover bolted to the top of the frame. The relationship of the various parts that is maintained by the gearing assures the optimum position of the master gear and counterweights for the absorption of piston thrust and balance of forces. The only other main bearing required is the lower one located in a hub which is part of the frame. A thrust bearing to carry the weight of the crankshaft is also incorporated. The upper main bearing is in the heavy symmetrical cover which is bolted to the cast main frame. Mounted on this cover are the governor, fuel pumps, mechanisms for oil and gas operation and controls. Circular manifolds for scavenging and exhaust are located below the operating platform. The motor driven centrifugal blower discharging scavenging air into the manifold is included with other auxiliaries grouped in a unit at the engine base. Also included in this auxiliary group is a motor driven centrifugal pump for circulating cooling water through the cylinder and head jackets and a motor driven rotary lubricating oil pump for the circulating pressure system. There are two systems of lubrication: force feed mechanical lubricators for the pistons and a circulating pressure system for all other parts requiring lubrication. This circulating pressure system consists of a motor driven rotary pump which takes its suction from the sump tank and discharges into the lower bearing of the shaft. From this bearing, the oil enters the drilled passageway in the shaft and rises where it is distributed to the crankpin bearings in the master gear, through drilled passageways in the connecting rods to the wrist pins, to the pinion bearings and to the upper bearing for the crankshaft. The pistons are made of a special aluminium alloy and are oil cooled.—*Motorship (New York), Vol. 33, July 1948, pp. 34-36.*

Wear Tests on Cast Iron Cylinder Liners

This paper, based on very extensive service tests, including marine service and the use of corrosive fuels as well as on laboratory data, gives a correlation of structure of cast iron with its wear-resisting qualities when used for Diesel engine cylinder liners. The most suitable iron was found to be an alloy with total carbon of

2·85 to 3·30 per cent, silicon 1·25 to 1·75 per cent., manganese 0·80 per cent maximum, phosphorus 0·2 per cent maximum, sulphur 0·12 per cent maximum, nickel 1·0 to 1·5 per cent, chromium 0·30 to 0·40 per cent, molybdenum 0·25 to 0·35 per cent. This iron is a standard type with many producers. The combination of alloying elements refines the pearlitic grains and gives good wear resistance. From the foundry standpoint it is an excellent iron to handle. The general conclusion is that of the various structures examined, type A graphite with a truly pearlitic structure, gives the best wear-resistance. It is suggested that a suitable specification for machinable cylinder liner iron would be "the iron used shall have type A graphite with a pearlitic structure containing no free ferrite, and a Brinell hardness of over 190".—*T. E. Eagan, Foundry, Vol. 76, May 1948, pp. 134-139, 308-310, 312. Abstracted in The Nickel Bulletin, Vol. 21, June 1948, p. 87.*

Cast Crankshafts

A detailed survey is made of published information on the subject of cast crankshafts and the following aspects are discussed: (1) the behaviour of cast crankshafts in service and the influence of the various material properties; (2) cast materials, surface treatments, and special heat-treatments; (3) features of design; and (4) the advantages of using cast crankshafts. Reference is also made to sources of information concerning the production of cast crankshafts. The results of various tests on cast crankshafts and on the more conventional forged crankshafts are given and indicate that cast crankshafts normally have lower bending fatigue strengths than forged shafts, the materials used for forged crankshafts having, in general, considerably greater tensile strengths than the cast materials. The torsional fatigue strengths of cast shafts compare more favourably with those of forged crankshafts, but are lower than those of forged crankshafts of high tensile strength. Nevertheless, cast crankshafts are seen to have a very good record for behaviour in service. The various points concerning the advantages of using cast crankshafts can be summarized in the statement that the casting process provides a means of quickly and cheaply supplying a crankshaft of very high wear resistance and of the most desirable shape, this shape being such as to impart to the engine certain favourable characteristics which could not be obtained in the forged shaft except at high cost.—*Journal of The Iron and Steel Institute, Vol. 159, Part 3, July 1948, pp. 247-274.*

Self-scaling Evaporators

One of the biggest difficulties in the operation of evaporators and distillers is the removal of the scale which forms on the heating surface. Attention may therefore be drawn to a self-scaling type of evaporator having a capacity of 1,100 gallons of fresh water per day which has recently been approved by the American Coast Guard, after a 2,000-hour test without overhaul, for use on lightships. The still, as it is termed, is of all-Monel metal construction and comprises an upright cylindrical shell arc-welded from ⅛-inch Monel sheet. Inside are two chambers provided with vertical corrugations arc-welded from light-gauge Monel sheet which serve as interchangeable evaporator and condenser sections. Live steam inside the evaporator section boils sea water in the shell around it, the vapour passing through a cyclonic separator which takes out the entrained particles of water. It then condenses on the fin-like corrugations of the condenser section which is kept cool by the entering feed water from the sea. When it is desired to descale, steam is fed into the evaporator section which flexes the corrugations outward. Cold sea water is then let into the shell causing instantaneous condensation of the steam which, it is stated, produces a nearly perfect vacuum that sucks the corrugations inward. This flexing back and forth of the corrugations cracks off the scale which is then expelled. The purity of the water produced by these stills is said to be 0·20 grains per gallon which is considerably better than the 0·25 grains maximum set by the U.S. Department of Public Health.—*Shipbuilding and Shipping Record, Vol. 72, 22nd July 1948, p. 95.*

The Down-jet Furnace

In the patented down-jet furnace developed by the British Coal Utilisation Research Association and described in the first issue of the B.C.U.R.A. Quarterly Gazette, the fuel, instead of being carried on a normal grate, is carried on a solid hearth or clinker-removal device and the combustion air is fed through one or more nozzles located above the fuel bed, the air being blown down into the fuel. As a result, the bed may be several inches deep without ill effect, for the degree of interaction between the air and the fuel can be governed by controlling the air jet. There are no adjustments of primary and secondary air, the combustion chamber can be quite small and there are no firebars to get burnt. The ash sinks into the fuel bed and forms a dense clinker pad containing little or no combustible matter, and it is stated that for one-shift operation—up to 10 hours—the furnace can be so designed that it requires no attention as far as ash removal is concerned. For continuous operation a mechanical ash removal gear has been devised. Another feature of the design is the rapidity with which steam can be raised from cold. So far, the device has only been fitted to relatively small boilers up to 300lb. of steam per hour at 200lb. per sq. in., but the results have proved very promising and designs are in hand for larger units.—*Shipbuilding and Shipping Record, Vol. 72, 22nd July 1948, p. 95.*

Passengers and Boilers

A great deal of attention is now being paid to the problem of disposing of a ship's funnel smoke without interfering with the comfort of the passengers, and many ingenious mechanical devices and funnel shapes are being adopted. In the case of the French packet "El Djezair", building at La Seyne for the North African service, an old practice is being reverted to which has been occasionally tried in the past. A 6,000-ton ship of 20 knots, she is primarily designed for passengers and has stowage for rather more than 2,000 tons of cargo. Her machinery and funnel are placed so far aft that the smoke can give no trouble. Well-known ships can be recalled where this was tried in the past. There were the earliest Red Star liners, when it was adopted because they were going to carry oil in bulk as well as passengers until the authorities stopped the combination. There were the famous clipper-stemmed steamers on the Chilean coast, noteworthy for their service as auxiliary cruisers, whose twin funnels, abreast, were right aft primarily to allow the ships to be used in their various calls up the coast as floating markets with an uninterrupted 'tween deck. There were also the Matson liners until after the first world war. The idea has many advantages for the passenger, particularly on a hot weather service, but the appearance is unpopular and if the ship is to carry much cargo the question of trim also demands consideration.—*Shipbuilding and Shipping Record Vol. 72, July 22nd 1948, p. 95.*

Mounting of Boiler Water Gauges

It is surprising to see, as present day practice, water gauge glasses on cylindrical, multi-tubular boilers which do not register continuously the correct water level above the combustion chamber tops, without the boiler operator having to resort to blowing down and recharging the system with water at boiler temperature. It is possible today to see new vessels delivered so fitted, where twenty minutes after the gauge glass pipes have been re-flooded, the water disappears completely from vision, due to the cooling effect of the stagnant water in the pipes, which in some cases are 10 to 14 feet in length. Should these pipes be lagged in a manner equal in thicknesses to those fitted on main steam pipe it will only increase the time from 20 minutes to about 45 minutes, before the water will disappear from a glass tube of standard ⅝-inch diameter. It is possible, in a short time, to lay a bare hand on an unlagged water pipe to the gauge fitting while a full head of steam is on the boiler. It is of first importance that the water level in the gauge glass should be an indication of the water level above the combustion chamber at all times. It would appear that this arrangement is common when the boilers are fired from the engine-room space and where the boiler backs are remote from the engine-room, when the gauge glass fitting is mounted on the style plate between the smoke-box doors. Where boilers are fitted with two water gauge fittings, it would be possible to mount the fittings on the boiler circumferential plates in such a manner that all long connecting pipes are eliminated for the water connexions. The steam pipe connexion may be a wandering lead provided it drains back to the boiler or to the fitting without kinks or bends, which would trap condensation. A suitable connexion for the water supply when the fitting is on the style plate on boiler front, is to lead a steel tube through the forced draught air casing to the boiler front plate at the shortest possible height below the gauge glass fitting, thus reducing to a minimum the stagnant water below the glass and always maintaining the temperature of the water at the gauge glass, as near as possible to that inside the boiler, which would result in water always being visible in the glass tube and avoid the undesirable feature of having to blow down the water in the gauge glass in order to determine the correct level of water in the boiler.—*The Journal of Commerce (Shipbuilding and Engineering Edition), No. 37,562, 15th July 1948, p. 6.*

Application of Light Alloys to Coasters

The light alloys, while more expensive than steel, have certain advantages in ship construction, and the object of the present paper is to demonstrate these advantages in a particular type of vessel, viz., coasters. Coasters are in general quite fast vessels for their lengths, and it would appear that the advantage of weight-saving in such vessels where the speed length ratio is something over 0·70 would make the use of light alloys worth while. The subjoined table gives the particulars of a small coaster:—

Length, b.p.	163 feet
Breadth	27 feet
Depth (mid.)	12ft. 4in.
Draught (loaded)	11ft. 4¾in.
Displacement (loaded)	1,077 tons
Block coeff. (loaded)	0·750
Deadweight	731 tons
Cargo capacity (bale)	33,540 cu. ft.
Cargo capacity (grain)	35,725 cu. ft.
Speed	9 knots

The midship section is shown in Fig. 4. The vessel has an upper deck with a poop and forecastle. A large hatch extends for almost the entire length of the single hold, the width of the hatch being 15ft. 3in. The deck between the hatch side and the ship's side is supported by cantilever beams spaced four frame spaces apart and by deck girders which are run in conjunction with the hatch side and are on top of the deck. Strength is obtained in the sides by fitting web frames. A double bottom having a depth of 29 inch is fitted in the hold and solid floors are fitted on every frame. The structure which is contributing to the longitudinal strength of the ship consists of the bottom and side shell, deck, tank top, flat plate keel and centre girder together with the deck girders. The replacement of this steel structure by a light alloy structure will first be considered. The first question which arises is the choice of material. Suppose the alloy A.W.6C, containing 5 per cent magnesium and having a 0·1 per cent proof stress of 8 tons per sq. in., is used in the soft condition. This material has an ultimate strength of 17 tons per sq. in. compared with an average of 29 tons per sq. in. required

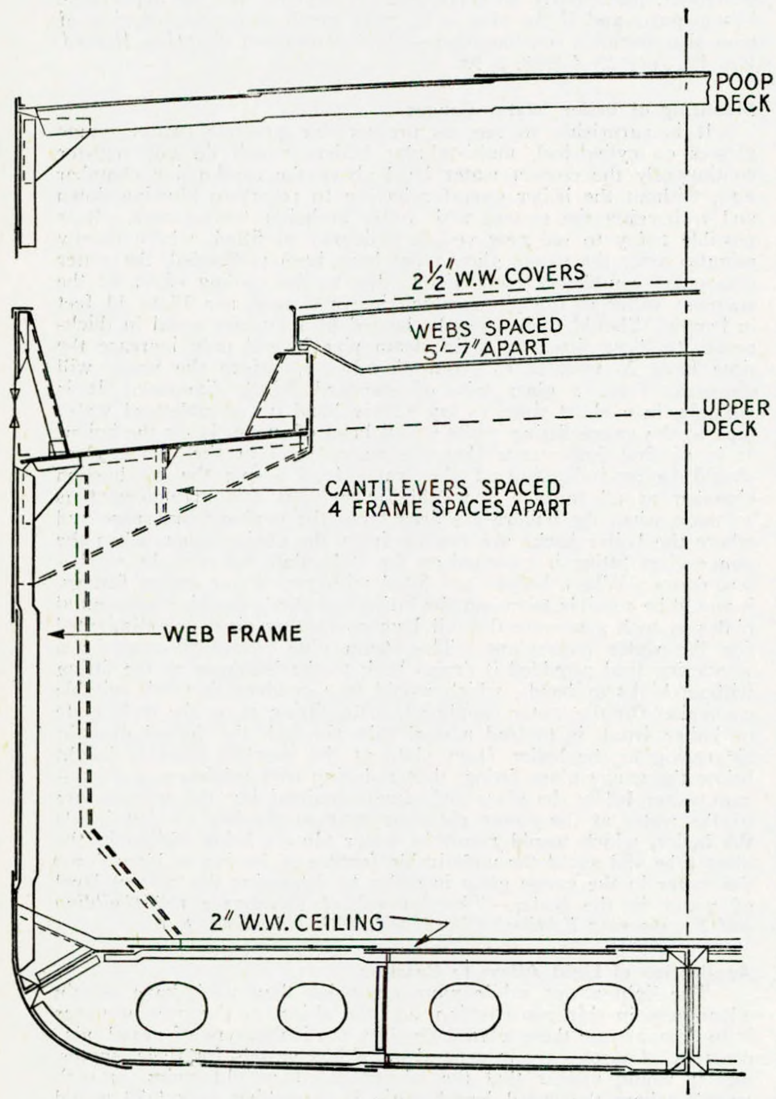


FIG. 4.—*Motor coaster: midships section*

by Lloyd's Register of Shipping for ship plates. To attain the same longitudinal strength, therefore the thickness of all the "longitudinal" material should be increased in the ratio $\frac{29}{17} = 1{\cdot}71$. The following table gives a comparison of the scantlings of the various parts in steel and light alloy:—

	Steel, inch	Light alloy, inch
Flat plate keel	0·44 ...	... 0·75
Tank top centre strake ...	0·37 ...	... 0·63
Tank top plating	0·33 ...	... 0·57
Centre girder	0·36 ...	... 0·62
Margin plate	0·35 ...	... 0·60
Bottom shell	0·37 ...	... 0·63
Side shell	0·37 ...	... 0·63
Sheer strake	0·44 ...	... 0·75
Upper deck	0·32 ...	... 0·55
Hatch side	0·41 ...	... 0·70

The specific gravity of the light alloy should give a weight of about 167·5lb. per cu. ft. so that the ratio of the weight of material in the light alloy and steel vessels would be $\frac{167{\cdot}5}{490} \times 1{\cdot}71 = 0{\cdot}584$. Thus more than 40 per cent of the weight of longitudinal material can be saved by the substitution of a light alloy for steel. Another factor which may affect the scantlings of the longitudinal material is the possibility of buckling between the transverse stiffeners. It can be shown that if

f_S = ultimate strength of steel,
f_A = ultimate strength of light alloy,
E_S = modulus of elasticity of steel,
E_A = modulus of elasticity of light alloy,
t_S = thickness of steel,
t_A = thickness of light alloy,

then $\frac{t_A}{t_S} = \sqrt{\frac{E_S}{E_A} \times \frac{f_A}{f_S}}$ in order to obtain the same resistance to buckling. With regard to sectional material such as framing and deck beams, in order to obtain the same strength an addition of from 25 to 30 per cent of the sectional area would be required if the depths are kept the same as in the steel ship. This would result in about 55 per cent saving of weight. The floor plates which resist transverse bending and which also have to resist crushing when cargo is carried in the holds would be able to fulfil this latter condition by having their thicknesses increased in the ratio of the cube roots of the elastic moduli, i.e. in the ratio $\sqrt[3]{3} = 1{\cdot}44$. The weight ratio of floors would then be $\frac{1{\cdot}44 \times 167{\cdot}5}{490} = 0{\cdot}491$. The structural parts above the upper deck, such as the poop and forecastle, would have adequate strength if the scantlings were increased by about 30 per cent. If the entire structure of this vessel were constructed of light alloy in place of steel then a saving of weight of structure of about 110 tons would result. If only the parts above the upper deck were constructed of the lighter material then about 26 tons would be saved.—*W. Muckle, Journal of the Hull Association of Engineers, No. 15, New Series 1947-1948, pp. 5-18.*

The New Thornycroft Funnel

The "Commandant Queré" is the first ship to be fitted with a new type of funnel, designed by Thornycroft's to counteract the tendency for smoke from a funnel of the modern, low shape to be drawn downwards, to the annoyance of passengers on the upper deck. The advent of forced draught fans for watertube boilers has removed the main reason for tall funnels, and in most new construction the funnels are comparatively short. Thornycroft's have found a tendency for smoke or hot gases to be drawn down into the area of eddies and low pressure in the lee of the funnel. Wind tunnel tests were carried out on models under varied conditions of wind, speed and direction, and it was found that the trouble could be avoided if the top section of the funnel were given a cross-section of aero-foil shape. This has been done, and horizontal vanes, extending to the limits of the broader cross-section below, have also been fitted to assist in smoothing the air flow. An arrangement has also been incorporated in the funnel of the "Commandant Queré" whereby air is drawn in through louvres in the front of the casing and is then given an upward path, to help the smoke to rise. It is understood, however, that this has been found to be unnecessary and will be omitted from future construction. The new funnel arrangement was demonstrated during the recent trials of the ship. The engine room was ordered to make smoke, and the ship was then swung round. There was a strong breeze at the time, and the smoke was blown well clear of the ship, but it was noticeable that the smoke remained in a narrow stream for some time. It is understood that a similar funnel top is to be fitted to the Khedivial Mail Line passenger vessel "El Mulek Foad", completed by Thorneycroft's last year.—*The Shipping World, Vol. 118, 30th June 1948, p. 619.*

ENGINEERING ABSTRACTS

Section 3. SHIPBUILDING AND MARINE ENGINEERING

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

A New French High Pressure Boiler

Four passenger liners at present building in France will be equipped with high pressure water-tube boilers operating at 855lb. per sq. in. pressure and a final temperature of 896 deg. F. The boilers will all be of different types, and one, the F.C.M. 47/60, is of an entirely new design. (This boiler was described in a previous abstract published in Vol. XI, No. 4, p. 40). Of the four liners concerned, two, each of 20,000 tons gross for West Indies service, are under construction at the yard of the Ateliers et Chantiers de France, Dunkirk, and at Brest Naval Yard respectively. The vessel building at Dunkirk, the "Flanres", will have four Penhoët P.41 boilers, while the "Antilles", under construction at Brest, will be fitted with four La Mont boilers. Both vessels will be driven by turbine machinery of 40,000 s.h.p. The other vessels of the series are both of 10,000 tons gross and are intended for North Africa service. These are the "Ville de Marseilles", building by the Forges et Chantiers de la Mediterraneé, and the "Ville de Tunis" with three Velox boilers. These vessels are also turbine driven, the total machinery output being 15,000 s.h.p.—*Shipbuilding and Shipping Record, Vol. 72, 29th July 1948, pp. 133-134.*

Hydrodynamic Characteristics of the Variable-pitch Screw Propeller

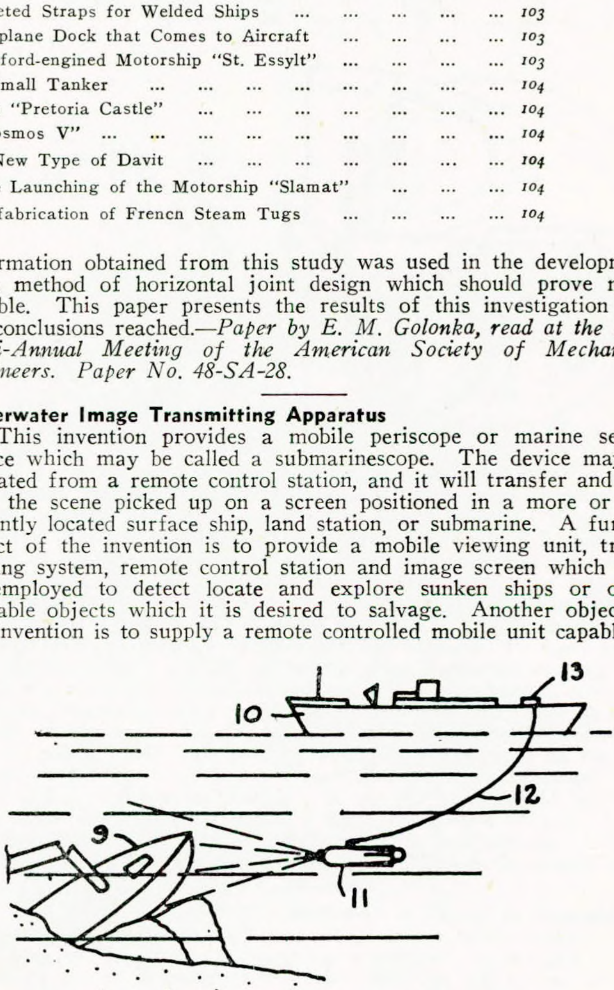
This paper reports in a general way on the results of tank tests conducted on towed and also on self-propelled models equipped with variable-pitch screw propellers. The various models tested included those of a trawler and of an ice-breaker. Comparative tests with the employment of a fixed-pitch screw propeller were made in every case. —*E. Castagneto, La Ricerca Scientifica, Vol. 18. May-June 1948, pp. 574-577.*

Design of Main Cylinder Joints for Steam Turbines

Although only a limited number of steam-turbine cylinder horizontal joints have steam leaks when first placed in service, these leaks are a source of annoyance and expense. Herein are suggested joint, flange, and bolting practices emanating, to a great extent, from an elementary stress check used in a study of both leaky joints and joints that have been steamtight in service. As a result of the correlation of this work, three joint stress requirements are presented and if adhered to will assure a good and reliable horizontal joint design. With the increasingly higher operating pressures and temperatures in power plants the proper design of the horizontal joint on a high-pressure steam-turbine cylinder has become a problem of considerable importance from the standpoint of preventing steam leakage in this joint during normal operation. Although steam joints have been carefully designed, steam leakage has occurred in a few installations. Such leakage is usually corrected after initial operation of the turbine. It was decided to make a detailed study of the joint design of a number of large steam turbines in which no leakage difficulty had developed in service, as well as units in which trouble occurred. Information obtained from this study was used in the development of a method of horizontal joint design which should prove more reliable. This paper presents the results of this investigation and the conclusions reached.—*Paper by E. M. Golonka, read at the 1948 Semi-Annual Meeting of the American Society of Mechanical Engineers. Paper No. 48-SA-28.*

Underwater Image Transmitting Apparatus

This invention provides a mobile periscope or marine seeing device which may be called a submarinescope. The device may be operated from a remote control station, and it will transfer and display the scene picked up on a screen positioned in a more or less distantly located surface ship, land station, or submarine. A further object of the invention is to provide a mobile viewing unit, transmitting system, remote control station and image screen which may be employed to detect locate and explore sunken ships or other valuable objects which it is desired to salvage. Another object of the invention is to supply a remote controlled mobile unit capable of



use in supervising, directing and controlling undersea salvage operations and undersea military and civilian activities such as submarine, ship and dock repairing, channel dredging and mine laying. The diagram shows a cross-sectional view illustrating the use of the invention to transmit a continuous illuminated picturization of a wrecked ship under water to the visual screen positioned on a ship on the surface of the water. (9) indicates a wrecked ship resting on the bottom of the sea; (10) is a control ship riding on the surface of the sea. At a suitable place on the control ship is located winch mechanism (13) from which the control cable (12) connects to the mobile unit (11), which is illuminating and picking up the image of the wrecked ship (9).—*United States Patent No. 2,433,971, dated 6th January 1948, issued to H. A. Adams. The Shipping World, Vol. 119, 18th August 1948, p. 132.*

Improvements in the Exhaust Heads of Steam Turbines

The connexion between the last expansion stage of a steam turbine and the condenser under vacuum is effected generally by a curved member of complex shape providing for the passage of the turbine shaft and carrying fluid-tight packings. In the most general case the flow of steam effects in the corresponding exhaust head a change in direction of 90 deg. towards the bottom, going round the

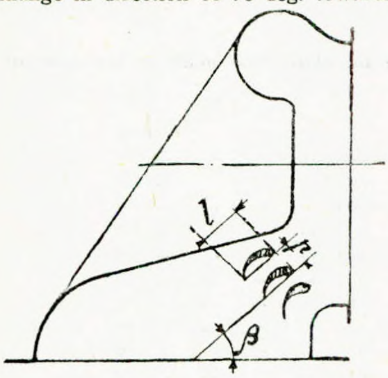


FIG. 2.

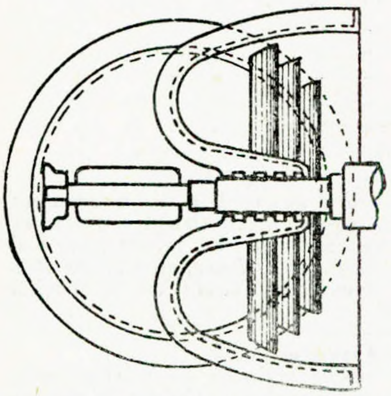


FIG. 2a.

obstacle created by the packing box and turbine shaft. It is of importance in order that the output of the turbine be not affected by this, that the flow of steam in the exhaust head be effected with a minimum of pressure losses between the outlet of the last wheel of the turbine and the inlet to the condenser. The present invention eliminates to a large extent these difficulties, reduces the coefficient of pressure loss of an exhaust head of given dimensions, and ensures greater homogeneity of the fluid jet in the plane of the outlet flange of the head. It consists essentially in an exhaust head comprising an elbow conduit having an inlet opening defining a plane perpendicular to the turbine axis and an outlet opening defining a plane parallel to the turbine axis, and plurality of blades of airfoil section, whereby the blades deflect only that part of the exhaust steam which follows the path of least radius in flowing from the inlet opening to the outlet opening. Fig. 2 illustrates the provision of the ramp of deflecting blades, and Fig. 2a is a section on the line indicated in Fig. 2.—*British Patent No. 600,835, issued to Société Rateau, Paris. Complete specification accepted 20th April 1948. Engineering and Boiler House Review, Vol. 63, August 1948, pp. 248-249.*

The Moment of Inertia of Propellers

A correspondent refers to the recently circularized suggestion of Lloyd's Register of Shipping with regard to the use of the wire suspension method for the experimental determination of the propeller moment of inertia. The author states that he has found that in practice a simpler and more reliable method is to suspend the propeller on a single bar of known diameter, length and modulus of rigidity, as shown in Fig. 1. A simple torsional-oscillation experiment can then be carried out, and the required moment of inertia is given by:—

$$I = \frac{29841\cdot5\ d^4}{L}\,(t/N)^2,$$

where I = moment of inertia, lb.-in.-sec.^{2} units.
d = diameter of bar, inch.
L = length of bar in torsion, inch.
N = number of complete oscillations in t sec.

The formula assumes the suspending bar to be of mild steel, the modulus of rigidity being taken as 12×10^6lb. per sq. in. The moment of inertia of plate and fixing bolts should be deducted from

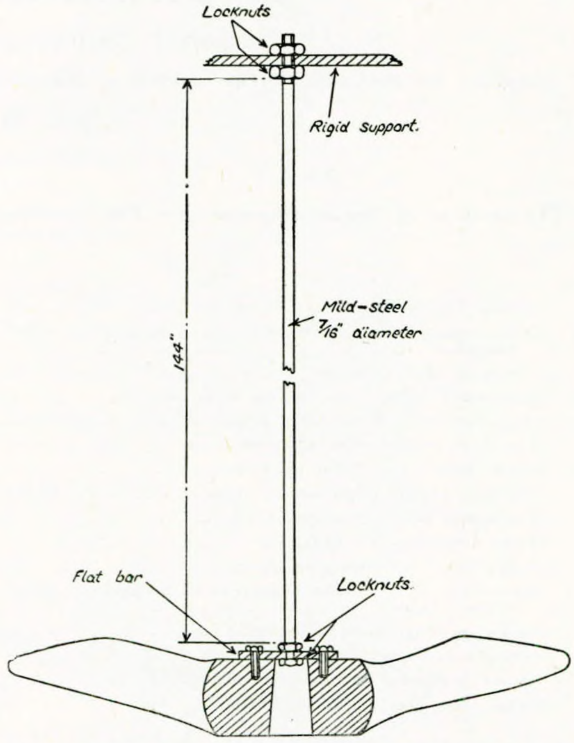


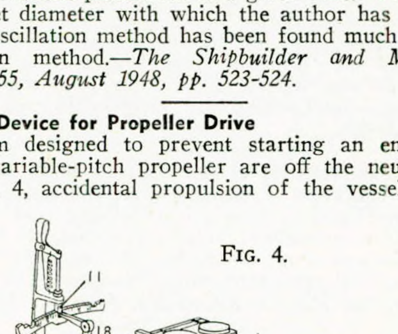
FIG. 1—*Method of suspension of propeller for determining moment of inertia*

the result, but this value is, in any case, small (of the order of 0·05lb.-in.-sec.^{2} for the arrangement shown). The advantages of the method as compared with the wire-suspension method are briefly:—(1) ease of erection (no levelling-off required); (2) it is unnecessary to know the weight of the propeller; (3) it is unnecessary to allow for the moment of inertia of the supporting table or platform; (4) there is less tendency for the propeller to "swing" out of centre; (5) the apparatus can be quickly prepared from materials available in an engineering shop, and (6) the result is obtained directly from the number of oscillations performed in a given time. For the propellers of up to 5-feet diameter with which the author has been concerned, the torsional-oscillation method has been found much superior to the wire-suspension method.—*The Shipbuilder and Marine Engine-Builder, Vol. 55, August 1948, pp. 523-524.*

S.L.M. Safety Device for Propeller Drive

Mechanism designed to prevent starting an engine when the blades of a variable-pitch propeller are off the neutral position is shown in Fig. 4, accidental propulsion of the vessel being thereby

FIG. 4.



avoided. The engine (1) drives the propeller (3) through gearing (2) and the blades are adjusted by a control rod (4). The oil supply under pressure to the servo-motor piston (5) is regulated by a plunger slide valve (7) connected to a control lever (8). The position of the latch (11) represents the neutral pitch of the blades. A bell crank lever (18) is coupled to a valve (19) adjusted so that the free passage of air for starting the engine through a pipe (20) is allowed with the valve in open position. If the latch (11) is lifted out of engagement with the neutral slot and the lever (8) is moved, the bell crank lever (18) is released and the valve (19) shuts the starting air conduit (20) through the action of a spring (17), so that the engine is unable to operate.—*British Patent No. 598,905, issued to Swiss Locomotive, Works, Winterthur. The Motor Ship, Vol. 29, August 1948, p. 200.*

Air, Fuel and Oil Filtration in an Internal Combustion Engine

This article comprises a brief survey of the fundamental aspects of filtration theory and practice. In connexion with fuel filters for Diesels, the author points out that dust or impurities in Diesel fuel may not directly cause wear in the main engine cylinders as it possibly will never reach the combustion chamber, but it will cause wear and inefficient operation of the plungers in a fuel pump, which are the "pulse" of a Diesel engine. Clearances in the barrel of a fuel pump are of the order of 1/50,000 inch (½ micron) and even the smallest solid particles will damage the plungers. There are no rings on these fuel pump pistons to seal, hence the necessity for the closest of fits. Slack in the fuel pump causes lower injection pressure, with consequent poor fuel atomization, and the well-known resultant troubles. Further, if the tiniest particles of dirt should find their way under the seat of an atomizer, dribble will occur instead of a fine, even spray of atomized fuel, and "black smoke", poor performance and contaminated lubricating oil will result. It is almost impossible to remove all traces of dirt and sediment from Diesel fuel during production, and hence it is particularly important that all fuel should be settled and filtered before use. It has been estimated that 90 per cent of fuel atomization worries are basically due to poor fuel settling or inefficient fuel filtering. Most Diesels do have one, and often two, fuel filters in the fuel lines, and of varying types, but constant inspection of these filters is necessary, and all storage equipment for Diesel fuel should be carefully arranged and fitted with fine filters.—*K. R. McNaught, Journal of The Institution of Automotive and Aeronautical Engineers, Vol. 8, May 1948, pp. 56-60.*

The Latest 13,000 b.h.p. Fiat Engine

The last of eight double-acting two-stroke 13,000 b.h.p. engines of the Fiat type has been completed at the manufacturers' works at Turin. The original reason for ordering was to re-engine the geared turbine ship "Roma", of 30,000 tons gross, and the motor ship "Augustus". Four were to be installed in each vessel. All of the engines are now available and it is possible that two new passenger ships of 20,000 tons gross will be ordered, in both of which four units will be installed. A speed of well over 25 knots would be attained. The engine, an illustration of which is given in the original article, has 12 cylinders with a diameter of 650 mm. and a piston stroke of 960 mm. The normal output of 13,000 b.h.p. is obtained with a mean effective pressure of 5·2 kg. per sq. cm.—*The Motorship, Vol. 29, August 1948, p. 169.*

Titan Separators for Boiler Oil

The article reports that the makers of the Titan centrifugal separator have designed and built a special type of machine for the purification of fuel of a heavier and more viscous grade than Diesel oil. The fuel purified by these seperators in the vessels operated by the Cie. Auxiliaire de Navigation is stated to be No. 2 boiler oil, with a specific gravity closely approaching 1. It has a viscosity of 110 deg. Engler at 20 deg. C. or 68 deg. F., 17 deg. Engler at 45 deg. C. or 113 deg. F., and 3·2 Engler at 85 deg. C. or 185 deg. F. The latest installation of these machines is in the 16,000-ton motor tanker "President Meny", one of a class built at the Odense yard for different owners. Each ship is fitted with a 5,640 i.h.p. eight-cylinder pressure-charged B. and W. engine, having cylinders 740 mm. in diameter, the piston stroke being 1,500 mm. and the revolutions 115 per min. The speed of all the vessels is about 13½ knots loaded. The name given to this type of separator is "Superjector". The sludge extracted from the oil is discharged periodically through peripheral slots in the bowl. These slots are closed and opened by means of hydrostatic pressure (actuated by a water service) while the machine continues to run at full speed. The revolutions are 6,000 per min. and a direct drive is provided by a 3·75 h.p. electric motor. A centrifugal clutch is fitted. The maximum capacity is 3,000 litres, or about 660 gallons per hr.. but when the machine is purifying No. 2 boiler oil, the service capacity is 1,200-1,500 litres, or approximately 265-330 gallons per hr. The supply of oil to the separator is heated electrically, by exhaust gas from the engine, or by steam. In some instances it is the practice to eject the sludge three times an hour, each operation taking about 15 seconds. The sludge is delivered into a collecting tank and discharged overboard by compressed air, the system adopted being similar to that used for sewage ejection. The large outlet trunks on the machines seen in the illustration are for sludge discharge, and of the two upper pipes on each separator, the lower is for water outlet, while the upper pipe passes the purified oil from the separator bowl.—*The Motor Ship, Vol. 29, August 1948, p 166.*

A Double-acting Scavenging Pump

In Fig. 1 is illustrated an engine having a cylindrical crosshead which acts as a double-acting scavenging pump, the bottom of the cylinder, which forms the crosshead guide, being closed by a sliding plate (28), which encircles the connecting rod (6). The engine, as well as the pump, is of the double-acting type and of a Danish design, with exhaust valves at the top and bottom, scavenging air being admitted through centrally arranged ports. It will be seen from the diagram that the piston rod (4) is connected to a crosshead (5). The

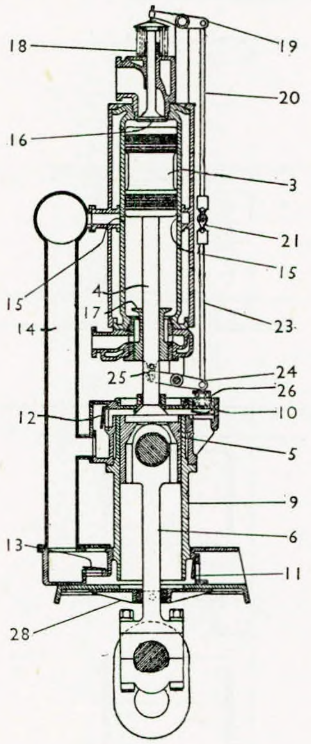


FIG. 1.

pump cylinder (9) forms the crosshead guide, and suction valves (10. 11) are provided at the top and bottom respectively, corresponding discharge valves (12, 13) being fitted. The air delivery pipe (14) is connected to both ends of the pump and discharges air into the cylinder through posts (15) which supply both end of the cylinder, according to the position of the double-acting piston (3). The upper valve (16) is an ordinary poppet valve, while the lower valve (17) is tubular to allow for the passage of the piston rod (4). The top valve is opened by a lever (19) and a vertical rod (20) moved by a cam (21). The lower valve (17) is opened by the same cam and a vertical rod (23), which is attached to a forked lever (24) having suitable arms (25). The top valve is closed by a spring (26) below the vertical rod (23).—*British Patent No. 600,425 issued to O. Petersen, Copenhagen. The Motor Ship, Vol. 29, August 1948, p. 200.*

Conversion of a Further Swiss Paddle Steamer to Diesel-electric Drive

As a result of the successful operation of the Diesel electric drive supplied for the paddle boat "Genève" in 1934, Brown Boveri has received an order from the Compagnie de Navigation du Lac Léman for the electrical equipment of a similar drive for the paddle ship "Lausanne". Referring to Fig. 1 (p. 100) the main generator for feeding the paddle driving motors has an output of 390 kW. at 450 volts. An auxiliary generator for 30 kW., 65 volts is incorporated in the main generator and the set rigidly coupled to a Sulzer four-stroke Diesel engine. The continuous rating of the Diesel engine, which is supercharged on the Büchi principle by a Brown Boveri exhaust turbo-charger is 610 h.p. at 600 r.p.m. The two paddle driving motors are each rated 245 h.p. at 225 volts and 530 r.p.m. and are flexibly coupled to a pinion on both sides of the gearing, which has a ratio of 530/47 r.p.m. The gear-wheel shaft is rigidly connected with the existing paddle-wheel shaft on both sides. The company is also supplying the complete switching and manœuvring equipment. The main generator is of the Ward-Leonard type and feeds the two paddle-drivng motors. It has self, separate, and counter-compound excitation which gives it a highly drooping external characteristic; the

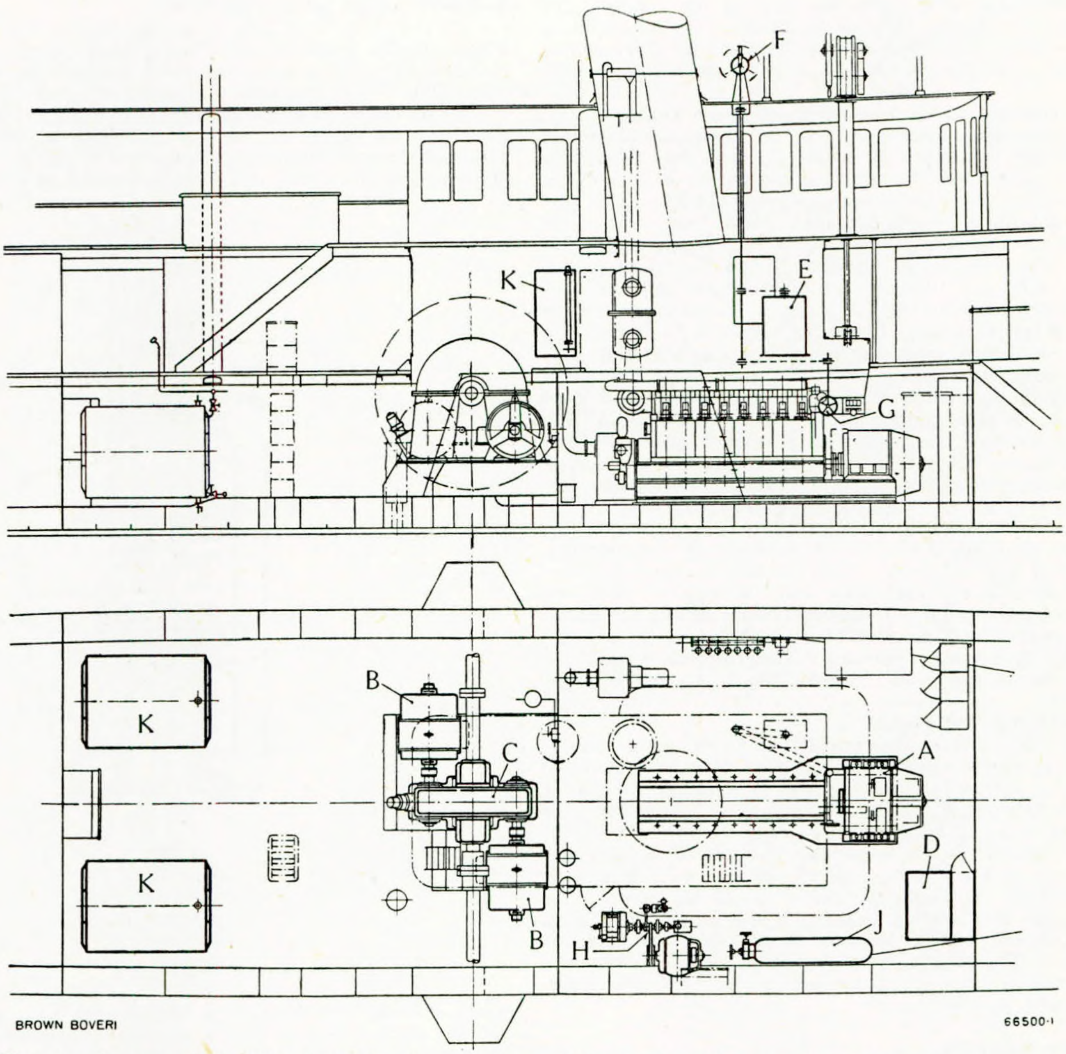


FIG. 1.—*Layout of the Diesel-electric plant on the paddle steamer "Lausanne" of the Compagnie de Navigation du Lac Léman*

A—Diesel generator set.
B—Paddle driving motors.
C—Gearing.
D—Switchboard.
E—Main generator potentiometer.
F—Potentiometer control on the bridge.
G—Potentiometer control in the engine room.
H—Auxiliary diesel set with harbour generator, compressor, and pump.
J—Main diesel engine starting air tanks.
K—Diesel oil tank.

maximum sustained short-circuit current only amounts to approximately 2 to 5 times the rated current. In this manner, even during the severest reversing manœuvres, impermissible overloading both of the electric drive and Diesel engine is definitely avoided. All manœuvres are carried out directly by the captain from the bridge where three steering positions are provided, one on the starboard side, another on the port side, and the third in the centre near the steering wheel. A further steering position is located in the engine room near the switchboard.—*Th. Egg, The Brown Boveri Review. Vol. 34, August/September 1947, pp. 187-188.*

Insulating Equipment Shipboard

Because of the characteristics of ship design, construction, and operation, the proper insulation of shipboard equipment requires special consideration and attention. Piping aboard ships generally has more bends, fittings, valves, etc., per linear foot than similar equipment on land, because of the compact layout necessary on vessels. Such construction increases the tendency for water to condense out in steam lines. Where steam lines pass through bulkheads, a special type of construction is necessary to make the bulkheads watertight and at the same time to protect the insulation. An expansion collar or joint is welded to the bulkhead around the opening through which the pipe passes. The other end of the expansion joint is bolted to a flange on the pipe. In this way, the pipe can expand and contract freely, without damage to the insulation and without creating an opening in the bulkhead through which water could seep, should the compartment become flooded. To reduce fire hazard, insulated lines are finished with fire-resistant cloth rather than the customary canvas, and painted with water paints, rather than oil paints. Insulated pipe lines situated near hatchways, ladders, catwalks or other points where the insulation might be damaged are enclosed in galvanized sheet-iron jackets. The jackets are long enough, generally around 5 feet, to protect the entire length of the endangered section of insulation. Removable insulation is used aboard ships to a much greater extent than is the practice in industry, because it is often necessary to overhaul and repair various flanges, fittings, valves, turbine parts, etc., which must therefore be easily accessible. The insulation consists of a wire framework shaped to fit the particular piece, and covered with wired-on insulating blocks. It is finished and painted in the same way as the adjacent equipment. This construction makes for a durable, efficient insulation that can be removed and reapplied quickly and as often as necessary without the possibility of damage occurring to adjacent insulation. Turbine insulation is generally a combination of both permanent and removable insulation. Main turbine bodies are blocked-in permanently, the blocks being held in place by means of galvanized iron wire tied to steel bars tack-welded to the turface of the turbine. Sufficient wire is used so that a tight fit is obtained. This is important because turbine insulation, being subject to a great deal of vibration, has a tendency to break loose. Main turbine joints are insulated with removable insulation because they may need to be opened for maintenance work. Removable insulation made with block is not practical in this case because it is too cumbersome. Instead, asbestos fibre blankets which are easily removable, are used. Insulation in the vicinity of bearing covers is also removable so that the covers can be removed without tearing up the insulation. Steel plates protect the insulation on turbine ends above bearing covers to prevent damage to the insulation when the covers are lifted.—*Marine Engineering and Shipping Review, Vol. 53, July 1948, p. 73.*

New Air Preheater Design

The new air preheater proposed by R. H. Bent is based on the rotating element principle as applied to the Ljungstrom type preheater. The design is such that the elements are very easy to remove and replace. In practice, the user would be equipped with a clean set of elements and interchange a few sections at a time, as and when the opportunity occurred during normal operation periods; this procedure would avoid the accumulation of large deposits of dirt to impair the performance of the heater. In addition, the gas and air streams pass through the elements twice in reverse directions, further reducing the fouling hazards and making it unlikely that condensation will occur. Air may be delivered from the heater at two distinct temperatures (approximately 280 deg. F. and 450 deg. F.) by bleeding off part of the main air stream after it has passed through the elements only once. The elements are revolved in such a way that the cold elements, which have just given up their final quota of heat to the air stream, enter the gas stream, which is already partly cooled. The gas is ultimately discharged to atmosphere. The elements partly heated, pass round and re-enter the gas stream, where hot gases again pass through them but in the reverse direction. Fully heated, the elements then leave the gas zone and enter the secondary air stream, which, already initially heated, receives another charge of heat bringing it up to its full final temperature. The partly cooled elements finally enter the main air stream and give up all available heat to this air before completing the full circle and re-entering the gas zone. A simply designed casing with the doors encloses the heater, a patent for which is pending.—*Power and Works Engineering, Vol. 43, August 1948, pp. 253-254.*

Smoke Abatement on Marine Installations

Developments in smoke abatement on board ship were discussed by G. H. Hodges and C. H. Lawrence in a paper presented at a recent convention of the Smoke Prevention Association of America. Referring to the two types of fuel used on board ship, oil has many advantages, it was stated. It can easily be handled and stored and can be burned in a compact space. Firing of oil from a burner where it is atomized permits quick and complete mixing of oxygen and fuel. However, to obtain efficient and smokeless combustion, the proper relation between air and oil must be maintained at all times either manually or by a combustion control system. Coal is often cheaper than oil, and it was predicted that it may be used even more in the future, as the present demand for fuel oil exceeds the wartime peak and is still increasing. A large percentage if not all the smoke from a coal-burning installation is caused by incomplete combustion of the hydrocarbons. Lack of oxygen in the furnace is not necessarily the cause of incomplete oxidation of the carbon in the hydrocarbons. It may be caused by insufficient turbulence to mix the available air and combustible gases. Introduction of overfire air above the fuel bed was recommended in the paper to correct this condition. Air jets may be placed around the furnace and fed by an air duct supplied by a forced-draft fan, or steam jets operating in the air ducts can be installed. However, such installation is valueless if the operating personnel does not use it, and it is therefore better to build it into the original installation where it is accepted as part of operating procedure than to introduce it later. Careful operation is also required to insure proper firing procedure, and the correct air-fuel ratio must be adjusted for each rate of operation. A properly designed combustion control system can be of great assistance in this matter and will do a great deal towards smoke elimination at both a steady load and during load swings. Flue dust can be reduced by extracting the dust from the gases either as they pass through or after they have left the boiler unit, and additional flue dust can be removed by installing collectors or precipitators in the boiler breeching. The centrifugal design seems most adaptable for marine work and possibly some development using supersonic sound waves may find application in this field also. The limited space factor has greatly hindered introduction of flue-dust removal equipment aboard ship. Air heaters were also mentioned as of great assistance in burning coal and as contributors to combustion efficiency.—*Marine Engineering and Shipping Review, Vol. 53, July 1948, p. 63.*

Cargo Ships Built for Lloyd Brasileiro

The delivery in recent months from the Ingalls Shipbuilding Corporation yard at Pascagoula, Miss., of the cargo vessels "Loide-Venezuela", "Loide-Equador", and "Loide-Peru", completes a contract for fourteen vessels delivered to Lloyd Brasileiro. This order was the largest ever placed by a South American nation for ships to be built in the United States. In addition six sister vessels were constructed by Canadian Vickers. The "Loide-Venezuela" is a single screw ship of the shelter-deck type, with a raked stem and cruiser stern arranged for carrying general cargo, refrigerated cargo and edible oils. There are two complete steel decks, a forecastle deck and a third deck in holds nos. 1 and 2. The hull is divided by eight watertight transverse bulkheads extending to the shelter and forecastle decks, which provide a one-compartment standard of flooding. In the case of the forward and after peaks and adjoining cargo holds, a two-compartment standard is achieved. Special care has been exercised to ensure equalizing an unsymmetrical flooding in an emergency. The vessel is of steel construction with six cargo holds, three forward and three aft of the machinery spaces. The stem is a casting. The stern is of cruiser type in conjunction with a full contra-rudder. rudder post, and stern post. The drive is through a single screw from geared-turbine propulsion located amidships. The hull is transversely framed and is completely welded except for the gunwhale angle connexion of the sheer strake and shelter deck which is riveted. All cargo holds, except refrigerated cargo holds, are ventilated by a "Cargocaire" system for conditioning the air in the cargo spaces. Each hold has its own separate supply and exhaust fan which may be dampered in such a manner that in favourable weather three changes of fresh air an hour are produced. During stormy or humid weather, the dampers may be thrown on to recirculation and the cargo kept dry by injecting a quantity of dry air into the recirculated air stream of the supply fan. This air is dried in centrally located absorption beds which supply enough fresh dry air for all the holds. Refrigerated cargo space has been provided in hold no. 3. These spaces are insulated and designed to maintain temperatures of 0 to 40 deg. F. with an ambient temperature of 100 deg. F. The deck machinery is electric. The steering-gear is of the Rapson Slide electro-hydraulic, double-ram type. The steering gear is capable of moving the rudder from hard-over to hard-over (70 deg.) in 30 seconds when the vessel is going ahead at a speed of 16·5 knots, and in not more than 60 seconds when the ship is going astern at a speed of 8 knots. The gear is designed to provide for operation of the rudder by either ram at normal rates up to and including 50 per cent of the maximum ahead speed of the ship. The main propelling unit consists of a General Electric high-speed, cross-compound, double-reduction geared turbine of the latest marine design driving a single screw, supplied with superheated steam from two Combustion Engineering Co. oil-fired, cross-drum, single-pass, sectional-header boilers fitted with economizers. The boilers and turbine are located in a common machinery space, the turbine and gear being forward and the boilers aft of the turbine on the operating floor level above the fuel-oil settling tanks. Three auxiliary turbo-generator sets are located on the starboard side of the operating flat, with the refrigeration compressors, "Cargocaire" unit, and main air ejectors to port, the main switchboard being located amidships against the forward bulkhead. Most of the auxiliary equipment is located on the engine-room floor level. The main turbine is designed to develop 6,000 s.h.p. at the point of best economy and 6,600 s.h.p. at maximum power with propeller speeds of 92 and 95 r.p.m., respectively. The design steam conditions are 440lb. per sq. in. gauge and 740 deg. F. at the turbine inlet and 1½ inch of mercury exhaust pressure. When going astern the unit will develop 2,400 s.h.p. at 46 r.p.m. operating with steam at 325lb. per sq. in. gauge, 740 deg. F., exhausting to 2 inch of mercury pressure, and with steam flow not exceeding 42,000lb. per hr. The two boilers are designed for an overload operation of 81,800lb. per hr., with an air pressure of 6 inch and a furnace heat release of 99,500 B.T.U. per hr. per cu. ft. of furnace volume.—*Marine Engineering and Shipping Review, Vol. 53, July 1948, pp. 38-51, 63.*

Motor Boat with Variable Pitch Propellers

A new high-speed long-range craft called the "Celerity" has recently carried out a series of trials at Spithead. Although ordered originally by the Royal Air Force and laid down during the Japanese war for air-sea rescue work in the Pacific, the boat has been completed as a private venture by the Bristol Aeroplane Co., Ltd. With very compact propelling machinery, the boat has a slightly higher speed than any of the coastal craft at present in service in the Royal Navy. This is achieved by the use of four air-cooled radial engines, the transmission to the variable-pitch propellers being taken through a gear box in the conventional manner. The craft is of hard-chine construction and has two rudders. She carries conspicuous cowls to exhaust the air drawn in through the casing. Her most outstanding feature is her extremely long range at economical speed—7,000 miles at a speed of about 10 knots. The "Celerity" has a standard displacement of 76 tons, and is 105 feet in length and 22 feet in beam, with a draught of 5¾ feet. The fuel capacity is 6,800 gallons and the maximum continuous speed 36 knots, although the figure of 40 knots has been given as the maximum in light condition. Embodied in the design of the boat were new structural features which have led to a reduction in weight without loss of strength. At some points considerable additional strength has been obtained over conventional construction . The propelling machinery comprises four converted Bristol Hercules Mark XVII engines, each developing 1,675 b.h.p. at 2,900 r.p.m. (1,160 r.p.m. at propellers). Rotol variable pitch propellers are used.—*Lloyd's List and Shipping Gazette. No. 41,700, 5th August 1948, p. 11.*

Passenger Ship for Iceland

The latest twin-screw passenger motorship for the Iceland service has been delivered by Aalborg Vaerft A/S, Aalborg, to the Icelandic Government. Named the "Hekla", the ship is intended for the passenger and mail traffic. The principal particulars are as follows: length overall, 239ft. 4in.; breadth moulded, 36 feet; depth to shelter deck, 21 feet. The ship is of all-welded construction, and the saving in weight obtained has been devoted to extra cargo-carrying capacity; in spite of the accommodation for 400 passengers, the ship's deadweight capacity is about 550 tons. The engines consist of two single-acting 7-cylinder direct-reversible two-stroke Atlas Polar Diesel engines of the enclosed pressure lubricated, trunk engine type, with pressure atomizing. developing 3,300 h.p. at 300 r.p.m. This output gave the ship a speed of 17·1 knots on her trial trip. The main engines are equipped with a direct-driven cooling water pump, bilge pump and a starting air compressor.—*The Shipping World, Vol. 119, 11th August 1948, pp. 114-115.*

Shallow Draught Design for Berg River

The purse-seiner "Patrysberg", recently completed by Misplon and Co., Ltd., Capetown, for the Marine Products Corporation of Africa represents an American design modified to suit South African coastal conditions. One of the main modifications is a reduction in draught to enable her to sail with comparative safety over the sandbanks which cover a large area at the Berg River mouth. The bottom of the boat has been flattened considerably, and she has solid oak frames instead of the usual steamed timbers. The solid oak frames will enable the boat to stand any bumps she may get in striking the sandbanks. The usual purse-seiner turntable on the stern has been dispensed with and the bulwarks aft rebuilt. Without the turntable the vessel can be used for activities other than purse-seining. The stern is built up of 5-in. by 12-in. solid Oregon blocks. The "Patrysberg" is smaller than the usual purse-seiner, her length being 45 feet, beam 15·3 feet, mounded depth 5ft. 3in., and the unusually low draught of 3ft. 6in. She is 22½ tons gross. For her size, the "Patrysberg" has a remarkable capacity, for she can carry 41,000lb. of fish, plus the 6,000lb. which is the total weight of her seine netting equipment. Powered by a 64-h.p. Caterpillar Diesel marine engine, she has a speed of 8 to 8½ knots and a cruising range of 150 hours. The boat is fitted with sail, to meet the legal requirements covering South African fishing boats. The "Patrysberg" is dual controlled, for apart from the wheel in the wheel-house, there is another wheel on the "flying bridge", which is for use on the fishing grounds.—*The South African Shipping News and Fishing Industry Review, Vol. 3, July 1948, pp. 68, 71.*

Coaster for Puget Sound

A recent issue of the Marine News describes the cargo handling equipment of the new 800-ton deadweight coaster "F. E. Lovejoy", specially designed for economically working cargo on the Puget Sound. The conditions on that service are peculiar: the trade is local and the trips short, the harbours are well protected and the tidal range is about 16 feet. In recent years it has been the custom to set up the cargo on pallets and handle these in and out of the ship by lift trucks, which. with their drivers, are carried on board acting as the ship's cargo gear. The "F. E. Lovejoy" is unique in that an elevator is provided to lift the cargo from the hold and 'tween decks to the brows, which can be rigged abreast the elevator at the height appropriate to the tide. The superstructure, which is 11ft. 3in. in height, is described as a "strong house", the main strength of the ship being at the main deck. Since the fork lift trucks used to work the cargo develop highly concentrated wheel loads, the main deck and tank top had to be made sufficiently strong to prevent a permanent set in the plating between the beams, which would interfere with the loading and unloading. The plating was therefore made $\frac{7}{16}$-inch thick, in association with 24-inch frame spacing, but, after the ship had been a year in service, it was found necessary additionally to stiffen the plating in way of the elevator, where the traffic is concentrated. by means of girders. Since the truck equipment is all rubber tyred, to prevent skidding which might occur on a wet deck, the entire main deck and tank top are covered with two inches of hot laid asphalt concrete. Another unusual feature of the ship is the large capacity ballast pump which is used to trim the ship to keep her on an even keel while loading and unloading. Under favourable conditions the loading and discharging rate is sixty to seventy tons per hour, and when carrying newsprint the ship can be loaded in eight to ten hours with only four men and the machines working.—*Fairplay, Vol. 171, 12th August 1948, p. 460.*

Laminating for Small-boat Construction

Since 1943 laminated marine parts for small-boat construction have been accepted by many builders who were formerly sceptical of this type of construction. Laminating for small-boat construction has now been accepted by a great many manufacturers of pleasure boats as well as work boats. The Puget Sound Naval Shipyard built hundreds of laminated parts as keels, stems, aprons, shaft logs, etc., for construction of small boats. These boats were used in all parts of the world under all conditions and have proved, upon inspection, to be superior to solid members. In marine work even the garboard planks can be laminated in a jig to the desired shape, saving a great deal of time and material. The pioneer work at the Puget Sound Naval Shipyard retained all the rigid controls and requirements necessary to guarantee a waterproof glue line. Bureau of Ships specifications call for white oak throughout the structural members of all small boats, which increases the laminating problems. In laminating timber products for marine use, low-temperature phenol, resorcinol, and melamine resin glues are the only types suitable, and not all of these meet requirements. At present, all acceptable glues are of the liquid type, and they are usuable only for about 60 days, or 90 if kept in cold storage. Because precision equipment is required to maintain the necessary control, it is generally impractical for each manufacturer of small boats to do his own laminating. Rough planning of lumber is an essential first step in laminating, and proper amount of glue and pressure are important. Softwoods require a pressure of not less than 100lb. per sq. in. and pressures up to 300lb. per sq. in. are not harmful to the glue line. For spreading glues a spreader, with a micrometer setting on the spreading rolls is necessary, and it is important to consider ease of cleaning the glue from the spreader when choosing a glue. Time and temperature for curing are also important. The U.S. Navy recommends 150 to 210 deg. F. and ten hours in the curing chamber after the innermost glue line reaches this temperature. The humidity should be 85 per cent to protect laminations from checking and shrinking while curing.—*Paper by D. F. May, read at the Annual Meeting of the American Society of Mechanical Engineers, Paper No. 47-A-68.*

The 9,200 ton M.S. "Triton"

At the conclusion of the war, Wilh. Wilhelmson, Oslo, ordered a series of six vessels from Kockum's yard, and the first two, the "Tourcoing" and "Tournai", were completed last year. They are twin-screw vessels of 10,500 tons deadweight, but the latest ship, named "Triton", is a single-screw vessel with the following characteristics:—

Length overall ...	463ft. 7in.
Length b.p. ...	430ft.
Breadth moulded ...	59ft. 6in.
Draught ...	25ft. 5¼in.
Gross register ...	5,415 tons
Net register ...	3,117 tons
Cubic capacity of holds ...	654,800 cu. ft. grain
...	599,300 cu. ft. bales
Main machinery...	8,200 i.h.p.
Speed, loaded ...	17 knots
Speed, on trials...	18·5 knots

The engine is a Kockum-M.A.N. two-stroke double-acting design with seven cylinders 720 mm. in diameter, the piston stroke being 1,200 mm. At 110 r.p.m. the output is 8,200 i.h.p. or 7,000 b.h.p. At sea the exhaust gas from the engine is taken through a Cochran waste-heat boiler, which raises steam for heating the accommodation and the vegetable oil tanks. Oil firing may be used when the engine is not running. Current is supplied from three four-cylinder Diesel engines coupled to 155 kW. 230-colt generators and for harbour use a Diesel-engined generator of 15 kW. is installed. The Diesel engines driving the main generators have a cylinder diameter of 275 mm., with a piston stroke of 420 mm., and two of the engines are also coupled to manœuvring air compressors. Fresh-water cooling is utilized for the jackets of the main and auxiliary engines. Four electrically driven centrifugal pumps are installed, two for the circulation of the fresh water around the jackets and two for the salt-water circulation in the coolers. Two electrically driven pumps are installed for bearing lubrication and for cooling the main engine pistons, and there are two De Laval centrifugal purifiers for the fuel and lubricating oil, provided with heaters.—*The Motor Ship, Vol. 29, August 1948, p. 165.*

First Ocean-going Australian-built Motor Ships

This article is accompanied by a reproduction of the general arrangement plans of a standard Australian-built 6,500-ton motor cargo ship. Of particular interest is the fact that the Doxford-type machinery is also to be manufactured in Australia. The main details of the six ships, which are being built to the order and under the supervision of the Australian Shipbuilding Board, are:—

Length b.p.	380ft.
Length overall	405ft. 2in.
Breadth moulded	53ft.
Depth moulded to shelter deck	33ft.
Depth moulded to second deck	24ft. 3in.
Loaded draught	22ft. 6in.
Corresponding d.w.c.	6,500 tons
Machinery	2,800 b.h.p.
Service speed	12½ knots

The vessels are of the open shelter deck type, constructed to the highest class of Lloyd's Register. The hulls are generally of riveted construction, but welding has been introduced to a considerable extent. The end connexions of the keel, inner bottom plating, inner bottom girders, and shell plating, are welded. The transverse bulkheads, deckhouses, masts and derrick posts are completely welded. The cargo-handling equipment comprises sixteen 5-ton derricks and one designed to lift 25 tons. The winches, windlass and capstan are electrically driven and of Clarke, Chapman design. The steering gear is a Hastie electro-hydraulic unit operated in conjunction with a Brown telemotor. The holds are clear of obstruction and no pillars have been used. The engines are of the standard Doxford type with the scavenge pump centrally located and driven from the crankshaft. The four cylinders have a diameter of 560 mm. with a piston stroke of 2,160 mm. and the output of 2,800 b.h.p. will be developed continuously when running at 110 r.p.m. All the engine-room auxiliaries are electrically driven and current for these, and for the deck auxiliaries, is supplied from four 150 kW. 22-volt Diesel-engined generators. Four of the vessels will be constructed by the Morts Dock and Engineering Co., Ltd., at Woolwich, Sydney, and two by Evans, Deakin and Co. The engines will be built at the Australian Government Engineering Works at Melbourne and Brisbane. Most of the equipment will also be manufactured in the Commonwealth.—*The Motor Ship, Vol. 29, August 1948, p. 166.*

The "Astarté", a 21,500-ton Tanker

The recently completed "Astarté" is the first of a series of three large tankers ordered from the Chantiers et Ateliers de St. Nazaire Penhoët by the French Government. The second and third vessels are named "Bagdad" and "Ariane"; the former will be completed shortly and the latter in 1949, and they have been allotted to the Cie. Navale des Petroles and to the Cie. Auxiliare de Navigation respectively. The main particulars of the "Astarté" and her sister ships are as follows:—

Length b.p.	552ft.
Length overall	580ft.
Beam	74·1ft.
Draught loaded	31·9ft.
Deadweight capacity	21,500 tons
Machinery	8,700 i.h.p.
Service speed	13·5 knots
Gross register	14,750 tons

Two Schneider-B. and W. four-stroke pressure-charged engines are installed. They have six cylinders, 740 mm. in diameter, with a piston stroke of 1,500 mm. and run at 120 r.p.m. The two oil-fired boilers with a heating surface of 260 sq. m. can be heated by the exhaust gases at sea. There are three 137 kW. 110-volt generating sets, two being driven by steam engines and the third by a Diesel engine. Each of the main engines also drives a 55 kW. generator. The hull of the "Astarté" is divided into nine centre tanks and five tanks on each side, the pump-room being arranged between Nos. 6 and 7 tanks. The fuel tank is between the forward engine-room bulkhead and tank No. 1. There are four horizontal pumps each with a capacity of 500 tons per hour. Welding has been used to a substantial extent in the building of the hull of the ship, and as a result the saving in weight effected is about 9 per cent.—*The Motor Ship, Vol. 29, August 1948, p. 189.*

Riveted Straps for Welded Ships

When failures of American welded ships started to become frequent the blame was placed, at first, on the method of construction adopted in these ships. It was pointed out, quite reasonably it seemed, that the welding together of large subsections would result in severe internal stresses, which might have a detrimental effect on the strength of the hull. Subsequent investigations showed that these stresses did, in fact, exist, and reached a maximum along the welded seams of the plating. Furthermore, it was shown that the stresses did not disappear after the ship had been in service. A thorough study of the subject, however, led to the formation of the opinion that these locked-up stresses were not responsible for the failures of welded ships, and remedial measures taken were rather in the direction towards eliminating discontinuities in the structure which might give rise to cracks. Furthermore, barriers to prevent the spreading of cracks, in the forms of riveted straps, were arranged in "Liberty" cargo ships and T-2 tankers, the classes of ships particularly prone to failures. As an additional precaution, a method of relieving the locked-up stresses at the welds has been developed in America by the Linde Air Products Co., and this process has been applied by Todd Shipyards Corporation to a large number of welded tankers. According to the American journal "Marine News", the operation basically consists of heating a 6-inch strip of plating on each side of, and parallel to, the welded seams, to a temperature of 350 to 400 deg. F. by means of oxy-acetylene flames. About six to eight inches behind the advancing flames a jet of water is shot against the heated area to dissipate surplus heat and localize the application to the seam, and, of greater importance, to assist and supplement the expansion forces set up by the heating to effect the desired stress relieving. The locked-up stress in the first place is due to the expansion and contraction of the plate at the welds being restrained by the body of the plate which is unaffected, and the object of the stress relieving operation is to expand the plate temporarily on both sides of the weld, so that these locked-up stresses are dissipated. On cooling, the locked-up stresses, it is stated, are reduced to a negligible value. Stress relieving is usually done to the welds within the midships two-thirds length, and in a T-2 tanker approximately 9,000 feet of welding is treated. Four special machines are required for stress relieving the welds on a ship. They are all the same in principle, but each is adapted for treating a definite locality. The machine employed on the side of the ship moves along a track connected to the shell by welded brackets, that for the bottom runs on a track laid on the dock bottom, while the deck machine, and the fourth modification, a small, general purpose outfit, are guided by hand along the weld being treated. This method of stress relieving has also been applied with success to a number of other types of welded structures, such as gas storage tanks, high-pressure penstocks and the like.—*Fairplay, Vol. 171, 5th August 1948, pp. 409-410.*

Seaplane Dock that Comes to Aircraft

The Experimental Towing Tank Laboratory of Stevens Institute of Technology, Hoboken, New Jersey, has tested a seaplane dock designed by the U.S. Navy Department, which brings the dock to the aircraft instead of the aircraft to the dock. On the basis of experiments made at the Tank a full-scale dock was constructed and put into service. The dock was to be self-propelled and to have water jets along the sides of a central slip for controlling the aircraft while entering or leaving; by directing the jets against the sides of the plane and varying the flow it could be held steady in position or moved bodily in a lateral direction. A model dock equipped with jets was constructed, and a seaplane model manœuvred into the slip to determine the effectiveness and best arrangements of the jets.—*Shipbuilding and Shipping Record, Vol. 71, 24th June 1948, p. 760.*

Doxford-engined Motorship "St. Essylt"

The new cargo motorship "St. Essylt" of the South American Saint line is a Doxford-engined vessel with the following principal dimensions:—

Length overall	472ft. 5in.
Length between perpendiculars	440ft. 0in.
Breadth moulded	59ft. 4in.
Depth moulded to shelter deck	39ft. 8in.
Depth moulded to second deck	30ft. 8in.
Deadweight, about	9,500 tons
Gross tonnage	6,950 tons
Net tonnage	3,850 tons
Grain capacity, about	632,800 cu. ft.
Speed in service	14-15 knots

The vessel has a raked stem, with considerable flare, and a cruiser stern. She has a streamlined rudder and sternframe, and deck erections comprising a long forecastle extending over no. 1 hatch, and two-tier deckhouses. The midship superstructure is about 150 feet in length. The main engine is a standard five-cylinder Doxford unit rated to develop a service b.h.p. of 5,300 at 114 r.p.m.; the bore of the cylinders is 670 mm. and the combined piston stroke 2,320 mm. The scavenge pump is of the crank-driven type, located between cylinders nos. 3 and 4. A Bibby-Doxford detuner is fitted to the forward end of the crankshaft where the main engine controls, it is interesting to note, are also located—an unusual layout for a single-screw Doxford installation, but one which the owners desired. Monitor alarms are provided in connexion with the cooling water and forced lubrication systems, and "Pneumercator" tank gauges are provided adjacent to the main gauge board and controls. A composite boiler of the Riley three-furnace Scotch pattern is provided in a separate compartment at the base of the funnel, this boiler being 12ft. 6in. long by 11 feet in diameter. The two wing furnaces are oil fired and the centre furnace is arranged for either oil-firing or exhaust gas. The oil burning installation is of the Wallsend low-air-pressure type.—*The Marine Engineer, Vol. 71, July 1948, pp. 325-328.*

A Small Tanker

This article describes the features of a small tanker, now under construction at New Bedford, Massachusetts, U.S.A. The overall length of the tanker, which was designed by a Chicago firm of naval architects, is 54 feet with a beam of 15 feet and a draught of 6ft. 8in. when carrying full cargo. The hull design is of the double chine type with transverse framing. Of welded steel construction, this type vessel is very sea-worthy while being relatively simple to build. The basic design requires a minimum amount of structural shaping, as well as shell framing. Cargo capacity of the four forward holds is 12,624 gallons in either fuel oil or gasoline, and the kerosene cargo capacity is approximately 2,670 gallons. Two holds amidships will carry 3,200 gallons each and two holds forward will take 3,112 gallons apiece. Kerosene is carried aft in two holds of 1,335 gallons capacity each. After discharging part of her cargo the tanker can be trimmed by means of three ballast tanks. Up to 1,650 gallons of water can be pumped into a tank at the bow and 1,400 gallons into two stern tanks holding 700 gallons each. Power is furnished by a 6-cylinder 165 h.p. Diesel provided with a power take-off at the front-end of the engine to drive three 2½-inch cargo pumps through a clutch arrangement. The pumps are installed in a separate compartment just forward of the engine room. A selective system of valves permits any of the six cargo holds to be evacuated through these pumps. Fuel is carried in two 700-gallon tanks on either side of the engine room. A small third tank permits this vessel to carry a total of 1,550 gallons for her own engine. The "Tiny Tanker" is designed for maximum utility in tanker service. Boats of this type have broad general application and some special virtues. Because of their shallow draft, even when travelling under full load, they can bring tanker service into waters that would bar passage to heavier boats and barges. Maximum space is given over to cargo. The pump arrangement is simple yet provides desired flexibility in discharging cargo. Although the engine room is compact, there is ample room for necessary inspection and maintenance on the Diesel.—*Motorship (New York), Vol. 33, July 1948, p. 45.*

The "Pretoria Castle"

The R.M.S. "Pretoria Castle", the largest ship yet to be engaged in the South African trade, is of 28,705 tons gross and thus exceeds by some 1,500 tons the tonnage of the "Capetown Castle". The "Pretoria Castle". with her rounded forward superstructure and curved stem, is generally similar in arrangement to the "Capetown Castle" but the streamlined funnel of the new ship is slightly taller. The principal particulars of the "Pretoria Castle" are as follows:—length overall, 749 feet; length between perpendiculars, 700 feet; breadth moulded, 83ft. 6in.; first class passengers, 227; cabin class passengers, 478. The propelling machinery consists of steam turbines, to Parsons' latest design, driving twin screws through double reduction gearing. The ahead turbines are all of reaction design, and the h.p. and l.p. astern turbines which are incorporated in the i.p. ahead and l.p. ahead casing respectively are of the impulse type. Steam for the main turbines is supplied by three oil-fired water-tube boilers of Babcock and Wilcox latest design at a working pressure of 600lb. per sq. in. at the superheater outlet, with a temperature of 850 deg. F. Howden's system of balanced draught is used for the boilers, and a Howden Ljungstrom regenerative air preheater is fitted to each boiler. Weir's system of regenerative feed heating is fitted, the condensate from the main condensers passes through four stages of feed heating before entering the economizers which are incorporated in each main boiler. Two Cochran oil-fired auxiliary boilers are fitted.—*The Shipping World, Vol. 119, 21st July 1948, p. 57.*

"Kosmos V"

The propelling machinery of the "Kosmos V", to be supplied and fitted by the North Eastern Marine Engineering Company (1938) Ltd., will consist of twin-screw N.E.M.-Doxford opposed-piston airless injection balanced oil engines, having eight cylinders 725 mm. in diameter by 2,250 mm. combined stroke. They will develop 10,500 b.h.p. in service (11,850 i.h.p.) at 115 r.p.m. The pumps are steam-driven, steam being supplied by five oil-fired Scotch boilers, two of which also utilize exhaust gases from the engines in two of their four furnaces These boilers also supply steam for three evaporating and distilling plants, each with a capacity of 200 tons a day. There are five 240 kW. electric generators in the factory 'tween decks, used only for the whaling factory machinery, and two other 240 kW. and one 110 kW. generators, all of 220 volts. There are also two 50 kW. 110-volt generators, used only when the vessel is used as a tanker. There will be over 100 electric motors on board, including those for the steering and for the cargo winches and mooring capstans.—*Fairplay, Vol. 171, 15th July 1948, p. 276.*

A New Type of Davit

The davit arm is pivoted at the gunwhale, so that the lifeboat attached to it can be swung out easily. The operating system of the davit is kinematically a four-bar crank mechanism with two rotating links (the davit arm and the toggle lever pivoted on a fixed bracket) and a coupler (the rod connecting these two links). The toggle lever carries a handle by which the whole mechanism is operated. The wire rope for holding the lifeboat runs over two pulleys on the davit arm and a further pulley on the toggle lever. No winch is therefore necessary with this device. The operation of the handle is comparatively easy since, after the davit arm has been brought to the vertical position, the further movement of the lifeboat—inwards or outwards—is assisted by the weight of the boat itself. The davit arm can be swung through about 180 deg., and this imparts a practically horizontal movement to the boat. A diagram of the davit and photographs of a model in different positions are shown.—*Abstract No. 1,869, Journal of The British Shipbuilding Research Association, Vol. 3, No. 6, June 1948. J. A. Schepers, Schip en Werf, Vol. 15, 30th April 1948, p. 163.*

The Launching of the Motorship "Slamat"

The twin-screw motorship "Slamat" was launched on 1st May by the Rotterdamsche Droogdok, Co. for the Rotterdam Lloyd; she will be put into service in August. The design of the vessel goes back to 1939, the year in which she was ordered. Steel and machinery were brought from British firms in 1945, but difficulties in delivery delayed completion till this year. The main dimensions of the "Slamat" are: length overall, 518·4 feet; beam, 65·6 feet; height to upper deck, 41·0 feet; deadweight, 12,000 tons; speed, 16 knots; shaft horse-power, about 8,000. Welding has been used for the construction of all parts of the shell-plating, the decks, double-bottom, and bulkheads. The hull structure is designed on the longitudinal-frame system. The ship is classified by the Bureau Veritas. The double-bottom is used for the storage of fuel oil, of which up to 2,000 tons can be carried. There are seventeen electrically-operated winches. The steering gear is of the electro-hydraulic type. The vessel is equipped with eleven single and twelve double cabins for thirty-five passengers. The "Slamat" has a modern automatic fire indicating and fighting system. Each of the two main single-acting, two-stroke Sulzer Diesels develops 4,000 s.h.p. at 125 r.p.m. Each cylinder has its own scavenging pump; this arrangement has allowed the length of the engine room to be shortened by 8·2 feet. The pistons are oil-cooled, the cylinders fresh-water cooled. The fuel consumption is about 0·3lb. per s.h.p.-hr. and the thermal efficiency of the engine roughly 40 per cent. The exhaust gases heat a Schelde-La Mont exhaust-gas boiler which delivers steam at a pressure of 103lb. per sq. in., part of which is used in the water-distilling plant. There is an auxiliary oil-fired boiler for harbour operation.—*Abstract No. 1,832, Journal of The British Shipbuilding Research Association, Vol. 3, No. 6, June 1948. Schip en Werf, Vol. 15, 1st May 1948, p. 187.*

Prefabrication of French Steam Tugs

Four tugs for service on the Rhine were recently launched at Cherbourg Arsenal, these being the first of a series of twenty-five vessels ordered by the French Government for various operating companies and named "Actif", "Adroit", "Brave", and "Fantasque". These tugs are divided into three types whose dimensions are as follows:—

	Type A	Type B	Type C
Length	113ft. 0in.	115ft. 0in.	129ft. 6in.
Breadth ...	23ft. 0in.	23ft. 5in.	24ft. 7in.
Depth	10ft. 2in.	8ft. 10in.	8ft. 6in.
Draught ...	6ft. 11in.	5ft. 3in.	4ft. 3in.
Power	550 s.h.p.	550 s.h.p.	2 × 320 s.h.p.

The propelling machinery in each case consists of triple-expansion steam engines with Bauer-Wach exhaust turbines taking steam from Prudhon-Capus boilers. The tugs are prefabricated. Seventeen welded hull sections are constructed in the shops and assembled on the slipway, the heaviest section weighing 13 tons. The steam machinery is being manufactured by the firm of Indret.—*The Marine Engineer, Vol. 71, July 1948, p. 350.*

ENGINEERING ABSTRACTS

Section 3. SHIPBUILDING AND MARINE ENGINEERING

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The Two-stage Ignition of Higher Hydrocarbons at Atmospheric Pressure

The "low-temperature" region of ignition of the higher paraffin hydrocarbons is of importance since it comprises the temperature range within which knocking occurs in internal-combustion engines. In this region slow oxidation, "cool flames", and two-stage ignition are evident. The relations of these phenomena to temperature and pressure follow a complicated mechanism which has not yet been completely elucidated, and this paper deals with research work on this subject. Ignition experiments were carried out with a Moore type apparatus consisting of silica crucible partly immersed in a lead bath, the gas mixture in the crucible being sampled through a capillary tube. With n-heptane ignition was found to be preceded by a "pre-ignition pulse" which persisted even at temperatures at which ignition did not occur. Gas samples were collected at different reaction stages and a theoretical explanation of a chain reaction in accordance with the experimental results is presented.—*B. Friedlander and L. Grunberg, Journal of The Institute of Petroleum, Vol. 34, July 1948. pp. 490-510.*

Localized Overheating in the Wall of a High Pressure Vessel and Its Effect on Rupture Strength

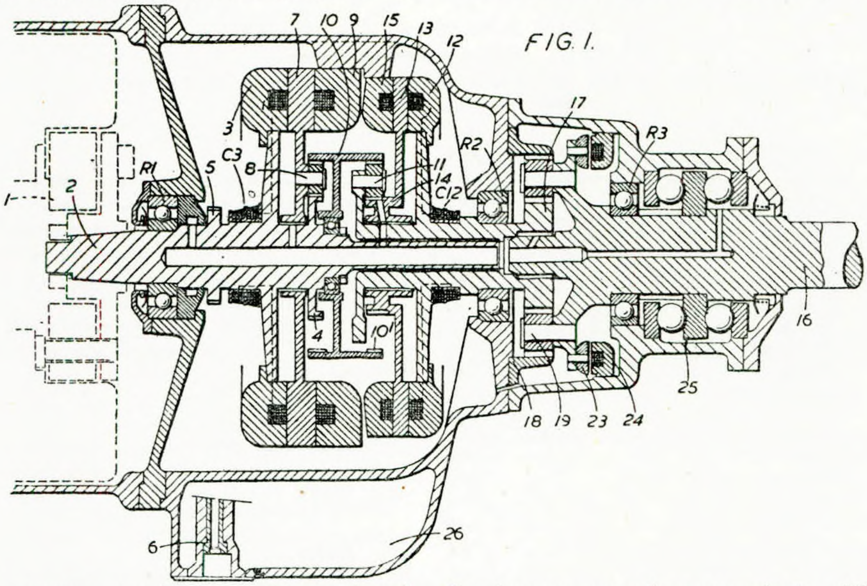
While this paper is mainly concerned with the analysis of the failure during hydrostatic pressure test of a large vessel for the chemical industry, damaged by local overheating, a list of generally valid recommendations for the care and operation of high pressure vessels is given as follows. If the vessel has been fabricated from an alloy steel or a steel containing over 0·2 per cent carbon, no welding operations should be carried out, unless the vessel can be suitably preheated. Otherwise, welding will cause the formation of martensite with subsequent danger of crack formation. While vessels fabricated from low carbon low manganese steels can of course be welded without danger of formation of martensite, it is preferable that they also should be preheated prior to welding. In any case all vessels should be stress-relieved after welding. Avoid heavy grinding operations on thick walled vessels because the heat generated can cause the formation of martensite. Avoid all scoring or marking of the vessel, such as rough machining, chisel marks, stamping of numbers, etc. These can cause stress concentrations with the subsequent development of fatigue cracks. Do not allow large temperature gradients to exist between the inside and outside walls of the vessel during operation or hydrostatic testing. If the vessel is at elevated temperatures during the operation allow it to cool to approximately room temperature before filling with water for hydrostatic tests. Before applying the pressure allow the temperature of the water and walls of the column to come to equilibrium. Following hydrostatic testing examine the vessel carefully, preferable by the magnaflux method, for any cracks or defects. Avoid subjecting the vessel to a heavy blow while under pressure. The shock may be sufficient to act as a "trigger" for the propagation of a small crack.—*A. H. W. Busby, The Engineering Journal, Vol. 31, July 1948, pp. 382-391.*

Nylon for V-belts

An American manufacturer has developed a nylon-reinforced V-belt said to have twice the strength and four times the average life of conventional belts. The belt contains a series of tough nylon cords covered with a special synthetic rubber compound capable of withstanding the deteriorating effects of heat and oil. The belt is particularly recommended for power transmission on equipment subject to rough usage. In addition to high tensile strength, it has great flexibility and sufficient amount of elasticity to absorb shock, according to the makers.—*Motorship (New York), Vol. 33, June 1948, p. 58.*

Combined Reversing and Change-speed Gearing

This invention comprises in combination a flexible coupling by which the combined reversing and change-speed gear is connected to the engine; an electromagnetically operated reversing gear comprising a planetary gearing; an electromagnetically operated change-speed gear providing two gear ratios; a reduction gear; a propeller shaft brake, preferably of the electro-mechanical type; and a thrust bearing for the propeller shaft. The reverse gear is essentially constituted by the first gear-train of the apparatus. On the driving shaft (2) are fixed a rotating electromagnet (3) fed by means of a collector (C3), a sun gear (4) and a sprocket wheel (5) controlling the pump (6) which effects the circulation of the lubricating oil. An armature (7) forms one piece with the planet-carrier (8) loosely mounted on the shaft (2). This armature may, at will, be held either with a stationary electromagnet (9) or by the rotating electromagnet (3). The whole gear train, together with an annulus (10) which transmits the movement to the change-speed box, forms the reversing train, which works as follows. When going ahead, electromagnet (3) is energized, which rotates armature (7) with shaft (2) and, since the planet-wheels are now at rest, causes the annulus (10) to rotate in the same direction and at the same speed as shaft (2). When going astern, the stationary electromagnet (9) is energized, which prevents armature (7) from moving and consequently causes the planet-wheels driven by the sun gear (4) to rotate on their axles, that operation having as result the rotation of the annulus (10) in the reverse direction. Referring to the change-speed box, the movement of the annulus (10) is transmitted to the second gear-train by means of annulus (10^1). The planet-wheels of the second gear-train are mounted on a carrier (11), which forms one piece with the driven shaft and the rotating electromagnet (12) fed by collector (C12). The armature (13) connected with the sun gear (14) may, at will, be held by the rotating electromagnet (12) or by the stationary electromagnet (15). This apparatus operates as follows. In order to obtain full speed, electromagnet (12) is energized and armature (13) is thereby rotated with the electromagnet (12). The sun gear (14) and the planet-wheel carrier (11) then run at the same speed, the result of which is that the planet-wheels are now at rest, consequently the driven shaft (16) rotates at the same speed as the driving annulus (10^1). On the other hand, in order to obtain the reduced speed, armature (13) is constrained to remain motionless by energizing the stationary electromagnet (15). The planet-wheels then rotate around the sun gear (14) so that the shaft (16) rotates at reduced speed in the same direction as the driving annulus ((10^1).—*British Patent No. 600,790, issued to Société d'Applications des Brevets Cotal. Complete specification accepted 19th April 1948. Reproduced by permission of the Comptroller of H.M. Stationery Office (British Patent Specifications can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2. Price 1s. each inland, or 1s. 1d. each abroad). The Shipping World, Vol. 119, 11th August 1948, p. 110.*



Anson Vibrometer

The Anson Vibrometer is a pocket-sized instrument designed and developed by a British firm for separating and analysing complex vibrations in machines. It is claimed that it can also be used as a highly accurate revolution counter. The action of the instrument depends on the phenomenon of resonance, utilizing the principle of the vibrating reed. A thin high-grade steel reed can be wound out of the instrument by a thumb knob. Variation of the cantilevered length of the reed varies its natural frequency of vibration. The frequency of vibration is indicated by a dial and pointer, calibrated on the relative position of the winding drum to the casing, in either vibrations per second or per minute. When the instrument is held against a vibrating body the extended length of reed will vibrate at a maximum amplitude when its natural frequency coincides with the vibrations of the body. By applying the instrument at various points and "tuning in", the source and rate of vibration can be determined. Frequencies between 3½ and 350 cycles per sec. can be searched out, and where several different vibrations exist in a machine, each frequency can be segregated.—*Power and Works Engineering, Vol. 43, August 1948, p. 250.*

Proposed Recommended Practices for the Preparation of New Turbine Lubricating Systems

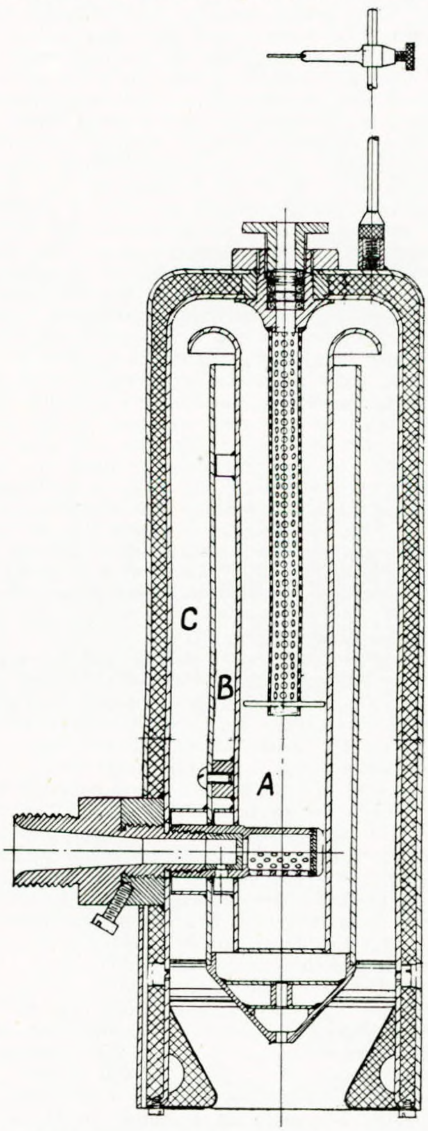
This paper reports that numerous discussions between the representatives of turbine builders, operators, oil suppliers, turbine equipment suppliers, and consulting turbine engineers in attendance at meetings of Technical Committee C Section 1 of the American Society for Testing Materials have indicated the desirability of pooling the available experience with respect to the preparation of new turbine lubricating systems in order that the most desirable practice might be standardized. The pooled information contained therein should be considered a "guide to desirable practices". The original report states that the preparation of new turbine lubricating systems should be accomplished through the co-operative efforts of turbine builders, operators, and oil suppliers. Piping and other fabricated parts, including oil tanks and gearcases should be cleaned after manufacture. Cleaning should also be carried out after erection, and flushing should be carried out by circulating flushing oil. This should be followed by the application of displacement oil in order to ensure the complete removal of the flushing oil. The report includes description of a complete procedure of this kind which has been found to be highly satisfactory by a large number of shipbuilders.—*Trans. A.S.M.E., Vol. 70, May 1948, pp. 363-367.*

Adjustable Speed Feed Pumps

In the marine water-tube boiler, the size of the drum is so small relative to the steam output that the problem of the control of the feed pump is one of considerable importance. An American journal draws attention to a system tried out in a large electrical generating station, in which, as an alternative to throttling the delivery from the feed pump, the speed of the pump is adjusted in terms of the demand for feed water in the boiler. The three feed pumps are of the centrifugal type having a normal running speed of 3,600 r.p.m., driven by 1,800 r.p.m. motors through step-up gears and fluid drives so that complete control of feed water flow can be obtained by regulating the pump speed with the automatic feed water control system. It is suggested that when the feed pumps are operated at constant speed, the flow is reduced by throttling, and if they are designed to prevent pressure rise when throttled, they are less efficient, require more power at reduced flow and may be unstable. Throttling centrifugal pumps for long periods to reduce flow may also seriously increase their maintenance costs. These difficulties are overcome by using a constant speed motor with a variable speed drive, the efficiency of the power transmission using an hydraulic coupling being of the order of 96 to 97 per cent. It is further stated that the speed of response is less that 30 seconds over the full range of the capacity of the pump.—*Shipbuilding and Shipping Record, Vol. 72, 15th July 1948, p. 63.*

The Noble Live Steam Jacketed Two-pass Wire-drawing Calorimeter

The function of the throttling calorimeter is based upon the fundamental principle that saturated steam upon expanding through a throttling orifice at high velocity becomes either drier, or, within certain ranges of initial moisture, more superheated. The Noble calorimeter, which is shown diagrammatically in Fig. 1, is designed for the latter conditions. Saturated steam which is taken from the boiler, by means of a suitable sampling tube fitted to the boiler outlet, enters the calorimeter by way of the convergent inlet nozzle and then expands through two identical orifices; one discharging into a mixing chamber and escaping into the measuring chamber A: the other discharging into the live steam jacket B. The steam from both chambers A and B flows into chamber C and leaves the calorimeter by the exhaust cone. The whole instrument is lagged with insulating material and the external surface nickel-plated. A set of double orifices is supplied to enable the calorimeter to be used for steam at any pressure between 200-950lb. per sq. in., the orifice bores being designed to pass a flow of 180±20lb. per hr., taking into account both the back-pressure velocity loss and any other losses. The steam from the measuring orifice flows into the mixing thimble so as to provide a turbulent effect and to ensure that all water droplets in the steam are evaporated, even under heavy moisture conditions. After leaving the mixing thimble the steam flows upwards and surrounds the thermometer which is placed in the perforated protecting tube. This thermometer is so arranged that its immersion can be varied and permits the necessary movement to locate the point of maximum temperature while eleminating errors inherent in solid pockets. The velocity loss of the steam leaving the calorimeter is accounted for in correction curves which are supplied with the instrument. It is well known in turbine design that when steam is discharged at high velocity through an orifice, to a pressure approximating atmospheric, there exists a considerable degree of under-cooling which is only recovered after the steam has travelled some distance. This phenomenon is taken into account in the design of this instrument by the provision of a moveable thermometer which thereby avoids the serious errors which can be encountered if this phenomenon is ignored. During tests a record has to be taken of the temperature of the expanded steam in the calorimeter, the boiler drum water level and the rate of evaporation and the superheat temperature (when there is no desuperheater installed). Furthermore, boiler water concentration should be measured, a sample being taken at the point of maximum turbulence. A thermometer couple with ¼-inch outside diameter sheath can be used to measure the temperature in the calorimeter in place of the thermometer.—*Engineering and Boiler House Review, Vol. 63, August 1948, pp. 246-247.*



Sectional arrangement of Noble calorimeter

The Calculation of Compressible Fluid Flow by the Use of a Generalized Entropy Chart

Calculations of the flow of gases in pipes or ducts of varying cross-sections are important in the design of turbines and compressors, nozzles for various applications, exhaust or radiator ducts, thrust augmenting devices, etc. Provided certain simplifying assumptions are made, there is no difficulty in writing down the basic equations, but when the velocities are comparable to that of sound, and compressibility effects cannot therefore be neglected, the solution of the transcendental equations present difficulties which hinder a clear discussion of the physical phenomena. The authors solve the problem by the use of a generalized entropy chart, off which results may be read directly. For example, if the conditions in the reservoir from which the gas is assumed to be discharged are known, the complete conditions at any given cross-section may be read off when two parameters at the section considered are specified. The parameters may include the velocity, pressure, density, temperature, local Mach number, local velocity of sound, area of cross-section, mass flow per unit area, momentum per second, etc. The method is not confined to isentropic flows and may be applied to such problems as the flow in straight pipes or convergent and divergent nozzles including losses be either friction or condensation shocks.—*Paper by J. Kestin and A. K. Oppenheim, The Institution of Mechanical Engrs., 1948.*

Some Advantages of Planetary Gears

Planetary gears, in order to work satisfactorily, need special means of securing automatically an equal load distribution between the planets. Unless such means are provided, even the highest obtainable accuracy in producing the gears will not be able to guarantee this equal load distribution. An unequal load distribution means that, at least periodically, the whole load may have to be carried by one single planet. Therefore, in order to avoid failure, the gearing would have to be dimensioned accordingly, and no advantage in dimensions and weight would be gained, compared with the usual type of non-planetary gearing. This survey deals with planetary gears having special means for providing automatically an equal load distribution on the planets, such as have been developed by the author. They have proved to be very successful and, compared with the usual type of non-planetary gears, they show many advantageous features. In a planetary gear the total load is divided between several planets and this is the main reason for the small dimensions of planetary gears. If, for instance, three planets are used, each tooth engagement on the sun gear will have to carry one-third of the whole load. That means, roughly speaking and not considering some influences of secondary importance, that the sun gear will need to have the dimensions of a pinion designed for about one-third of the actual load. Because of the small dimensions obtainable with properly designed planetary gears, the weight of such units and the amount of steel required for their production are low. Furthermore, the correct mesh of the gear teeth does not depend on the stiffness or rigidity of the gear casing. Therefore light weight casings can be provided for planetary gears without endangering their operating characteristics. In order to show the progress that has been achieved through the application of planetary gears, the design data of two gears, used for marine propulsion, are outlined as follows:—

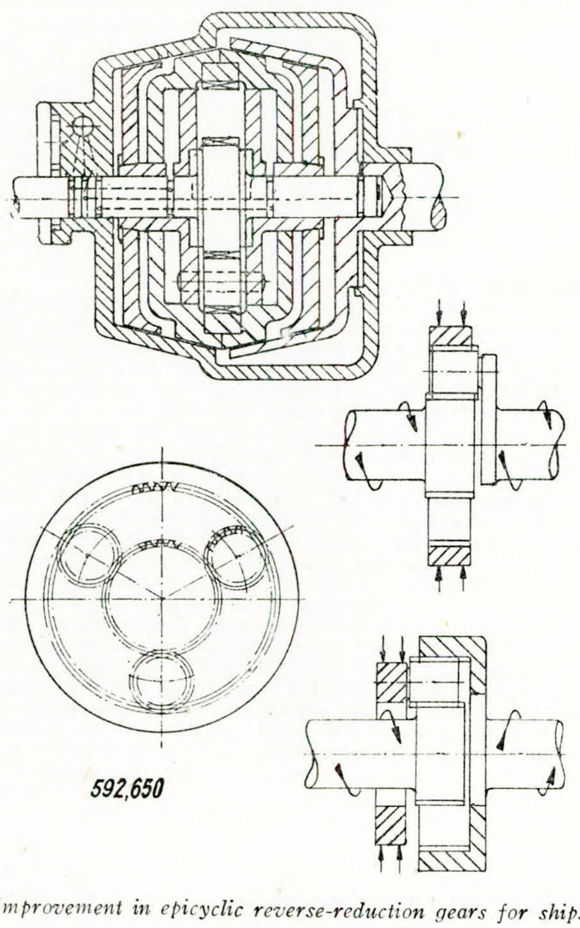
(1) A turbine reduction gear.
  Maximum load: 5,000 s.h.p.
  Reduction from 3,770 to 580 r.p.m.
  Weight: 2,200lb.
  Outer diameter of casing: $35\frac{5}{8}$ inch.
  Length between coupling flanges: $29\frac{1}{2}$ inch.
  A comparable non-planetary gear, designed as a double reduction gear in order to obtain small dimensions, still would have a weight of approx. 10,500lb., or 4·77 times as much as the planetary gear.

(2) A reduction gear to be flanged to a marine Diesel engine.
  Maximum (continuous) load: 2,500 h.p.
  Reduction from 670 to 470 r.p.m.
  Weight: approximately 1,300lb.
  Outer diameter of casing: 26·4 inch.
  Length between coupling flanges: 25·5 inch.
  A comparable non-planetary gear would weigh approximately 9,000lb. or 6·9 times as much as the planetary gear.

The efficiencies measured on a number of different planetary gears were very high. This seems to be remarkable also from the point of view that every power flow has two working gear engagements, both having the same load and the same speed. The efficiency of the aforementioned turbine reduction gear for marine propulsion was measured as 99·4 per cent, as was also that of the Diesel reduction gear for marine propulsion.—*W. G. Stoekicht, Journal of the American Society of Naval Engineers, Vol. 60, May 1948, pp. 169-178.*

Epicyclic Reverse-reduction Gears

"Improvements in Encyclic Reversing and Speed Reduction Gear" is the title of a recent British patent specification in the name of William Smith. It is numbered 592650, and relates to the ahead to astern direction, to be operated by oil controlled cone clutches in a simpler and more economical manner. An epicyclic reversing reduction gear in accordance with the invention has a driving member consisting of a sun pinion and when driving in a forward direction, i.e. with driving and driven shafts running in the same direction, and with the driven member running at reduced speed, there is an internal gear which is held stationary, and planet wheels transmit the drive.



Improvement in epicyclic reverse-reduction gears for ships

The internal gear and the casing carrying the planet wheels are held stationary against the outer casing of the gearbox, and in contact with the driven shaft respectively, by means of oil-operated cone clutches, the inner members of the clutches being integral with the internal gear and with the casing carrying the planet wheels, and are held in contact with suitable cones integral with the stationary casing of the gearbox and with the driven shaft respectively. When it is desired to transmit the drive in the reverse direction of rotation i.e. the driving shaft rotating in opposite direction to the driven shaft but at reduced speed, the sun pinion is again the driving member, but now the internal gear is the driven member whilst the planet wheels are held stationary, there being a cone clutch on the casing carrying the planet wheels which is held by oil pressure in contact with the outer casing, and also a cone clutch on the sun wheels which is engaged with a cone on the driven member by oil pressure. When no drive is required to be transmitted to the driven member in either direction of rotation, the planet wheels and casing carrying them are free, and the clutches are not engaged with either the stationary casing or driven shaft, the operating means of the clutches being out of action. The arrangement of cone clutches and oil-operating means is such that both clutches for one direction of rotation are engaged in the same direction together, and both clutches for the reverse direction of rotation are engaged in the opposite direction and together.—*The Marine Engineer, Vol. 71, July 1948, p. 333.*

Pumping by Means of Compressed Air

This paper describes a novel type of compressed air operated underwater pump developed by the author for the pumping out of sunken vessels. This pump possesses two alternate operated air cylinders equipped with suction and discharge valves. Water is admitted to one cylinder through the suction valve and the water is then discharged through the delivery line above the surface by blowing compressed air into the cylinder. While one cylinder is being emptied in this manner, the other cylinder is being filled. Compressed air admission to the cylinders is controlled by an air distribution valve of the piston type which is operated by a snap-action float in one of the cylinders. In order to maintain the compressed air supply to the cylinders at the proper pressure, a weight-loaded air pressure control valve is provided which controls the air supply pressure to the aforementioned distribution valve. The paper gives a complete theoretical analysis of the operation of the pump, and actual operating data on a pump of 200 cu. m. per hr. capacity suitable for operation at depths of 25 metres are included. The prototype pump was used at Toulon on the occasion of the raising of the sunken mail steamer "Kairuan". After 13 months of operation in both salt water and fresh water the pump was opened for inspection and was found to be in perfect condition. The author also describes a similar pump based on the same principle, to be installed in a vessel. The paper also includes salient data and preliminary layout of a land installation to serve as pumping plant for a drydock at Brest. The duty of this pumping plant is given as 160,000 cu. m. of water to be pumped in about 4 hours, three pumps to be installed for this purpose. The compressed air supply is to be taken care of by a 3,000 h.p. Rateau air compressor with a delivery pressure of 3 kg. per sq. cm.—*Paper by J. P. Polouektoff read at the 40th Annual Session of the Association Maritime et Aeronautique, 28th May, 1948.*

New Types of Boiler Feed Pumps

The trend to higher pressures in marine work has necessitated the development of new boiler feed pumps specially designed for maritime requirements. An outstanding example of recent high-pressure ships are the dry-bulk cargo vessels built by Bethlehem Steel Co., Shipbuilding Division, for Ore Steamship Co. These vessels are of 32,300 tons displacement when loaded and develop 11,000 s.h.p. at 95 r.p.m. of the screw and a speed of 16·4 knots. Steam pressure at the superheater outlet is 1,450lb. per sq. in. at 750 deg. F. Throttle conditions are 1,410lb. per sq. in. and 740 deg. F. Live steam reheat is employed between the high-pressure and the low-pressure turbines and also between the intermediate- and the low-pressure turbine. Four feedwater heaters are used, the second heater being of the direct-contact de-aerating type. It is from this heater that the boiler feed pumps take suction. Pump conditions are as follows:

Gallons per minute	200
Total head, feet	3,900
Temperature	250 deg. F.
Discharge pressure	1,650lb. per sq. in.
Suction pressure	30lb. per sq. in.
Rotational speed	6,480 r.p.m.

Drive is by General Electric type turbines with 1,400lb. per sq. in. steam at the throttle. The units are mounted directly on a transverse bulkhead in the hull, three per vessel. Fig. 6 (p. 109) shows the details of the pump. The shaft is supported vertically by the turbine through a solid coupling. Pump suction is at the top and the flow is downward through the first four stages. The stream is then conducted to the bottom of the unit where is passes upward through the remaining four impellers. The bottom steady bearing is internally lubricated and an adequate flow of water is assured by connecting the lower end back to first-stage discharge pressure, thus resulting in three stages of pressure difference across the bearing. The centre internal bearing is located between stages 4 and 8 and is likewise assured of adequate lubrication by virtue of the pressure differential. Discharge

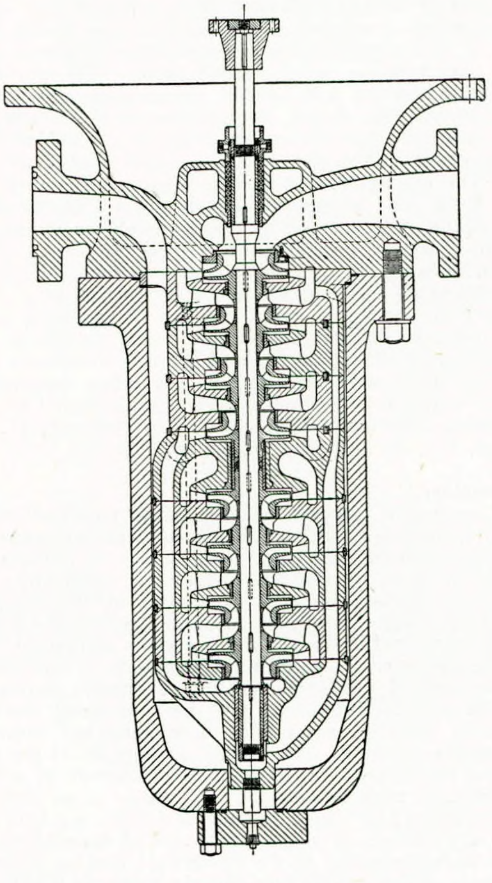


FIG. 6.—*Section through pump*

pressure exists in the space between the rotor assembly and the forged outer barrel, and this pressure acting on the end of the rotor assembly eliminates the need for heavy rotor through-bolts. Nominal bolting is provided to hold the assembly during non-operating periods and during assembly. All contact parts are of corrosion resistant materials for resistance to high-purity feedwater. As in stationary practice, an effort has been made to simplify design by eliminating all unnecessary parts. Solid impeller hubs, stationary wearing rings of simple design, and the use of centering rings instead of dowels to align the channel rings all lead to a rugged design having ease of maintenance.—*Combustion, Vol. 20, July 1948, pp. 28-31.*

Non-metallic Bearings

The physical properties of a number of non-metallic bearing materials and the operating characteristics of such bearings were discussed in four papers of the symposium contributed by the Rubber and Plastics Division and presented at the Annual Meeting of the American Society of Mechanical Engineers. In the first of these papers, read by A. Bednar and entitled "Some Characteristics of Soft Rubber as a Material for Water-Lubricated Bearings", reference is made to the successful employment of bearings of soft rubber composition as stern-tube and strut bearings of large ships and boats. It is stated that rubber bearings perform almost unbelievably well at the outermost end of the cutter shafts on hydraulic dredges where they support the rotating cutter as it digs into the bottoms of rivers and harbours. Laboratory tests and actual observations in service indicate that these soft-rubber materials when properly prepared, have the ability to deform and so allow abrasive particles to pass between the resilient surface of the rubber bearing and the revolving shaft with minimum pressure against these surfaces. The upper limit of speed for water-lubricated bearings has not been determined. On a special racing boat built in Britain some years ago, rubber bearings were used for a 1⅜-inch diameter shaft turning at 12,000 r.p.m., these bearings showed absolutely no distress after considerable service and numerous record runs on this boat. Shaft journals should be smooth, and consequently reasonably hard corrosion-resistant materials are necessary. Certain grades of bronze, properly processed, and monel metal have been found satisfactory in sea water. Generally for continuous operation, the bearing should be open at both ends for free circulation of water when submerged, or provision for circulating water should be made. For extremely slow speeds or intermittent service such as rudder pintle bearings, no water circulation is required. In the second paper H. V. Townsley gives "Some General Information about Lignum-Vitæ Bearings". The author explains that this wood when used as bearing material does not require lubrication of any kind, the Guaiac gum which forms one-third of the material being an excellent lubricating agent. At normal temperatures this gum remains in the bearing indefinitely. The bearings are designed for working pressures of 75 to 150lb. per sq. in. in the direction of the long grains and as high as 300lb. per sq. in. on the end grain. In the third paper "Properties and Applications of Laminated Phenolic Bearings", read by L. E. Caldwell and J. Boyd, reference is made to laminated phenol bearings made from plate stock. They are available up to 3-inch interior diameter in any length that is practical to bore and are used primarily for small-craft stern-tube bearings. Stave bearings are fabricated from laminated plate stock and can be made in any size from 3-inch interior diameter upwards. They are used mainly for stern-tube and rudder-stock bearings. In the case of full- or bushing-type bearings it is essential that swelling be taken into account. In stave-type stern-tube bearings, for instance, the staves are so installed that the load is carried on the edge of the laminations, which gives more uniform wear properties. In installing the staves it is desirable to machine the individual pieces and to bore the assembled bearing dry. If the staves in a 6-inch stem-tube bearing with ½-inch thick staves were to swell freely, the circumference would increase about 0·6in. and the thickness of the staves about 0·0015in. In order to keep radial swelling as small as possible, stern-tube bearings are usually fitted with elastic or spring staves. The last paper entitled "Reduction of Wear in Rubber Stern Bearings by Flow-Controlled Continuous-Film Method" was read by R. D. Smeallie. As a result of a study of the hydrodynamics of submerged bearings it was found that by placing two axial-flow control grooves running from end to end on the inside periphery of the mating bronze bushing a continuous film was obtained characterized by a reduced low speed coefficient of friction. For example, at 100 r.p.m. with a load of 30lb. per sq. in., the frictional torque is 50 per cent less than for the interrupted-film method. To contribute further to low frictional characteristics at low speed, axial water traps or reservoirs are designed in the form of moulded grooves placed in the rotary rubber journal. These grooves supply additional water under pressure regardless of how slowly the shaft may rotate.—*Mechanical Engineering, Vol. 70, July 1948, pp. 599-608.*

Keeping Up Steam Jet Ejector Performance

This article describes the various steps to be taken if the performance of a steam jet ejector has become unsatisfactory in the course of time. In such cases recent operating history may yield a clue to the possible source of trouble. For example, if the vacuum maintained by an injector is steady but gets a little poorer day by day, a steam leak through the nozzle threads may have developed, and if the ejector is of the multi-stage type, the steam leak probably is in the first stage. If a multi-stage ejector seems to be getting unusually sensitive to small increases in non-condensable load, a steam leak in the last stage or possibly the next-to-last stage should be looked for. If, even when operated on a steam pressure appreciably higher than its design steam pressure, an ejector "breaks" or "coughs" with each small drop in steam pressure, then a worn diffuser should be looked for. When an ejector is operating brokenly or coughing, the vacuum not only drops badly but also fluctuates widely and the air chamber of the stage in trouble (and the air chambers of all preceding stages of a multi-stage ejector) usually gets quite warm. This indicates the stage that is in the worst trouble. Wear in diffusers is more critical than internal wear in nozzles. Wear in a nozzle tends to compensate for wear in the diffuser. In case of doubt as to the effects of wear a new diffuser should be ordered first, since a new diffuser will operate with a nozzle a little worn, while the effect of replacing a worn nozzle with a new one is to make operation worse if the diffuser is worn. A worn nozzle can be operated with a new diffuser, but a new nozzle cannot be operated with a worn diffuser. If, in an emergency, it is necessary to try to keep an old ejector in stable operation, that is, without breaking on steam pressure dips, until such time as it may be taken out of service long enough to check it thoroughly for repairs, the steam pressure should be raised at the ejector in order to see if it will operate stably at some higher steam pressure. If the ejector proves stable at a higher steam pressure, then, by slowly reducing the steam pressure, the exact minimum steam pressure should be determined at which each individual stage of a multi-stage ejector will operate stably, starting with the last stage first, then the next-to-last stage, and so on. The next step will be to compute the percentage increase of the minimum stable operating steam pressure of each stage expressed in lb. per sq. in. abs., not lb. per sq. in. gauge, over the original design steam pressure (also expressed in lb. per sq. in. abs.). Then the nozzle of each stage requiring higher steam pressure should be re-drilled to give this same percentage increase in nozzle throat area. This usually permits the ejector to operate stably on a minimum pressure equal to or slightly higher than the design pressure.—*L. S. Stinson, Powerfax, Vol. 26, No. 1, 1948, pp. 11-14.*

Metals with Controlled Expansion

Of recent years engineers have begun to take more seriously into account the possibility of lengthening the life of working parts and equipment by controlling the expansivity of the materials employed, and this necessarily involves choosing metals with known and appropriate expansion properties. After considerable research, the nickel-chromium alloy cast irons have been found extremely valuable in this respect by reason of their high damping capacity, wear resistance, corrosion resistance, excellent machinability, and great range of thermal expansivities. For example, with these materials it is possible to choose expansivities at normal temperatures ranging from 2·2 to 10·7 millionths per deg. F. This last expansivity approximates to that of Y-alloy, an aluminium alloy (12·5), and is virtually equal to that of other aluminium alloys at 10·5 millionths per deg. F. at normal temperature. For example, an engine cylinder liner of one type of nickel-chromium alloy cast iron has been mounted in aluminium cylinder blocks so as to give a combination of high expansivity and better resistance to wear and corrosion. This enables the cast alloy liner to expand to almost the same extent as the cylinder block itself when operating at temperatures up to 370 deg. C. In consequence, there is no pulling away of one metal from the other, and this means that transfer of heat from liner to cylinder block is facilitated. Only a relatively small shrink fit is needed to take up the variation in expansivity between the nickel chromium cast alloy liners and the aluminium blocks, as compared to what is necessary with gray cast iron and steel liners. . The latter, in fact, require shrink fits so high that they impose stresses upon the block that are liable to distort it, and so in practice reduce the shrink fit, thereby causing the liner to part from the block at working temperatures. When these nickel chromium alloy liners are cast in one piece with the aluminium cylinder blocks, the amount of deformation resulting is extremely small, because both metals have much the same expansivity. When steel or gray cast iron are bonded with aluminium cylinders, on the other hand, variations in temperature set up severe expansion stresses resulting in distortion of both materials. The deformation so produced in the walls of the engine cylinder sets up ring flutter and fatigue, with deleterious results on engine performance.—*E. Barber, Practical Engineering, Vol. 18, 20th August 1948, pp. 138-139.*

High Creep Strength Austenitic Steel Tubes

Gas turbines of the closed-cycle type have as essential parts air heaters and heat exchangers of heat resisting steel tubing. The tubes for such units may range from ½-inch to 2-inch diameter (12 to 50 mm.) with wall thicknesses of about 14 S.W.G. (2 mm.). In service these tubes may attain an operating temperature of 700 deg. C. to 750 deg. C and must resist both creep and corrosion by the combustion gases. The stresses involved are of the order of 1 to 3 tons per sq. in. and at the operating temperatures indicated only the highest grades of heat-resisting steel tubing will be capable of extended life. For example, the 18/8 type of austenitic steel stabilized with titanium or niobium would under these conditions stretch within a few thousand hours far more than could be tolerated. It was therefore evident that steels previously developed and extensively used for the high temperature parts of jet and gas turbine engines would be needed to meet the requirements and therefore investigations were carried out to ensure that they could be successfully fabricated into tubes and that the welding properties were adequate to enable complex banks of tubing to be assembled. Considerable experience had already been gained in forging and rolling Jessop G.18B steel, an alloy, which has now been used extensively in gas turbines for about five years for highly stressed, high-temperature components. This alloy was a natural choice for preliminary experiments in the manufacture of tubes from high-temperature materials and an added reason for this solution was the extensive long-time creep data available. The chemical composition of Jessop G.18B is as follows: carbon, 0·4 per cent; manganese, 0·8 per cent; silicon, 1·0 per cent; nickel, 13·0 per cent; chromium, 13·0 per cent; tungsten, 2·5 per cent; molybdenum, 2·0 per cent; niobium, 3·0 per cent; and cobalt, 10·0 per cent. From extruded hollows tubing of 1-inch outside diameter and 10 S.W.G. has been produced by cold drawing. By subjecting the tubing to solution treatment at 1,280 deg. C. and air cooling a creep strength 30 per cent better than that of standard forged or rolled bars was obtained. In addition to the high standard of scaling resistance, creep strength and corrosion resistance demanded of an alloy for use as air heater tubes, the material must also be readily weldable as the complicated internal construction of such a unit involves many welded joints. The physical characteristics of each welded joint should approximate closely to those of the parent metal. An earlier investigation on the welding of G.18B and allied materials had shown that satisfactory welded joints could be made by electric flash-butt, electric arc and solid phase or pressure welding. The quality was judged by room temperature mechanical tests and creep tests at elevated temperatures. In the construction of an air-heater unit, the welded joints should be internally smooth in order to minimize the resistance offered to the gas flow. This almost eliminates the use of welding processes such as flash-butt welding and solid phase welding, where the production of a good welded joint depends in part on a certain amount of upsetting taking place, which produces an internal flash which would be difficult to remove. The natural choice of method for multiple tube construction is electric arc welding. Best welds are obtained by using welding electrodes of the same material. Welding is preferably followed by a low temperature stress relieving treatment.—*G. T. Harris and W. H. Bailey, Metallurgia, Vol. 38, August 1948, pp. 189-192.*

The Spraywelder

The "Sprayweld" process, which employs powdered special hard-facing alloys, combines both metallizing and welding practices because it utilizes the advantages of both. In general, the initial steps in this process follow those of standard metallizing procedure. First, the overlay of the hard-facing alloy is applied by the Spraywelder to the desired thickness. Then it is fused to the base metal by any one of the following methods: (1) oxy-acetylene equipment; (2) induction heating equipment; (3) controlled atmosphere furnace. Regardless of the method used, the result is a smooth uniform overlay having a fusion bond between it and the base metal identical to the bond obtained when the same alloy in welding rod form is applied by oxy-acetylene welding. Among the advantages of the process are stated to be the following: (1) a uniform deposit of any thickness up to 0·060 inch may be obtained; (2) there is no porosity in the Sprayweld deposit; (3) finishing time and costs are held to a minimum; (4) any contour or shape which can be sprayed may be overlaid. The main limitation of the Sprayweld process is the thickness of the overlay which can be applied. As much as 0·080 inch can be sprayed on and bonded satisfactorily, but where this much overlay is required it is suggested that the work should be done by oxy-acetylene welding. For economic reasons, as well as the fact that heavier overlays are more difficult to fuse than lighter ones, it is recommended that 0·060 inch be considered the maximum. Furthermore, since the overlay shrinks about 20 per cent in fusing, the actual maximum thickness before fusing should be considered about 0·075 inch.—*Welding, Vol. 16, July 1948, pp. 314-315.*

Novel Developments in Design and Operation of a.c. Welding Plant

Beginning with a critical examination of the inherent shortcomings of the present types of a.c. welding plant, the author points out the direction in which development work is proceeding and gives the results of some recent promising investigations at present in the experimental stage. Referring to a.c. transformers, he states that there is some justification for the criticism that the welding transformer causes some unbalance on the normal three-phase power supply. The welding arc draws its energy as a single-phase load, and if connected to a three-phase system, is bound to load the three lines unequally. In most cases where the welding load represents perhaps 25 per cent or less of the total, the unbalancing effect is small enough to be ignored. It is obvious, of course that, so far as practicable, steps should be taken to ensure that, where a number of sets are involved, an approximately equal number should be connected to each phase. Experience has shown that difficulties arise mainly on small installations where the welding load may be an appreciable percentage of the total demand and where less than three sets are installed. Of the suggestions which have been made to solve the difficulty, one of the most interesting is the use of the multi-phase arc. As early as 1920 a proposal was made with the object of utilizing three phases at the arc and thus to draw balanced currents from the three-phase supply. The method suggested involves the use of two electrodes simultaneously, fed from two phases of the three-phase welding transformer, the third phase of which is connected to the workpiece. The electrodes are insulated from each other so that successive arcs develop between no. 1 electrode and workpiece, no. 2 electrode and workpiece and between electrodes, and for conditions of balanced power input these three arc currents must be equal in magnitude. In practice it was found that the resulting welding conditions were not satisfactory for normal work, as the melting rate of the electrode was excessive for the heat input to the workpiece and the deposit lacked penetration. The difficulty could be overcome only at the expense of upsetting the conditions necessary for balanced power input. Quite recently a considerable amount of experimental work was carried out on somewhat similar lines and the results have been distinctly encouraging. In the modified arrangement the twin electrodes are now supplied from a three- to two-phase transformer and the work is connected to the neutral terminal of the two-phase secondary winding. Comprehensive tests show a number of important advantages as compared with normal single-phase welding. For instance, with equal kVA. input the rate of deposition from the two-phase arc is about 30 per cent faster than is possible on single phase. As the load on the three-phase supply is balanced the line current under these conditions is less than 60 per cent of that taken by the single-phase welder. In practice it is convenient to use two electrodes side by side, either clipped together or cemented in the process of manufacture. The flux coating acts as an insulator between the metal cores, and a modified form of electrode holder is necessary to connect the two-phase supply to the bared ends.—*E. C. Davies, G.E.C. Journal, Vol. 15, July 1948, pp. 111-122.*

Radiographic Control of Welded Repairs in Steel Castings

The application of radiographic inspection to castings both for the detection of defects and control of the subsequent repair by welding is a subject of considerable importance. In this paper, presented to the Industrial Radiology Group of The Institute of Physics the author deals with the techniques involved for the examination and the elimination of the flaws encountered. He also considers arguments for and against the use of gamma-radiography in this type of work. The defects in steel castings which require repair under radiographic control come from two classes of work. One, where the casting is not normally radiographed, but defects are found during testing or machining—usually on steam or water-test, or during service. The second class of work consists of those castings where radiographic examination of certain areas is specified and defects are shown on the radiographs. The areas chosen are located from previous experience of the same type of casting and have to take account of possible difference in methods of moulding. It would be impracticable to radiograph the whole of a large casting such as a high-pressure turbine casing, even if there were only three or four castings to the same design, and in practice twenty to forty radiographs have been found necessary to get a fair estimate of the quality of such a casting. An important point in this connexion is that one of the likely places for shrinkage defects is at the junction of walls or at rapid section changes, and it is in these places that X-rays will produce the least satisfactory radiograph, whereas with gamma-rays a good radiograph can usually be obtained, covering both the thick and thin portions of a section change on a single radiograph. Having taken the radiographs, it has then to be decided which defects need repair. Because different parts of a casting vary very greatly in importance, and because some areas may be cast much thicker than designed, to facilitate casting technique, a fixed specification or any set of standard radiographs such as those issued by the U.S. Navy department is not possible. All cracks and hot tears are marked on the films, to be cut out, and also practically all shrinkage of a filamentary form unless it is extremely shallow. Where shrinkage piping occurs in the thicker junction metal at the junction of two walls, there is no necessity to specify repair unless there is evidence of hot-tears or cracking associated with the shrinkage. However, this type of shrinkage often has smaller branch piping and cracks extending to the surface, which can cause a leakage on water test. This type of shrinkage can be extremely troublesome as the leakage points on the inner and outer surfaces are often a long way apart. There is another form of shrinking which is fairly common in steel castings—spongy metal. When it occurs at all, it seems to extend most of the way through the sections and has to be repaired.—*R. Halmshaw, Welding, Vol. 16, July 1948, pp. 284-290.*

Some Aspects of the Manufacture of Large Seamless Steel Tubes and Hollow Forgings

This paper describes the manufacture of large seamless tubes and hollow forgings by hot piercing and hot drawing, and cold drawing. The advantages of these processes are indicated whether the product is a plain cold drawn tube or a complex steam receiver or boiler drum with integral ends. Details are given of the necessary control of raw materials and the precautions to be taken during billet heating and working, to ensure the production of sound concentric forgings. The wide range of steels to which these processes are applicable is outlined. Diagrammatic illustrations are given which show various stages of the processes.—*Paper by J. W. R. Naden, Trans. I.Mar.E., Vol. 60, July 1948, pp. 151-162.*

Some 1,000 deg. F. Steampipe Materials

This paper presents long-time creep and rupture tests on molybdenum-vanadium pipe material in comparison with low chromium-molybdenum compositions. The molybdenun-vanadium composition shows superior long-time strength at high temperature. Furthermore, long-time soaking of molybdenum-vanadium piping material at high temperature has so far failed to show graphite formation. The purpose of the paper is to present a series of test results contributing to available technical information on materials suitable for high-temperature steam piping. Creep strengths are both listed and plotted for a rate of 0·01 per cent per 1,000 hr. Creep strengths for a rate of 0·001 per cent per 1,000 hr. are listed in tables.—*Paper by E. L. Robinson, read at the Annual Meeting of the American Society of Mechanical Engineers, No. 47-A-74 (1947).*

Technical Progress Report of the Ship Structure Committee

This Technical Progress Report, dated 1st March 1948, is arranged in four parts under the general subjects of design, fabrication, materials, and statistics. Under the first, design, is recorded confirmation of theoretical formulæ for the bending of the hull girder of a ship and demonstration by laboratory tests of the improvements to be gained by relatively simple changes in design details. The second part, on materials, summarizes the continuation of the basic work on steel hull plate, looking toward an understanding of the fundamental reasons for brittle fracture, and shows the progress being made toward improvements in specifications in an effort to lower the incidence of fractures. Methods of fabrication, the third part, summarizes the effect of certain fabrication practices on structural performance. In the fourth part cumulative statistical data on ship casualities are given.—*The Welding Journal, Vol. 27, July 1948, Welding Research Supplement, pp. 377-s-384-s.*

A Comparison of some Carbon Molybdenum Steels on the Basis of Various Creep Limits

In view of the practical importance of short-time creep testing, it was decided to supplement previous work on carbon steels by a similar study of the short-time creep limits of some carbon molybdenum steels during the course of a comprehensive investigation of the creep properties of this class of steel. The paper contains comparisons of various short-time creep limits with long-time creep data. Six steels are involved in the comparisons; five contain about 0·5 per cent molybdenum and one has 0·8 per cent molybdenum content. The five steels containing 0·5 per cent molybdenum were used for the comparisons at 500 deg. C. Four of these and the 0·8 per cent molybdenum steel are involved in the comparisons at 550 deg. C., and the effect of temperature in modifying the relationships of short-time and long-time creep limits is clearly shown by the data obtained for two of the steels over the range of temperatures 500-600 deg. C. (932-1,112 deg F.). Most of the experimental data is reproduced in the form of plotted curves. The authors point out that the results obtained indicate similar limitations in the applicability of short-time creep tests to estimation of design stresses for long-time service, as were disclosed by prior tests on carbon steels. There is not, at first sight, any reason why short-time and long-time creep limits should correlate, since with most engineering materials metallurgical changes occur during prolonged heating.—*Paper by A. E. Johnson and H. J. Tapsell, published by The Institution of Mechanical Engineers for written discussion, 1948.*

Single-projection Welding in Low Carbon Mild Steel

A report on the projection welding of steel drawn up by Mr. A. J. Hipperson for the FR.3 Committee of the British Welding Research Association provides information on this welding method. Although joints containing only one projection weld are rarely made in practice, it was first necessary to investigate the formation of single welds in order that a firm foundation could be established on which to base the experimental work on joints containing more than one projection. Where single welds are required, spot welding would normally be used, and the advantage of projection welding may be made in one cycle of operations of the welding machine. The work described in the report covers the preliminary experiments on single projections, and it has been possible to put forward optimum conditions for producing such welds. It includes a study of the effects of short circuit secondary current, duration of current, and applied pressure—the main variables involved—and also of many subsidiary variables. Records have been taken of the behaviour of the projection at room temperature under load, so that an assessment of the rigidity of the projection could be made. Welds produced under controlled conditions have been carefully examined for strength, size and consistency, and the effect of each variable upon these factors has been determined. Many difficulties not previously apparent have been brought to light, and methods for effecting possible improvements in the process have been suggested. The greatest difficulty would seem to be the lack of forging pressure, which occurs after collapse of the projection. This tends to produce slight cavities and porosity at the original sheet interface and, generally speaking, the welds are not quite so well consolidated as spot welds. One of the most interesting and important features of the results of the work is the high degree of consistency in weld strength that can be obtained from single projection welds, provided certain optimum values of the welding variables are used. A maximum scatter in the strength of welds, made under the optimum conditions established, was found to be −3 per cent. At least half of this scatter was accounted for by variation in line voltage during the welding tests.—*Mechanical World, Vol. 124, 13th August 1948, p. 194.*

Radiological Standards for Pipe Welds

The examination of welds in pressure pipes is a matter of very great importance and also one presenting particular difficulties. The author explains the problems and indicates satisfactory techniques. While the radiologist has a very important part to play in the interpretation of the film, the final decision as to what defects are allowable must, as in all radiographic inspection, be the business of the designer and the responsible engineer. For the thicker-walled pipes the desirable standards must be very similar to those for pressure vessels, but it is probably necessary to take a less serious view of small defects such as isolated inclusions and gas porosity. In the thinner walls, however, small slag inclusions should be regarded very critically, partly because there appears to be a tendency for cracks to be associated with them in these thin sections and partly because they are likely to be larger than appears from their width. Examination of sections of pipe welds shows that frequently an inclusion has a length, measured through the weld, which is of the order of twice its width. An inclusion only $\frac{1}{32}$-inch wide appears as a very insignificant defect when viewing a radiograph, but it may extend for $\frac{1}{16}$-inch through the weld, which is 25 per cent of a $\frac{1}{4}$-inch wall and even in a $\frac{1}{2}$-inch wall represents $12\frac{1}{2}$ per cent of the thickness.—*Paper by W. J. Wiltshire, read at the Industrial Radiology Group of the Institute of Physics, Summer Symposium, 1948. Welding, Vol. 16, August 1948, pp. 339-345.*

Standards for Welds in Ship Construction

The author believes that radiographic inspection in shipbuilding should be applied with caution and that the general adoption of radiography as an inspection method is impracticable for commercial use. But there is a very real use for radiography as an aid in development of welding technique, weld design and the training and grading of welders. Before any welded joint of new design is used in production, samples of the joint should be prepared, as nearly as possible under identical conditions to those that will exist in production. The samples should then be radiographed, sectioned, etched and mechanically tested. In this way only sound designs of joints will be used in actual production. Samples of new ideas in welding technique should be similarly treated. If radiography is used in the training of new welders and to assess the ability of all production welders, then a system of grading the welders can be introduced. Handled in the right way, regular radiographic tests of work carried out by all production welders can raise the standard of quality of workmanship considerably. Summing up, the author states that before acceptance standards can be formed for welded joints in complex structures such as ships, a very much greater knowledge is required of the effect of various defects, of different proportions on the load-carrying capacity of the joints used. It is suggested that large scale tests on plates of varying thicknesses and of widths of about 7 or 8 feet are required. These joints would require to be subjected to varying types of alternating, static and shock loads. This is a very big undertaking and one that could only be carried out by a national research association. One of the most important factors in the application of radiography are the qualifications and ability of the man who has to decide whether a weld is to be cut out and rewelded or whether it is acceptable. His knowledge of ships' structures and possible loading, of practical welding procedures and of radiography must be of a very high standard. Radiography if applied in a practical and reasonable manner will be of great assistance to all those responsible for the strength and efficiency of ships' structures; if great care and consideration are not used in its application, many of the advantages of welded or partially welded construction may easily be nullified.—*Paper by R. J. W. Rudkin, read at the Industrial Radiology Group of the Institute of Physics, Summer Symposium, 1948. Welding, Vol. 16, August 1948, pp. 335-338.*

Unappreciated Advantages of Modern Gray Iron

The outstanding properties of gray iron which are an improvement over those of steel are resistance to wear and galling, improved resistance to corrosion by water and by heat, less tendency toward warping under heating and cooling, increased capacity to dampen vibration, high notch fatigue, compression and torsional strength, to some extent increased electrical resistivity, and, finally, low cost of forming, and very good machinability. On the other hand, there are some properties which are definitely lowered by the presence of graphite, notably, a reduction in tensile strength, reduced stiffness or modulus of elasticity, and a low order to toughness. Comparisons between medium- and high-strength irons show that high-strength irons can be made to have about twice the toughness and greater stiffness, at the same time retaining good wear, machining, and damping properties. With different types of gray irons, which can be specified suitably, a variety of resistance to metal-to-metal wear can be achieved. It is essential to note that those gray irons with the high strength range and other properties attainable at extreme levels have alloy additions. This is not surprising, since it is well known how the extremes in combinations of properties are achieved in alloy steels, as compared with those attainable in plain steels. Similarly, the high mechanical properties of the better gray irons can be obtained with alloy additions and without the need of heat-treatment, whereas in steels the higher mechanical properties are associated with heat treatment. In general, the strength of gray iron, which commonly is of the order of 20,000 to 30,000lb. per sq. in. tensile strength can be increased to levels of from 40,000 to 70,000 to 90,000lb. per sq. in. tensile strength by the addition of from 1 to 4 per cent of suitable alloying elements such as nickel, chromium, molybdenum, vanadium, and copper. Marked improvement to corrosion resistance can be achieved with rather heavy alloy additions of from 20 to 35 per cent nickel. This group of irons is as different from gray iron as the austenitic 18-8 stainless steel is from plain steels. Piston rings for engines and pump pistons are most commonly made in gray iron because of the need for resistance to wear, corrosion, and heat, and high vibration-damping capacity. Motor blocks and engine and pump cylinders require resistance to wear and corrosion and high damping capacity, together with a low cost of forming the metal to the desired shape. One of the outstanding examples of applying modern gray iron is in engine and compressor crankshafts. They are used in small compressors, automotive engines, and indeed, in large Diesel engines such as submarine Diesels where the gray-iron crankshafts weigh up to 10,000lb. The use of gray iron in a crankshaft is for the high vibration-damping capacity, a high notch-fatigue strength of the metal, good wear properties on the bearings and the low cost of forming or founding and machining to the desired shape, as compared with forging and machining. For example, a forged-steel crankshaft weighed 18,000lb., and when ready for installation, 14,000lb. (4,000lb. removed). The gray iron crankshaft for the same engine weighed 10,000lb. as cast, and 9,200lb. after machining.—*F. G. Sefing, Mechanical Engineering, Vol. 70, August 1948, pp. 667-670, 674.*

Acceptance Standards in Radiographic Inspection

In this paper the author renders a critical review of known standards or codes used in industry for assessing the quality of materials by radiographic examination. Consideration is also given to standards of radiographic technique, and standards radiographs, that is, radiographs used for comparison purposes as standards of acceptability. The author states that the examples given by him were chosen partly with a view to establishing principles which might form a basis for a rationalized series of standards. Thus a relatively few master standards could be framed in which both radiographic technique and acceptance levels would be adequately codified. Among the conclusions which have emerged are the following. Total inspection of production is the general practice for welds in pressure vessels, weld junctions and cross-overs in ship welds and structural welds, and for parts of certain heavy castings such as turbine casings. The tendency is, however, towards sample inspection used as a means of radiographic quality control. There are a few comprehensive standards for Class 1 welding in existence, but in general the rules for acceptance tend to be over elaborated while too little attention is paid to radiographic technique. The use of radiography as a means of quality control (percentage inspection) dispenses to some extent with the necessity for detailed acceptance standards, and in consequence leaves more to the personal judgement of of the inspecting staff. The radiographic inspection of large castings in specified locations is becoming an established practice, but standardization has not yet reached the stage of development of grade 1 weld inspection X-rays and gamma-rays are in use for the inspection of ship welds, and heavy castings. Supplementary magnetic examination for surface cracks is recommended when gamma-rays are used, but X-rays are to be preferred whenever possible. The level of acceptance is fixed largely by accumulated experience and by the standard of quality which is readily attainable by first-class craftsmen. With few exceptions it seems very doubtful whether standards can be founded in detail on a scientific correlation of radiographic results with mechanical strength. The key to good industrial radiography is a clearly specified radiographic technique together with the use of well-designed penetrameters. These should, however, properly be regarded as scarcely more than makeshifts until urgently needed extended facilities can be provided for giving all the personnel concerned a sound knowledge of the principles of radiographic technique and interpretation.—*Paper by C. Croxson, read at the Industrial Radiology Group of the Institute of Physics Summer Symposium 1948. Welding, Vol. 16, August 1948, pp. 324-329.*

Modern Projection Welding

Projection welding is a method of resistance welding whereby the current-flow and heating during the welding operation are localized at predetermined points called "projections" or "embossments". There is said to be no faster, more economical, or stronger method of attaching fasteners than by projection welding. Fasteners provide the means by which the component parts of an assembly are held together. When determining whether a job should be projection-welded the following factors should be considered: (1) the materials used must be suitable for projection welding; (2) the work to be welded must be so designed and of a size to enable it to be carried to the welder; (3) the quantity must be large enough to warrant the cost of tooling up; and (4) suitable welding equipment must be available. One of the most important advantages of projection welding has been the economy, of attaching parts of irregular shape to sheet metal which could not be spot welded. Many times, three or four products of the same design can be welded in one operation and consequently the cost of welding is greatly reduced.—*Paper by R. A. Reich, read at the 1948 Semi-Annual Meeting of the American Society of Mechanical Engineers. Paper No. 48-SA-17.*

Induction Heating Speeds Production

In the opinion of the author a far greater use of induction heating could be made with distinct advantage in the welding shop. Preheating for welding is required when metallic arc welding high carbon steels so as to prevent hard zones forming in and around the weld, which would create cracking, or again in order to obtain a good deposit on a heavy mass of material and also to achieve sound welds on certain rigid structures. The author describes a case in which it was decided to carry out preheating by using a two-operator 50-cycle frequency transformer welding unit for induction heating a high-carbon steel shaft weighing between eight and nine tons. Twenty-four turns of 19/0·064 asbestos-covered copper wire were wound on this shaft and connected to the 80-volt tapping on the welding transformer. After approximately three and half hours the temperature of the shaft had reached 170 deg. C. with a temperature rise on the transformer of only 30 deg. C. The temperature of 170 deg. C. at the end of the shaft was maintained throughout the welding operation, which was completed in twenty-two hours by using only one half of the welding unit, the other half being used for the actual welding operation. It was noted on this particular shaft that the electromagnetic effect on the disturbance of the arc was negligible, which is not always the case, and so on this shaft it was therefore possible to heat and weld simultaneously. If one endeavoured to heat with the gas blowpipe and weld at the same time it would be most unpleasant and somewhat dangerous to the welder. This may result in an inferior weld, and to ensure a first-class weld this method is not to be recommended. Induction heating, besides giving an appreciable overall saving, gives the welding engineer a far greater control of heat distribution, the cooling can be arranged to suit any desired conditions, and this method is altogether cleaner, thus assisting in producing a weld of high quality.—*F. G. Rout, The Welder, Vol. 17, April/June 1948, pp. 43-44.*

Electric Propulsion of Double-ended Ferries

The British Thomson-Houston Co., Ltd., is supplying two electric propulsion equipments for conversion of the steam-driven double-ended ferries "Barrenjoey" and "Belgowlah", belonging to the Port Jackson and Manly Steam Ship Co., Ltd., Sydney, Australia. It is the first of these equipments that has just been tested, the tests giving most satisfactory results. Each of these vessels has a gross tonnage of 500 tons, an overall length of 210 feet, a designed speed of 16 knots, and passenger capacity of about 2,000 persons. There is a propeller and control bridge at each end. The electrical equipment includes four 320 kW. d.c. generators rated at 320 volts, 1,000 amps., each coupled to a 500 b.h.p. 600 r.p.m. English Electric oil engine. Each propeller is driven through a 790/158 r.p.m. reduction gear by two 615 h.p. motors, each rated 500 volts, 1,000 amps. The bridge controllers for these motors are interlocked in a manner similar to a tramcar, where the operator can only move the key from one controller after moving the hand lever to stop position. It is then taken to the controller at the other end of the vessel, and that controller unlocked for operation. The initial movement of the control lever energizes the electrical system, and under the control of an amplidyne exciter causes a current of 1,000 amps. to circulate through the main power circuit, comprising the armatures of one, two, three or all four of the 320 kW. generators, depending on the number in service, and the four propeller motor armatures. At the same time, a reduced value of excitation current taken from the 115 volt d.c. supply is applied to the propeller motors, the forward motor field windings taking a pre-set value of about 20 per cent of the after motors. During this period the engine governors are adjusted to hold the engine speeds at 350 rp.m. Under this condition both propellers begin to rotate in the required direction of rotation, the after propeller exerting the thrust which propels the vessel, the forward propeller merely turning at approximately zero thrust. A further movement of the controller steps up the propeller motor field strength in five stages to full value, the engine still being held at 350 r.p.m. by the governor setting for this speed. During this acceleration of the propellers the main circuit current is automatically held within a very close value of 1,000 amps.; the full power torque of the propeller motors, which is developed when the controller applies full power excitation to the propeller motors on the fifth power notch, very rapidly brings up the propeller speed to about 57 per cent full power value (approximately 78 r.p.m.) when four engines are in use. If the controller is allowed to remain on this notch with the engines running at 350 r.p.m. (i.e. 57 per cent of full power speed) a second amplidyne, which functions as a negative booster in the propeller motor excitation circuit, automatically comes into action and reduces the field strength of all the propeller motors, as they accelerate in speed so as to maintain the current value in the main power circuit at 1,000 amps. The next notch on the controller energizes a solenoid on the engine governors, and steps up the setting to 450 r.p.m. As the engines respond to this adjustment the second booster amplidyne automatically readjusts the propeller motor excitation current to a higher value, still keeping the main power circuit at 1,000 amps. as the engines accelerate up to 450 r.p.m. If the control lever is allowed to remain on this notch the propeller runs at approximately 142 r.p.m. The final controller notch energizes a second governor system, and steps the engine speed up to the full power value of 600 r.p.m and the aft propeller up to 158 r.p.m. Under this condition the field booster amplidyne operates at approximately zero voltage and the aft propeller motors run with full field excitation and with approximately 500 volts across each armature, the main power circuit still being maintained at 1,000 amps. —*The Journal of Commerce (Shipbuilding and Engineering Edition), No 37,580, 5th August 1948, p. 2.*

The Helux Lighting Plant for the M.S. "Rhein"

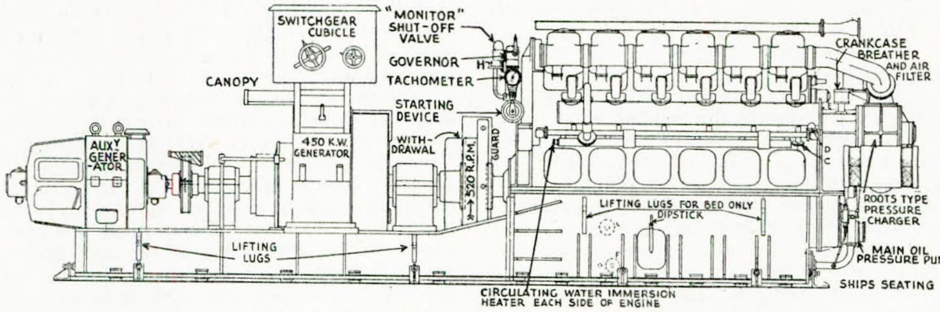
The Helux lighting plant recently supplied by Brown Boveri Co. for M.S. "Rhein" of the Lake of Lucerne Navigation Co. differs from all other plants previously supplied with respect to design and layout. The new regulation principle selected was necessitated by the relatively large system rating and the fact that even during the daytime there is a considerable demand for electrical energy. Further complications also arose from special operating conditions which necessitate very effective charging of the batteries while the vessel is under way. The higher voltage required for charging the batteries on M.S. "Rhein" is not obtained in the conventional manner by increasing the voltage generated by the Helux generators, but through an auxiliary motor-generator set arranged in series with the Helux generator. The characteristic of the auxiliary generator is such that the correct current required for rapid charging of the battery is obtained automatically. In addition, the auxiliary generator is counter-compounded by the system current which varies over a wide range so that the charging current decreases with increasing system current. When the power consumption is high, less charging current is fed into the batteries than with a small power consumption. In this way despite the rapid charge required it is possible to satisfy all conditions with a relatively small type of Helux generator. The plant consists of two Helux generators each rated at 21 kW., 110 volts, and one auxiliary generator set rated at 1·2 to 3·36 kW., 12-42 volts, one Leclanché nickel-cadmium battery with eighty-eight cells giving 400 ampere-hours at a 10-hour discharge rate, and the necessary switch gear. Due to the special operating and battery charging conditions provision had to be made for driving the Helux generators arbitrarily from either the starboard of port-side propeller shafts. A generator is therefore mounted on each propeller shaft and can be switched in from the bridge by contactors. After operation of these contactors the plant functions automatically. Governing and voltage regulation are effected by a Brown Boveri lighting regulator in conjunction with the special voltage characteristic of the auxiliary generator.—*Th. Geiger, The Brown Boveri Review, Vol. 34, October/November 1947, pp. 234-235.*

Nylon Hawser

The ocean going 1,200 h.p. Diesel electric tug "Margot Moran" has been furnished with an 8-inch nylon hawser more than a quarter of a mile in length. It is pointed out that this rope should compare favourably with eleven- or twelve-inch manila rope. The nylon rope is stated to have a 48 per cent elongation to its breaking point or a working elasticity of 26 per cent at half-load. To ensure stability in marine service the hawser was factory-conditioned by a special process said to represent the equivalent of months of use at sea.—*Marine Engineering and Shipping Review, Vol. 53, July 1948, p. 124.*

Mersey Dredger No. 26

Several new features are incorporated in the design and construction of the twin-screw Diesel-electric triple-grab hopper dredger "Mersey No. 26", the first of two dredgers for the Mersey Docks and Harbour Board, now nearing completion at the yard of Ferguson Bros., Ltd., at Port Glasgow. Built to comply with the requirements of Lloyd's 100 A.1. class, this vessel has the following leading particulars: length overall, 237 feet; breadth moulded, 40ft. 6in.; depth moulded, 17ft. 3in.; draught loaded, 14ft. 3in., hopper capacity, 1,350 tons. The vessel has a rounded plate stem and cruiser stern with a balanced rudder. A wide range of view for navigation and of the complete dredging and loading operation is afforded from the bridge, which is fitted so that the propellers can be controlled from that point. Three Priestman dredging cranes are fitted, one arranged to operate over the bows and one each over the port and starboard sides. These cranes operate to 70 feet dredging depth and have buckets of 70 cu. ft. capacity. Each crane discharges on to a stone grid fitted over the hopper. The eight hopper doors are controlled by a hydraulic ram capable of sustaining the whole load. The prime movers for the main Diesel-electric propulsion units of each dredger comprises three Paxman Mk. 12 RPL 12-cylinder V-type pressure charged engines. These engines have a 9½-inch bore with a 12-inch stroke, the 12-hour rating of each being 780 b.h.p. at 425 r.p.m., the three engines together developing 2,340 b.h.p. Each engine is built with a fabricated steel frame, the bedplate and crankcase being fabricated separately and jointed at crankshaft level. In addition to the engine, the bedplate carries both the 455-kW. generator and also the 62·5 kW. auxiliary generators. The fabricated steel frame has inspection doors in two tiers along the full extent of each side for access to the crankshaft. This design provides greater frame strength than the use of single opening of equivalent total depth. The pistons and connecting rods can be removed through these doors without disturbing the cylinder heads. A further point of interest in the design of these engines is the two types of connecting rods, those for one bank of cylinders being forked and carrying separate steel large-end bearings lined internally with anti-friction metal. These bearings operate on the crankpins and are turned externally to receive the "blade" rods for the corresponding cylinders in the opposite bank. The latter rods carry steel shells lined with anti-friction metal. The pressure charging equipment comprises Roots-type blowers, gear driven from the crankshaft, delivering air under pressure to the inlet manifolds. the positive displacement blower directly driven by the engines, obviates time lag and so ensures immediate response to any increase in load. Starting is by compressed air equipment. The main electric propulsion machinery is by the Metropolitan Vickers Electrical Co., Ltd. The three main generators which are installed have two-pedestal bearings of marine type, ring oiled, fitted with overhung auxiliary generators, each pair of generators being driven by one of the three Paxman 12 RPL engines. Two main propulsion motors in tandem. fitted with thrust bearing and speed indicating generators, are fitted and two metadyne exciter sets for main generators with driving motor are provided.—*The Shipping World, Vol. 119, 28th July 1948, pp. 77-78.*



Arrangement of Paxman 12 RPL pressure-charged engine and generators

Salt Water Corrosion of Ships

In the discussion of this paper, an abstract of which was given on pp. 68-69 of Engineering Abstracts, July 1948, Professor W. Beck points out that stray current troubles on ships can be expected in the case of a bipolar as well as in a unipolar installation of the electrical supply system. It is practically impossible to keep the insulation (e.g., of the enormous number of negative return cables) constantly in perfect condition. But local defects in the insulation may lead to the formation of dangerous potential differences on the body of the ship, and consequently, on any machinery. etc., in contact with it. For example, with a surface condenser or a pumping plant, the probability of electrolytic attack of the metal is very high. In this connexion it must be taken into consideration that the consumption of electrical energy on shipboard is enormous. On a well-known ocean steamer of medium size, the maximum consumption of electrical current approximated to 20,000 amps. If the electrical supply network is unipolar, the whole body of the ship represents a part of the return feeding system. Also, it can be expected that a number of the machine installations will be connected in parallel to the ship body. A transfer of current to an electrolyte solution may lead to anodic corrosion, and hence to considerable damage to the hull. In many cases it was observed that pin heads and rivet shanks were attacked by stray currents on ships with a unipolar electrical installation. In some cases electrolytic corrosion could be reduced by connecting the endangered construction to the negative bus bar of the d.c. generator. In special cases cathodic protection gave very good results. When electrical welding is utilized in ship building, it is recommendable to avoid negative ground connexions but to connect the parts to be welded directly to the negative pole of the welding dynamo.—*Corrosion, Vol. 4, August 1948, pp. 421-422.*

Preparation of Metal Surfaces for Organic Coating

This article reviews the various methods in use for the cleaning of metal surfaces prior to painting. The author points out that the practice of wiping the surface of the metal with rags, wetted with solvents leaves much to be desired. Salts, alkalis, acids, chalk marks, etc., are insoluble in organic solvents and cannot be removed by such expedients. The most satisfactory method is the vapour degreasing process in which the metal is passed through hot solvent vapours which condense on the cooler metal and wash the surface. Sand blasting will remove heavy oxide and scale from the metal surface, but coating operations should follow closely because the raw metal will rust quickly. Water solutions of alkalis are available for almost every type of metal cleaning, from heavy greases to light oils. Metal cleaned in alkaline cleaning solutions must afterwards be thoroughly rinsed in clean water. A rinsing procedure that fails to remove all residual alkali will give unsatisfactory results since all organic finishes are readily attacked by alkalis. Traces of alkali on the metal surface in most cases are even more detrimental to organic finishes than traces of oil or grease. The more satisfactory alkaline cleaning systems include an acid or neutralizing rinse following the water rinse. Dichromates or dilute chromic acid may be used for this purpose and are permitted to dry on the metal surface. When properly used, these rinses will prolong the life of the finish considerably. Phosphate treatment of the metal surface prior to the application of the organic coating offers important advantages, for the reason that it retards under-film corrosion. All organic coatings are somewhat porous and will permit a little moisture to penetrate to the metal surface. If corrosion then takes place, the organic coating will be ruptured mechanically because of the increasing volume of corrosion products. Or it may be damaged by chemical reactions between the elements in the coating and the products of corrosion. Phosphate films are decidedly effective in preventing corrosion creepage from small scratches and punctures in the finish. Many investigations have shown that the corrodibility of a metal surface is a prime factor in the life of organic coatings.—*G. R. Hoover, Corrosion, Vol. 4, August 1948, pp. 399-411.*

Cathodic Protection of Steel in Sea Water with Magnesium Anodes

The programme of research covered by the paper was designed to determine the feasibility of the use of magnesium anodes for the cathodic protection of steel in sea water. Its principal objectives were the selection of the most suitable magnesium alloy for this service with respect to solution potential, freedom from polarization, and current efficiency, together with a study of the minimum current requirements of the steel cathode under varying conditions of exposure. The actual tests consisted in studying the performance of a group of five magnesium alloys in sea water at the corrosion testing station at Kure Beach, North Carolina. The cathodes used in these tests were 12 × 12 × $\frac{3}{8}$-inch "killed" steel plates which were attached to channel iron racks. The plates were insulated from the supporting racks by bakelite washers and sleeves. The racks were suspended at a depth approximately 3-feet below mean low tide. The test plates were coupled to magnesium anodes through a current measuring shunt placed in series with a manually operated variable resistance, which was used to regulate the current flow to the desired value. Summing up, the author reports that magnesium anodes perform satisfactorily when used for the cathodic protection of steel in sea water. Solution potentials of −1·5 volts (versus saturated calomel electrode) are observed; these are practically independent of time and the magnitude of the current flow. Recoveries of 500 to 600 ampere-hours per pound of metal consumed are realized. Sand-blased steel is shown to require in excess of 10 milli-amp. per sq. ft. for initial protection, although protection may be eventually achieved by a fixed current density of approximately 6 milli-amp. per sq. ft. Rusted steel can be protected at a slightly lower current density. Protection can be effected at current densities as low as 3 milli-amp. per sq. ft. by the application of a high initial current (50 milli-amp. per sq. ft. to achieve immediate polarization. The high initial current density stabilizes the current requirements with respect to time. This permits the use of a considerably smaller permanent anode installation with a saving in current of approximately 40 per cent.—*R. A. Humble, Corrosion, Vol. 4, July 1948, pp. 358-370.*

Elliott Spray-tray Heater

Spray type de-aerating heaters have been developed mostly for use in marine applications where the roll and pitch of the vessel made it impractical to use tray type construction. Large numbers of spray type units were used by the American Navy and Maritime Commission during the war on ships ranging from battleships to cargo vessels. The Elliott spray-tray de-aerating feedwater heater incorporates a spray pipe and vent hood of stainless steel so arranged as to take care of the venting. The spray pipe sprays water into an atmosphere of steam for heating. The water is then collected and distributed over the de-aerating trays of stainless steel. The steam enters the shell and is directed through the de-aerating trays, and subsequently to the heating section. The coldest point in the unit is where the water leaves the spray pipe, the flow of steam carrying the non-condensable gases to this point. The continuous flow pushes the non-condensable gases into the vent hood, from which they are vented from the system. The elimination of the vent condenser reduces the headroom requirements by 2 to 3 feet, depending upon the size of the unit. Stainless steel is used for all baffling, the vent collecting hood, inner head, etc.—*E. B. Kuhn, Powerfax, Vol. 26, Summer 1948, pp. 20-23.*

Calculation of Torsional Vibration Stresses in Large Power Plants

The calculation of the resonant stresses of crankshafts has not been sufficiently developed because of the difficulties in the determination of the damping factor and the dynamic torque. Moreover, the variation of dynamic torque under transient conditions (in running through criticals, stopping, or starting) also requires further investigation. For instance, in the case of a marine engine changing its running speed during manœuvring, the value of the harmonic coefficient of the vibration torque will vary as a function of the mean indicated pressure, which also depends on the propeller torque and running speed. Similarly, the dynamic stresses occurring at stalling speeds can be estimated by taking the harmonic coefficients for zero i.m.e.p. Starting conditions, however, are apparently entirely different from the normal running conditions, and a correct prediction of the resonant stresses during starting would require determining the variation of the harmonic coefficients during the first few minutes after starting. Unfortunately, results of tests of this type have not so far been published. The variations of the harmonics during the

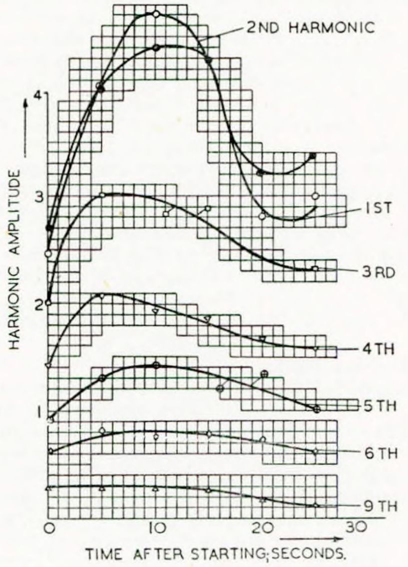


FIG. 1.—*Calculation of torsional vibration stresses in large power plants*

initial phase are shown in Fig. 1 as found by the author. The damping coefficient is determined from a comparison of the actual dynamic stress and the calculated stress of an engine, based on harmonic coefficients taken from a normal cylinder diagram. The damping torque is generally calculated using the following assumptions: (1) the forced vibrations at resonance are similar in shape to the free harmonic vibrations of the elastic system; (2) one type of damping is predominant, so that all other types of losses of oscillatory energy can be neglected. There is little difference of opinion regarding the values to be ascribed to propeller damping. Engine damping, however, is assumed either to vary linearly with the angular velocity of the vibration, or to be a function of the energy dissipation due to shaft hysteresis. For instance, according to the relation proposed by Professor Luntz, the damping coefficient would be proportional to the 2·17 power of the velocity.—*A. F. Gogin, The Engineers' Digest, Vol. 9, July 1948, pp. 227-229. From Symposium on the Dynamic Strength of Machine Parts, published by the Institute of Practical Mechanical Engineering and the All-Soviet Society of Engineering Sciences of the Mechanical Industry, under the patronage of the Academy of Sciences of the U.S.S.R., Moscow and Leningrad 1946, pp. 44-51.*

The Use of Thermocouples in High-velocity Gas Streams

The general purpose of this paper is to present background information which may be useful to those confronted with the problem of determining with a practicable minimum of error the temperature of a stream of hot gases such as may be encountered in a modern steam or gas turbine. Since the thermocouple is at present the most satisfactory and widely used instrument for this application, the discussion is limited to such temperature-sensing instruments. This report reviews the methods which may be used and the precautions which must be observed in obtaining precise and reliable gas temperatures, and includes general instructions for choosing the thermo-elements, making the measuring junction, terminals, leads reference junction and reference-junction bath, for selecting the measuring instrument, and for calibrating the wire and applying the calibration data. The individual effects of thermal radiation and conduction, of the transfer of heat to the measuring junction by convection, and of gas velocity are discussed by reference to equations and charts. By means of specific examples, some of these effects are related to the size, shape and material of the thermocouple or thermocouple well. It is shown that conduction along solid parts is of little consequence in most practical installations; that radiation is also of little importance in steam systems with well-lagged pipes, while the velocity effect becomes increasingly important as the development of power plants progresses; and that radiation is the most serious problem in existing gas turbines and jet engines. Since heat is transmitted to a measuring junction immersed in a stream of flowing gas by direct impact, it has been found desirable to speak of a static and of a total or dynamic temperature of the gas. The difference is a function only of the velocity and heat capacity of the gas, and is seldom of practical significance at velocities below 300ft. per sec. Its magnitude increases as the square of the velocity, so that it assumes considerable importance at flow rates now prevailing in some power plants. It is pointed out that the static temperature is not subject to direct measurement, that the total temperature can be measured with an instrument of a type which is not suitable for installation in many power plants, and that it is possible to determine experimentally the correction which must be applied to convert the indicated temperature to either static or total temperature. Such correction involves the use of a recovery factor which can be measured for the particular junction or thermocouple well being used in the gas stream. The recovery factors of various junctions and thermocouple wells are being measured in air at the National Bureau of Standards and in steam at the Naval Boiler and Turbine Laboratory, Philadelphia, under sponsorship of the Bureau of Ships.—*E. F. Flock and A. I. Dahl, Journal of the American Society of Naval Engineers, Vol. 60, No. 2, May 1948, pp. 139-162.*

Silver for Gas Turbine Device

Work sponsored by the Bureau of Ships, Navy Department, on a new device for gas turbines has been reported by Andrew I. Dahl and Ernest F. Flock, physicists of the National Bureau of Standards, Washington, D.C., where the development and tests were carried out. This is a small radiation shield of silver, gold or platinum, for use in measuring the temperature of streams of exhaust gas. In gas turbines, now being developed as power plants for land, sea and air use, problems have arisen in the use of thermocouples for indicating gas temperatures up to about 2,000 deg. F. In gas turbines the gases are normally much hotter than the surrounding walls, so that radiation from a thermocouple in the gas stream to the walls may cause error in observed values of gas temperatures. Effective radiation shielding of the measuring junction can be accomplished by pressing a small, tubular shield of silver, gold or platinum directly on an oxidized junction of base-metal.—*Motorship (New York), Vol. 33, June 1948, p. 51.*

Heat Transfer to Water Boiling under Pressure

The film coefficient of heat transfer from a hot metal surface to a boiling liquid was estimated from experiments with an electrically heated wire submerged in the liquid. The heat-flow rate was determined on the basis of the consumption of electric power. The temperature drop through the film was taken as the difference between the surface temperature of the wire and the mean temperature of the liquid. The surface temperature of the wire was estimated by means of a small thermocouple. The graphic representation of the film coefficient as a function of the temperature drop through the film is called the "boiling curve". With increasing temperature drop the film coefficient was found to rise first to a maximum, and then to fall to a minimum, from which it rose steadily as the temperature drop continued to increase. When water was boiled at atmospheric pressure, different heated metals gave different boiling curves. At atmospheric pressure and a temperature drop of 10 deg. F. the heat transfer coefficient was 100 B.Th.U. per hr. per sq. ft. per deg. F. for chromel C, 500 for tungsten, 3,300 for chromel A, and 20,000 for nickel. At different elevated pressures, the same metal gave different numerical values for the boiling curve. For chromel C and a temperature drop of 10 deg. F., the heat transfer coefficient was 1,200 B.Th.U. per hr. per sq. ft. per deg. F. for 50lb. per sq. in. g., 8,000 for 75lb. per sq. in. g., and 90,000 for 100lb. per sq. in. g. It was found that the mechanism of the boiling process is different for different parts of the boiling curve, and the mechanism of the boiling process permits the same heat-transfer rate with three different values of temperature drop For chromel C at atmospheric pressure a heat transfer rate of 100,000 B.Th.U. per hr. per sq. ft. per deg. F. was obtained with temperature drop values of 30 deg. F., 430 deg. F. and 1,650 deg. F., the corresponding values of the heat transfer coefficient being 3,330, 232, and 60·5 B.Th.U. per hr. per sq. ft. per deg. F. The authors believe that the presence of such boiling conditions may explain certain industrial operating phenomena.—*E. A Farber and R. L. Scorah, Transactions of The American Society of Mechanical Engineers, Vol. 70, May 1948, pp. 369-384.*

Turbine-electric Propulsion

Alternating-current electric drive provides favourable conditions for high efficiency in steam-turbine ship-propulsion. The modern trend, which is toward higher speed direct-connected propulsion turbine generators, is such as to decrease both generator and turbine weight. This is being accomplished by better design and materials, and still permits the critical speed of the set to be above the maximum operating speed. These high-speed sets also result in improved turbine performance, the turbine being inherently a high-speed machine. Speeds of around 5,400 r.p.m. corresponding to 90 cycles for a 2-pole generator are the rule rather than the exception. It appears, however, that an upper limit is being approached, except in very large vessels, due to the large number of motor poles and consequently large motor diameter, required to obtain the low propeller revolutions per minute. The torque requirements of the propulsion motor during a full-power, full-speed reversal are the most exacting, and usually fix the design for both propulsion motor and generator. The motor rotor is provided with a rugged squirrel-cage winding consisting of alloy bars imbedded in the pole faces, the bars being brazed to end rings with bolted joints between poles. The design of the pole face winding is of vital importance, and it must be adequate to handle full-speed reversal which is the worst condition of operation. Power input to the pole face winding is proportional to torque and the difference in speed between the motor rotor and synchronous speed (slip). This power, which must be dissipated as heat, comes from the propeller acting as a water turbine until reversed and also from the generator. The total heat dissipated by the pole face windings can be held to a minimum by designing the motor to have a substantial margin of torque over the propeller requirements, so that it can reverse the propeller quickly. Since total heat is the product of power and time, if the time is short, the heating is less, even though higher torque means a higher power input. It is extremely bad design, if the motor torque is less than the torque required by the propeller at any speed during the reversal, so that the motor "hangs up" and must wait for the ship to slow down before it can reverse the propeller. In the case of large high-speed vessels it may not prove feasible to design the motor pole face winding to produce sufficient torque and absorb the losses incident to full-speed ship reversal. It will then be necessary to resort to dynamic braking, which is accomplished by arranging the control so that a three-phase external resistor can be connected to the motor terminals, and at the same time energize the motor field with normal field current. The motor can then be brought to a stop and reverse power applied in a few seconds.—*H. C. Coleman, Marine Engineering and Shipping Review, Vol. 53, August 1948, p. 71-75.*

Flywheels for Liberty Ships

Frequent failures on Liberty type vessels in their propelling system have created intensive study of their design and practical operation to determine the causes of failures and the necessary corrective measures. The reasons for these failures centre around the vibratory torsional stresses set up at critical revolutions, especially if the main engine is operated at or near maximum designed speed for a sufficient period of time. The continuation of shafting troubles has risen to such proportions that the American Bureau of Shipping instructed their surveyors to reduce their "tailshaft-drawing due" dates from every three years to a maximum of two years for the Liberty type vessel. The most prevalent appearance of this failure is a fracture in the large end of the taper in way of the keyway of the tailshaft. To discover this fracture, the tailshaft must be drawn and submitted to a magnetic particle (Magnaflux) examination, as normal inspection methods are not sufficiently positive. Recent tailshaft examinations of the following Liberty ships: S.S. *Samuel Colt*, S.S. *John Goode*, and S.S. *Despina*, in the yard of the Todd Shipyards Corporation, disclosed this same condition. New tailshafts in each case were installed. The American Bureau of Shipping recommended to the owners to limit their speed to 66 r.p.m. for safe operating conditions although the designed speed is 76 r.p.m. Various tests were conducted and four modifications to overcome these failures were recommended by the American Bureau of Shipping, one of which is to install a flywheel aft of the main engine. This lowers the natural vibratory frequency of the system sufficiently to permit the operation of the engine at the maximum designed speed of 76 r.p.m. In anticipation of the action taken by the classification society in order to maintain the designed speed of the Liberty ships, Todd Shipyards Corporation authorised Gibbs and Cox, naval architects, New York, to make a complete study and prepare plans for the approval of the American Bureau of Shipping for these various recommendations. The first recommendation to be used was the installation of the flywheel installed on the main engine line shaft at the coupling between No. 6 main bearing and the thrust bearing. The size and weight, determined by calculations from torsio-graph curves was subsequently approved by the American Bureau and the

U.S. Coast Guard. A flywheel was installed on the *John Goode,* using drawings furnished by Gibbs and Cox which complied with regulations and inspection by the American Bureau of Shipping and the U.S. Coast Guard. The important parts being castings, patterns were made for the flywheel, worm wheel gear, and the turning gear pedestal. The rough weight of these castings totalled 19,930lb., including ⅛-inch material allowance for finish machining. The finished weight of the complete flywheel (wheel and gear) was 15,005lb. While the flywheel and associated parts were being machined in the shop, the existing turning gear, shaft coupling bolts, bearing cap, piping and gratings were removed. The completed flywheel was disassembled and lowered into place on the ship in halves. After rebolting and aligning with the coupling bolt holes, the wheel was bored for coupling bolts. With the wheel bolted to the coupling, installation of the worm wheel gear followed. The bearing cap was refitted and the turning engine was installed in its new position. After aligning the worm gear of the turning engine with the worm wheel, the pedestal foundation was drilled for fitted bolts. With the foundation secured, all alignments were checked by rotating the flywheel. Associated equipment such as piping, gratings and guards were reinstalled. Instruments to record on paper the torsional vibration were installed, and records taken during sea trials. The engine was operated at 76 r.p.m. and there was no evidence of excessive torsional vibration. There was no evidence of excessive heat in the main bearing due to the increased bearing pressure from the added weight of the flywheel. Final information regarding these tests is being formulated by the American Bureau of Shipping and the U.S. Navy, and will be available after all calculations are completed.—*Shipbuilding and Shipping Record, Vol. 72, 9th September 1948, pp. 301-302.*

Producer Gas Operated River Boats

According to German experience the four-stroke cycle producer gas engines with spark ignition as used in river boats cannot be successfully operated at mean effective pressures exceeding 4 kg. per sq. cm. Compared with a gas oil operated four-stroke Diesel, the equivalent output of the producer gas operated engines is therefore some 26 per cent less. Another disadvantage of the producer gas engine is that its fuel supply per working cycle is not metered by the fuel pump as is the case in the ordinary diesel, but as the gaseous fuel is drawn into the cylinder by suction, the fuel rate to a certain degree is affected by the engine speed. Producer gas operated engines cannot therefore be coupled direct to the propeller shaft, but a reversing gear and coupling must be employed so as to ensure manœuvrability. All these disadvantages are eliminated in producer gas engines fitted with ignition-oil injection which permits the employment of compression ratios as high as 11 to 12. Although mean effective pressures of 5·4 have been reached on the test bench with this type of producer gas engine, lower values of 4·6 to 5·0 kg. per sq. cm. are used in ship plant practice according to calorific value and hydrogen content of the producer gas used. An additional advantage of the ignition oil injection system is that starting and manœuvring can be carried out in straight Diesel operation. The amount of ignition oil required amounts to some 5 per cent of the fuel consumption in full Diesel operation. The design of producer gas plants has not undergone any radical changes since the first producer gas plant was introduced into shipboard use in 1935. Producer gas engine maintenance is higher than in Diesel operation owing to the greater cylinder wear. In order to preclude corrosion by the sulphur contents of the producer gas, corrosion resistant materials should be used; also the dew point of the gas should not be reached. It is for this reason that the employment of recirculating cooling water circuits is preferable. Pressure charging of the producer gas engine is possible, and it is suggested that the induction of the gas should take place first and be followed by introduction of the air charge. The induction of the producer gas into the cylinder by aspiration could therefore be retained in the pressure charged engine, the blower dealing solely with the air charge. This mode of operation should make it possible to operate with producer gas of moderately elevated temperature, as, for instance, 50 deg. C. Another possible mode of operation would be to introduce the air first and then charge the gas after termination of the scavenging period. This procedure appears to be particularly suitable in the case of two-stroke cycle engines; in fact, it has been found that by this method m.e.p. values comparable with those obtained in Diesel operation can be reached. In the case of gas turbine propulsion plant the employment of producer gas as fuel would eliminate the wear of the turbine blading by the ash content of solid fuel.—*K. Schmidt, Zeitschrift des Vereines Deutscher Ingenieure, Vol. 90, New Series, May 1948, pp. 151-154.*

Fiat-engined Motorship *Bergsund*

The single-screw motorship *Bergsund* is the first of six similar vessels building at the yard of the Furness Shipbuilding Co., Ltd., Haverton Hill, for Rederi A/B SVEA, of Stockholm, which vessels are to be equipped with Italian-built main engines. The *Bergsund* is of the single deck type with shelter deck, promenade and boat decks amidships, and top-gallant forecastle. The leading dimensions are: length overall, 284ft.; length between perpendiculars, 255ft.; breadth moulded, 39ft.; depth to shelter deck, 22ft. 11in. The main propelling machinery was installed by Richardsons, Westgarth and Co., Ltd., Hartlepool, and it consists of a Fiat six-cylinder Diesel engine giving a service power of 1,350 b.h.p. at 185 r.p.m. The cylinders have a bore of 450 mm. and a stroke of 740 mm. The engines for all six vessels of the series were ordered from the Ansaldo engine works at Genoa, and a test bed illustration of one of them accompanies the original text. Essentially the design conforms to Fiat standard practice, bedplate, main framing, etc., being of cast iron; tension through bolts are used. The engine is of the crosshead type and operates on the single-acting principle. A single crank-driven scavenging air pump is located at the forward end, together with certain engine-driven pumps. The crankshafts of the fuel pumps are gear-driven from the after end of the crankshaft. Pistons are oil cooled and jackets and covers fresh-water cooled; the fuel valves are water cooled. One of the engines intended for a later ship in the series was partly stripped after having completed its test-bed trials, and all parts were found to be in good condition, although the trials had been run on heavy low-grade fuel oil of 0·900 specific gravity at 15 deg. C.; the gross calorific value was about 10,600 cal. per kg. Several reversing and starting tests were carried out at the conclusion of the main tests and the engine also ran regularly (on heavy fuel oil, of course) for several minutes at 54 r.p.m. The oil was heated in the service tank to 23 deg. C. before use. The specific fuel consumption at normal rated output and speed was 180 gr. per b.h.p.-hr.; the exhaust gas temperature was around 285 deg. C. at this load. The full load test was of five hours duration and an overload output of 1,600 b.h.p. at 195 r.p.m. was maintained for three hours; for two hours 1,950 b.h.p. at 210 r.p.m. was carried.—*The Marine Engineer, Vol. 71, September 1948, pp. 408-409, 412.*

Water-cooled Manifolds

Data relating to the effect of water-cooled manifolds have become available as a result of collaboration between Dr. Alfred J. Büchi and the Superior Engine Division of the National Supply Corporation, in the U.S.A. The investigations were conducted on a four-stroke turbo-pressure-charged engine, and further interest is added in that the standard pressure-charged model with uncooled exhaust makes use of the Helix-haust manifold with asbestos lagging. General constructional details of the totally inclosed 14¼×20 inch engine used in the investigations embody a construction that is "en bloc", but with separate bedplate carrying the bearings. Through tie-bolts extend from the bedplate to the tops of the cylinder heads. Main bearings of the precision type have interchangeable top and bottom halves, and the shells are held to the bedplates by Meehanite top caps have four studs each. A similar type of semi-steel material is used for the very long oil-cooled pistons, the crowns of which have a simple dishing to form the open combustion chambers. The one-piece crankshaft is balanced by prolongations on each web; an extra bearing is provided at the flywheel end. The I-section connecting rods have four-bolt big ends. Two inlet and two exhaust valves per cylinder are fitted in cages, and are actuated by a chain-driven camshaft located near the top of the engine. An interesting feature is the shape of the water jackets, which gives a form of syphon action at the top portion of the liners. An individual Bendix-Scintilla fuel injection pump for each cylinder is fitted to deal with the fuel oil injection and these are operated from the camshaft. The investigations were undertaken on an eight-cylinder "Superior" engine set to give a nominal top output of 1,160 b.h.p. at 325 r.p.m., and working up to break mean effective pressures as high as 150lb. per sq. in. The article is accompanied by a graph which gives the fuel consumptions, exhaust temperatures, turbo-blower speeds, and gas and air pressures with cooled and uncooled manifolding. Actually the effects are not very pronounced. Specific fuel consumption and exhaust gas pressure before the turbine are so closely the same in each case as to be within the limits of experimental errors. Only in exhaust gas temperature before the turbine does the difference between the two increase markedly with increasingly b.m.e.p., for with turbo-blower speed and charging air pressure the differences, though existing, are more nominal; yet they do show that equal power can be obtained with lower exhaust temperature at the turbine, lower pressure-charger speed, and reduced charging pressure by using a water-cooled manifold.—*The Marine Engineer, Vol. 71, September 1948, pp. 415-416.*

Diesel Engine Crankcase Explosions

Referring to the recent enquiry into the explosion on board the

Reina del Pacifico, this article recalls that more than a year ago the problem of crankcase explosions was discussed at a meeting between representatives of the American Bureau of Shipping with chief engineers of seventeen of the leading American Diesel engine builders. The exhaustive discussions held led to certain recommendations being made to the American Bureau of Shipping which were adopted almost exactly as proposed. The following were among the recommendations made:—

(1) The crankcase should not be ventilated by a blast of air.
(2) The crankcase, if hot, should not be opened until at least 10 minutes after the engine has been shut down.
(3) Explosion relief valves should be installed on all engines having cylinders larger than 8-inch diameter.
(4) The explosion relief valves should be of the return-seating type and should relieve pressure readily and close quickly in order to prevent an inrush of air.
(5) The relief valves should have a free area of about 1 sq. in. per 2 cu. ft. of crankcase volume.
(6) The relief valves should be located at or near the ends of the crankcase.
(7) Natural ventilation through breathers on enclosed crankcases is approved.

It was the view of the majority of the chief engineers of the Diesel engine manufacturers represented at the meeting that forced ventilation of the crankcase should not be adopted, and generally the opinion was expressed that a natural breather with an absolute minimum possibility of air entry into the crankcase was necessary in some cases, and it was, therefore, agreed to permit a maximum of 1-inch water suction. This was, however, not a conclusion agreed by all. Engine crankcases invariably contain oil vapour which, when finely divided, can be an explosive mixture. This mixture is normally over-rich and not easily ignitable. Many engineers in America have reported experiencing occasional puffs of smoke from the engine breather, indicating that there may have been at times very light explosions which were of no consequence because of insufficient air remaining in the crankcase. Certain American engine builders have carried out research on the subject and have demonstrated, it is thought conclusively, that blow-out doors of any sort are dangerous. Crankcase explosions usually consist of a primary explosion which is of little consequence, and then a second explosion, due to an inrush of air, if there is any opening, as a result of the first. It was recommended that in order for it to be effective, an explosion relief valve must be of the non-return type. In this way the excessive pressure can be relieved without an inrush of air. The non-return valves must be light, and light-weight strip valves are suitable. These non-return valves are likely to leak oil. A gasket may be fitted over the outside, and this gasket is blown in the event of crankcase explosion and must then be replaced in order to prevent lubricating-oil leakage. During the course of experiments it was discovered that pressures of 60 or even 80lb. per sq. in. could be reached in a crankcase explosion. By providing a non-return valve of the proper size it was found that this pressure never exceeded 15lb. per sq. in. The reason for the recommendation that the crankcase doors should not be removed for 10 minutes after stopping the engine was that many instances were cited in which a crankcase explosion occurred after the engine had been shut down and after the operator had started to remove a crank door. This was believed to be caused by the inrush of fresh air diluting what was otherwise an over-rich mixture. One instance was given of an explosion, blowing out a crankcase door into a second engine alongside, breaking its crankcase covers and causing an explosion in the crankcase of this engine.—*The Motor Ship, Vol. 29, September 1948, pp. 225.*

Motorship Control Station Design and Layout

This article describes the salient features of the standardized control station developed by Sulzer Bros., which is used for modern heavy-oil engines over 2,000 b.h.p. regardless of the type of cylinders. The handling of a modern marine Diesel engine with direct airless injection can be done in principle with three controls:—

(1) The starting lever, with which the compressed air starting mechanism is actuated and the engine put into service.
(2) A control for regulating the amount of fuel delivered by the fuel pumps, and thus the engine speed.
(3) The reversing lever, with which, in direct-reversible engines, the direction of rotation is changed and with it the direction of the ship. In all Sulzer marine engines the reversing lever is combined with the starting lever, so that for the whole operation of the engine only two controls are required; the combined starting and reversing lever and the fuel regulating lever.

Apart from manipulating these controls, the operating engineer must simultaneously be able to supervise the working of the engine, which he can do with the help of the following instruments:—(a) the tachometer, which is normally combined with a stroke counter giving the total number of revolutions at any time; (b) the direction indicator, which shows the direction of rotation of the engine and consequently also of the ship's screws; (c) the pressure gauges for the starting air, scavenging air, cooling water, cooling oil and lubricant; (d) the thermometers for the exhaust gases, cooling water, cooling oil and lubricant; and (e) the regulating equipment for adjusting the cooling and lubricating oil pressures. In all large ships the orders from the navigating bridge are transmitted to the engine room through the ship's telegraph, which in recent years has been built on to the engine by Sulzer Bros., and has been used at the same time for locking the starting control so as to prevent false manœuvres. In the illustration of the controls and their casing the fuel lever is shown in the operator's left hand and the combined starting and reversing lever is in his right; the engine has been put into the astern position and the revolutions are in process of rising.

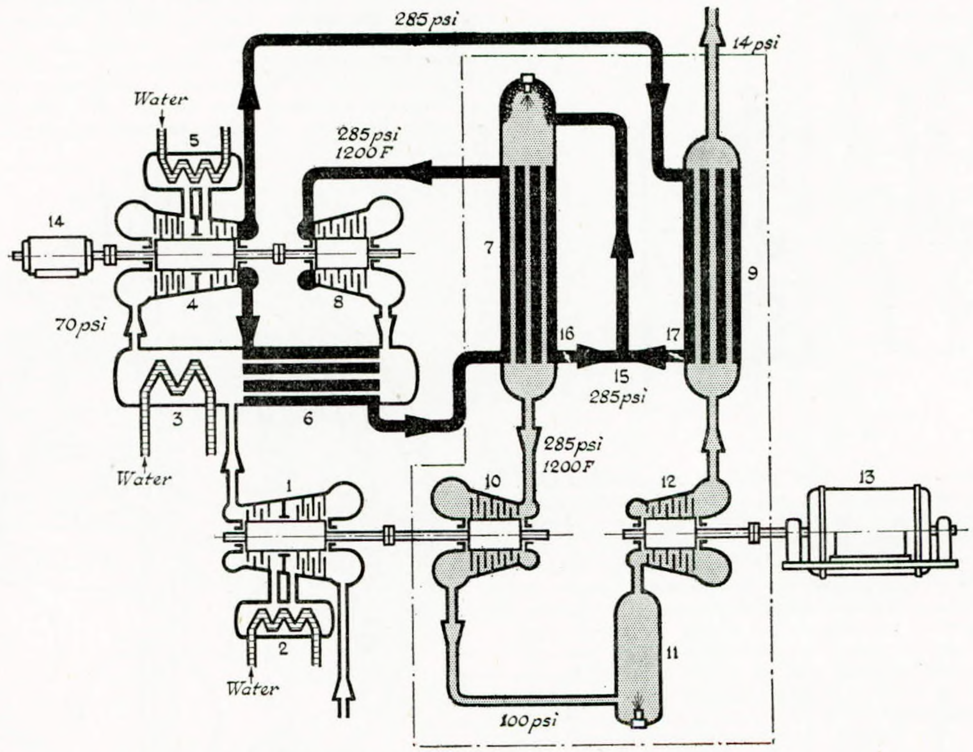
Lever controls of a modern Sulzer engine

Immediately above the direction indicator is the tachometer with built-in stroke counter shown just below the pointer. The direction indicator is housed in the casing. Above the control casing is seen part of the telegraph, the reply lever of which is used to lock the engine starting lever and thus prevent false manœuvres, as explained. The fuel lever (left) which is equipped with an appliance to permit of fine regulation, acts on the suction valves of the fuel pumps. These valves are kept open for a longer or shorter time after the beginning of the delivery stroke, according to the required engine output, so that a larger or smaller quantity of the fuel drawn in by the pump plunger flows back into the suction pipe while the rest is supplied to the cylinders. The starting and reversing lever on the right side of the control casing has its "Stop" position in the middle. The fuel pumps are then cut out through the raising of the suction valves, while the starting-air control valves are simultaneously lifted from the starting cams by spring pressure.—*The Marine Engineer, Vol. 71, August 1948, pp. 361-366.*

The Sulzer High-pressure Gas Turbine

In order to achieve a plant combining relatively small size and low weight with a high overall economic efficiency, the Sulzer gas turbine is built for high pressures. In the design shown in the accompanying illustration in diagrammatic form, the maximum pressure attained is 285lb. per sq. in. and the temperature 1,200 deg. F.

The position at which these values arise are shown in the diagram. The cycle upon which the Sulzer gas turbine is based may be described as being of the recirculation type, with a relatively small intake of atmospheric air and exhaust-gas discharge as compared with an open-cycle machine. In the evolution of this Sulzer special design here referred to, one of the main objectives has been the reduction of the volume of gas to be handled at low pressure, whilst the water requirements for cooling is less than one-quarter of the volume needed by a steam turbine of like power. The diagram shown refers to the particular arrangement adopted in a 7,500 b.h.p. marine set which has been seen partially erected; after full test-bed trials the plant may be installed in a ship for service trials. The following is a description of the Sulzer high-pressure cycle; numerical references relate to the diagram. A low-pressure (or make-up) compressor (1) takes in air from the atmosphere and compresses it in two axial machines arranged in series (with an intercooler (2) between them) to some 70lb. per sq. in. (5 kg. per sq. cm.). The air then passes through the cooler (3), which also serves as the return cooler in the air circuit. Next it goes to the high-pressure air compressor (4), which also consists of two axial units and an intercooler (5). The work done by this compressor provides air at about 285lb. per sq. in. (20 kg. per sq. cm.). The high-pressure air discharged from the compressor (4) now divides, one part of the air flowing through and being heated in the heat exchanger (6), and going thence into the tube stack of the air heater (7), where it is raised to the maximum temperature of the cycle, namely, 1,200 deg. F., and is still at approximately 285lb. per sq. in. The air thus heated passes to the high-pressure air turbine (8), which drives the previously mentioned high-pressure compressor (4). In passing through this turbine, the air is expanded down to about 70lb. per sq. in. (5 kg. per sq. cm.). Exhaust air from the turbine (8) then goes into the heat exchanger (6) and gives up most of its heat to the compressed air going from the high-pressure compressor into the exchanger (7). The expanded air at a much lower temperature then mixes with the fresh air being delivered by the make-up compressor (1), is cooled in the cooler (2) to 70 to 80 deg. F. (20-25 deg. C.), depending upon the temperature of the cooling water available, and finally recommences work in the air circuit. Dealing with the other portion of compressed air at 285lb. per sq. in. leaving the high-pressure compressor (4), it flows to the heat exchanger (9) and derives therefrom further useful heat. After this heating process the air goes to the main combustion chamber with its air heater (7). Some 50 per cent of the heat value of the oil fuel burnt in the heater is transmitted through the tubes, whilst the remainder is carried on to the high-pressure turbine and beyond. The gas leaves the heater at some 285lb. per sq. in. and 1,200 deg. F., passing to the high-pressure gas turbine (10) which drives the low-pressure or make-up compressor (1). Gases leave the high-pressure machine at about 100lb. per sq. in., pass to the secondary combustion chamber (11), and are therein reheated to a temperature suitable to the blades of the low-pressure (or work) gas turbine (12). After work therein, the expanded gas at a little above atmospheric pressure passes through the regenerator (9) and away to atmosphere. The bulk of gas thus discharged is, of course, far smaller than in the open-cycle machine of the same power rating. Both air circuits are connected by a pipe (15) in which are the valves (16 and 17); by a suitable adjustment of these valves it is thought possible to control air flow from the heat exchangers (6 and 9) to the combustion chamber (7), and thus obtain the best thermal efficiency under all conditions. Air is delivered to turbines (8 and 10) in the approximate ratio of 55 per cent to 45 per cent. The anticipated thermal efficiency of the cycle is around 35 per cent with a fuel consumption of some 0·4lb. per b.h.p.-hr. (180 gr. per b.h.p.-hr.). These figures are based upon a maximum blade temperature not exceeding 1,250 deg. F. (680 deg. C.) and very low cooling water temperature.—*The Oil Engine and Gas Turbine, Vol. 16, September 1948, pp. 172-175.*



Circuit diagram of the Sulzer high-pressure gas turbine

The main components are as follows: (1) low-pressure compressor with intercooler (2) between the stages; air therefore passes through the pre-cooler (3) to the high-pressure compressor (4), again having an intercooler (5) between stages; (6) air circuit heat exchanger; (7) main combustion chamber with air heater; (8) air turbine; (9) exhaust-gas heat exchanger; (10) high-pressure turbine; (11) secondary combustion chamber; (12) l.p. work turbine driving generator (13); (14) electric starting motor; (15) connecting pipe containing valves (16 and 17). Combustion gases are confined to the area within the broken lines and are indicated by a light dot tint; the h.p. air circuit is shown in solid black. Pressures are given in lb. per sq. in. abs. and temperatures in deg. F.

Gotaverken Turbo-charged Two-stroke

A high-speed engine fitted with a two-stage exhaust gas turbocharger is illustrated in Fig. 4. The low pressure conduit (1) and the high pressure conduit (2) supply the exhaust gas turbine (3), which has different expansion stages. The turbine exhausts through a pipe (4) and drives a compressor (5), which supplies scavenging and supercharging air to the cylinders through a pipe (6). The by-pass (7) connected to the exhaust pipe (4) places the low pressure conduit (1) in communication with the atmosphere. If the engine speed or load is rapidly increased, pressure in the conduit (1, 2) rises immed-

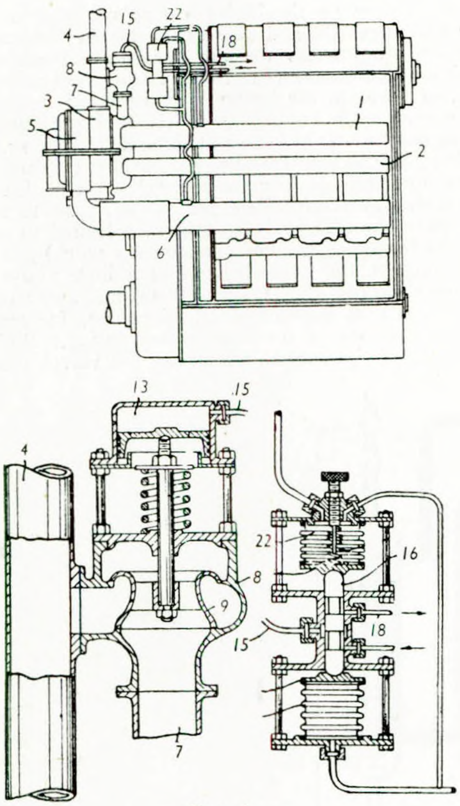


FIG. 4.

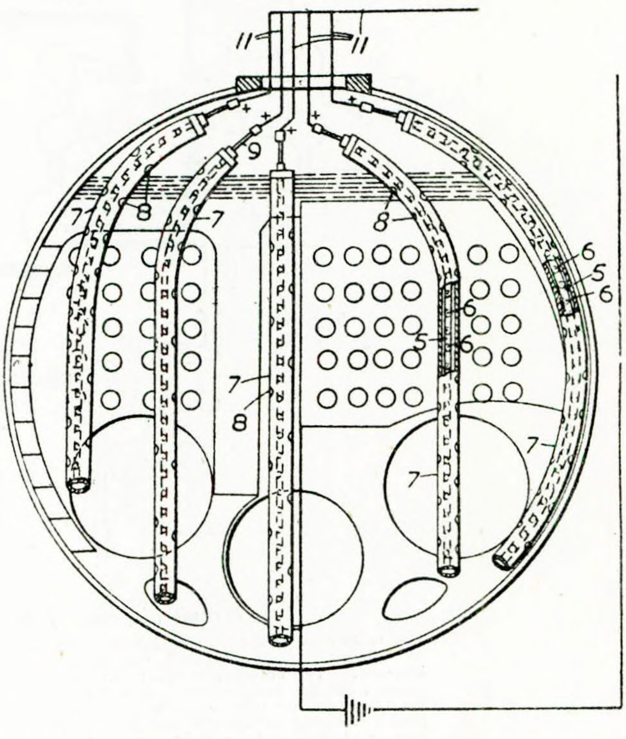
iately and an increase of pressure occurs in a diaphragm chamber (22). As a corresponding increase in the air pressure from the compressor cannot occur without some delay, the slide valve (16) moves downwards and communication is opened between the conduits (15, 18). Fluid is discharged from the servo-motor cylinder (13) of the by-pass valve (8). The valve (9) is opened and the low pressure gases are discharged to the atmosphere without passing through the turbine. As a result, the admission of scavenging air to the cylinders takes place normally. Due to the increased pressure in the high pressure conduit (2), the turbine speed and the amount of air supplied by the compressor are increased to such an extent that the slide valve (16) is returned to the position in which the by-pass valve (9) is closed. At the new engine speed, the exhaust and scavenging air pressures again counterbalance each other.—*British Patent No. 601,286, issued to A. B. Gotaverken. The Oil Engine and Gas Turbine, Vol. 16, August 1948, p. 148.*

Alloy Steel Bolts

The design of the bolts used in marine practice for such purposes as Diesel connecting rods and turbine casings presents considerable difficulties in view of the onerous conditions to which they are subjected in service. It is generally admitted that such bolts should be made of high grade alloy steel but even so, instances of failure have been recorded. The American journal "Steel" reports the results of an investigation into the strength of bolts made of high grade alloy steel. Using a steel having an ultimate strength of 260,000lb. (116 tons) per sq. in. different designs of bolts, subjected to various heat treatments, were tested in pure tension and also when subjected to bending in addition to tension by the use of tapered shim plates placed under the bolt head or under the nut. The results showed that in tension with little or no superimposed bending, ductile breaks through the threads occur except in the as-quenched bolts. As-quenched bolts showed brittle failures under the head at low and widely scattered loads thus indicating greater notch sensitivity at this point than in the threads. Failures under the heads can be prevented by adding a stress relief radius from shank to head. Superimposed bending at either the bolt head or at the threaded end of the bolt causes brittle failures in these sections at considerably reduced loads. The investigation indicated a higher tendency towards embrittlement for the section under the head than for the threaded section, and further tests are being undertaken to clarify this and other discrepancies.—*Shipbuilding and Shipping Record, Vol. 72, 16th September 1948, pp. 326-327.*

Methods for Descaling Boilers

This invention relates to the electrolytic descaling of boilers, particularly marine boilers, by the "cathodic" process which comprises connecting the boiler as cathode to the negative pole of a source of electrical energy having its positive pole connected to one or more anodes submerged in the water contained in the boiler. The invention consists in the provision of long, flexible anodes encased in perforated insulating sheaths. The flexible anodes and their flexible insulating coverings are dimensioned so that they may be passed between the tubes and other internal obstructions of the boiler shell into close proximity with the most remote and inaccessible parts to be cleaned. Each of the anodes shown in the drawing comprises a plurality of flat metal bars or plates (5) secured together by suitable pivot connections (6) thereby providing a long, flexible anode. The jointed bars (5) of each anode are enclosed by a flexible sheath (7) made of rubber or other suitable insulating material and provided with a multiplicity of small openings (8) through which the boiler water has access to the said bars. The accompanying figure shows diagrammatically the manner in which a plurality of anodes may be arranged in different parts of the boiler by passing them through or around the tubes of other internal obstructions of the boiler shell.



During this positioning of the anodes they are held out of contact with the metal parts of the boiler by their perforated insulation sheaths. In the use of this invention the manhole door is taken off the boiler and the boiler water is drained down to the level of the boiler tubes. The anodes are then placed in position within the boiler and the water raised to its normal level. If the rapid removal of scale is the primary objective, alkali is added to the boiler to give a 3 per cent alkaline solution which serves as an electrolyte. If there is oil present in the boiler a small amount of trisodium phosphate is added to this electrolyte. The anodes are inserted in position by passing them downwardly through the manhole so that they either hang in a straight position between banks of tubes or are bent to pass around curves or other surfaces within the boiler. A direct current of from 300 to 500 amps. at 20 to 50 volts is supplied to the anodes, the amperage employed depending on the condition of the boiler and the length of time during which the descaling apparatus is maintained in operation. A boiler heavily scaled can be completely descaled by the use of this invention in from 34 to 36 hours.—*British Patent No. 600,738, issued to F. G. Negus. Complete specification accepted 16th April 1948. The Shipping World, Vol. 119, 25th August 1948, p. 154.*

ENGINEERING ABSTRACTS

Section 3. Shipbuilding and Marine Engineering

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

Salvage of Dredger at Port Talbot

Whilst undergoing repairs the 810-ton bucket dredger "Don Federico" was lying afloat in Port Talbot Dock. On September 25th, 1941, in the early morning darkness of the "blackout", the dredger began to list and then turned over through an angle of 127 deg. and sank with her starboard side partly on the dry apron and her heavy 13-feet diameter spur wheel, which with its tumbler and shaft, weighed 23 tons, and the top of the central tower buried in the mud at the dock bottom. In this position the casualty completely sealed the entrance to the dry dock in which a large oil tanker was being overhauled. Owing to the age of the dredger it was decided not to attempt to raise the wreck but to remove the obstruction from the entrance and approach to the dry dock, this work to be carried out by the Ocean Salvage and Towage Co., Ltd. As shown in Fig. 2, the casualty lay with part of her port bilge about 10 feet above water, but the stern was completely submerged. It was decided to dispose of the wreck by turning the hull bottom upwards and removing it from the dry dock entrance under compressed air. This plan necessitated the removal under water of all superstructure to about deck level before turning the hull bottom upwards. The plan adopted was to parbuckle the hull after lightening it and thus so to cant the hull towards the dry dock entrance that the central tower would be raised from the dock bottom and held safely in the canted position whilst the removal of the central tower and remainder of the superstructure was carried out by the divers and the salvage vessels.

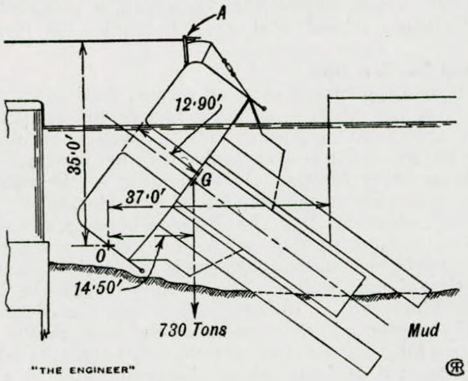


FIG. 2.—*Diagram of sunken dredger*

The required horizontal pull of the four parbuckling tackles to be applied was computed as some 200 tons, or 50 tons per winch and its purchase blocks. The concrete bases used as holdfasts measured 8 × 8 × 7 feet deep below ground level and were all in soft sand. It was found on completion of the parbuckling that there had been very little displacement of the holdfasts. Attempts to raise the dredger proved, however, unsuccessful, and it was decided to slew the wreck to a nearby bay where it would be quite clear of the approach to the dry dock and also conveniently situated for the breaking-up of the wreck for scrap at a later date. Using compressed air this operation was successfully carried out without incident.—*The Engineer, Vol. 185, 25th June 1948, pp. 610-613.*

Performance of La Mont Boilers in the *President de Cazalet*

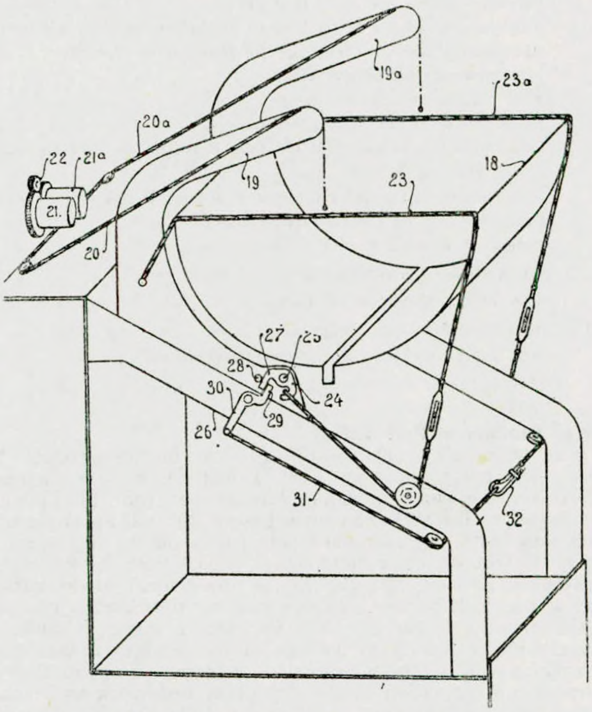
This article contains a summary report on the performance of the La Mont boilers of the *President de Cazalet* during trials and the subsequent voyage from Newcastle-on-Tyne to Marseilles. During the trials a few teething troubles were, as might be expected, encountered. These arose in the main through dirt, machine drillings, borings and other foreign material adversely affecting the satisfactory operation of valves, regulators, etc. The most unfortunate mishap was due to an excessive amount of dirt being carried over into one of the boiler headers so as to choke entirely one of the tubes, resulting in its failure. In the past, boiler manufacturers and firms specializing in feed regulators, valves and other mountings, have made pleas that every precaution possible be taken by all concerned to secure the exclusion of dirt and foreign matter from feed lines, etc. Important though this is in any installation, it seems to be doubly so in the case of La Mont forced-circulation boilers. This appears to be the main lesson learned from the trials of this initial installation; dirt in the system is fatal to its reliable operation. Once the preliminary difficulties were overcome the general programme of trials of the *President de Cazalet* proceeded satisfactorily. A maximum trial speed of 22 knots was attained, as has been recorded. The ahead-to-astern trial was exceptional. The turbines were reversed from full ahead at 145 r.p.m. of the propeller shaft to full astern at 100 r.p.m. in 71 seconds. The vessel's speed at the time of the manœuvre was about 19½ knots and in 1 min. 58 secs. it had lost way and come to rest. The flexibility of the La Mont boilers was admirably demonstrated during the astern manœuvre, the steam pressure being maintained without blowing of the safety valves, the water level remaining steady, and, of particular interest, the steam temperature not varying more than 15 deg. F. The French crew when taking over took a little time to adapt themselves to the greater flexibility of the boilers with which they were unaccustomed. At first, operation was erratic, two or more burners being flashed up and shut off in a matter of seconds. The result was that the water levels were unsteady, the boilers being automatically shut down on three occasions by the low water level protective devices. After the attention of the French engineers had been drawn to the necessity for handling the burners slowly and calmly and making more effective use of the variation of fuel oil pressure, matters soon rectified themselves; the machinery space crew seemed to settle down in a matter of about two hours. Despite the heavy pitching in the Bay of Biscay and rolling later encountered as a result of the mistral, no difficulty was experienced with the boilers or their associated circulating pumps. The water level in the gauge glass varied from 4 inch to 5 inch, the circulating pump speed remained absolutely steady, and the steam temperature did not vary. During the initial voyage the soot blowers were at first operated every 12 hours but later it was found that once a day was adequate to maintain the boiler heating surfaces in satisfactory condition. Throughout the passage combustion was extremely good, the funnel was at all times clear of smoke, whilst an average of 12·8 per cent CO_2 was maintained in the uptake.—*The Marine Engineer, Vol. 71, August 1948, pp. 367-368.*

Photo-projection—A Challenge to Shipbuilding Tradition

Photo-projection and "photo-lofting" make it possible to shorten the traditional sequence of shipbuilding by the elimination of the mould loft. The technique of photo-lofting was conceived and developed in 1938 by the Glenn L. Martin Aircraft Co., and it has since been established that photo-lofting exceeds mould lofting from the aspects of accuracy, speed and cost. In the aircraft industry photo-lofting has become an accepted and proven tool of standard manufacture. Drawing for photo-lofting and photo-projection is specialized to a considerable degree. Precision beyond that normally required in shipdrawing is achieved by several highly developed procedures. The more important considerations include a stable drawing medium, mechanically ruled grid lines, attention to width of line, fine tolerance in all dimensions and drawing to a large scale usually 3 inch=1 foot. Metal sheet, usually aluminium, suitably lacquered and surfaced, is a good drawing medium. Photographic limitations and ease of handling have resulted in a maximum sheet size of 5 × 9 feet, although sheets under this size are frequent, since the photographic apparatus is widely adjustable. Drawing is done with hard pencils kept to a carefully controlled sharpness. A sharp dense line is made having a thickness not exceeding 0·005 inch. Too light a line will lose sharpness in reproduction, while a line too wide becomes intolerable when photo-enlargement takes place. Scales and instruments are calibrated in fine intervals to permit extreme dimensional accuracy. Tolerances are held at 0·005 inch per foot so that even with a fourfold enlargement precision is within permissible limits. The scale used in shipbuilding photo-lofting, 3 inch=1 foot, is well suited for several reasons. Firstly, vessels under 200 feet in length can be drawn to this scale on ordinary drafting room equipment. Standard metal lofts placed edge to edge on tables can take waterline and body plans without using excessive floor space. Contracted station intervals in waterline plans reduce space requirements still more. Secondly, full size enlargement (four times drawing size) by the camera gives a line width very comparable with the ordinary mold loft pencil line. Thirdly, this scale permits adequate precision in drafting. Smaller scale than 3 inch=1 foot introduces unavoidable errors in enlargement, larger scale is unnecessary for accuracy and causes wasteful use of space. The steps in the application of photo-lofting to shipbuilding include conception, scale body plan, photo-loft body plan, scale template layout, and photo-template. Conception in photo-lofting consists of sketches and descriptions by the naval architect. These data and rough drawings are not precise but are adequate to give the draftsman a reliable point of departure in his refinement of the design. Ship drafting leading to a body plan is done to a scale of 3 inch=1 foot. Fairing and final body plan are precision drawn, on prepared metal sheet as described above. No table of offsets is made because the procedure under photo-lofting eliminates the need for such data. Once completed, the body plan is ready for photo-projection. At this point the camera, a gigantic precision instrument, reproduces the body plan on a glass negative, later projecting the lines of the negative on sensitized metal sheets. The several drafting loftsmen lay out shipbuilding templates from the photo-lofts, the use of several body plans permitting simultaneous lay out of plating by one man, framing by another, floors by a third, and still different members by others. The camera is then used again, this time on scale template drawings. Glass negatives about one foot square show precision templates of every structural member. These drawings are enlarged to full size by the camera, producing a photo-template. Fabricators can use these templates for actual cutting and joining of steel. No additional layout is required. Photo-lofting finds its best field where numerous one design vessels are to be built. Cost and layout time on a single ship do not show attractive advantages for photo-lofting.—*A. F. Bird, Journal of The American Society of Naval Engineers, Vol. 60, August 1948, pp. 253-260.*

Improvements in Gravity Davits

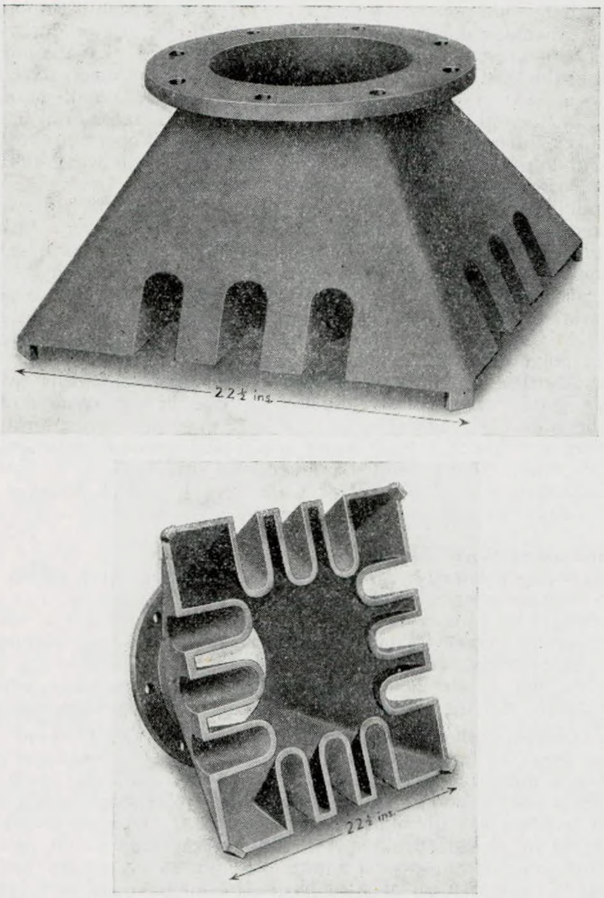
This invention consists of an installation for launching a lifeboat suspended from gravity davits. The stowed boat is prevented from upward movement by lashings, and together with the gravity davits, is held from outward movement by abutments adapted for rotation, each lashing and each abutment being provided with a locking member. The locking members of the lashings and abutments are held in the locked position by a common rope or cable. As shown in the figure, the lifeboat (18) is suspended from two gravity davits (19, 19a) by means of falls (20,20a), wound upon drums (21, 21a). These drums are connected through suitable gear wheels with a common centrifugal brake. The boat is prevented from upward



movement at one end by a lashing (23), the inner end of which is secured to the davit (19), the outer end being provided with an eye engaging a hook (24). This hook forms one arm of a two-armed lever, which can rotate about a pivot (25), the latter being secured to the davit (19). The other arm (27) of the lever extends into the gap between a locking pin (28) secured to the davit and one arm (29) of a lever held in position by the stretched rope (31) attached to the other arm (26) of the lever. If the slip hook (32) is opened, both lashings are released and both davits unlocked so that the davits with the boat are free to slide towards the water, their movements being controlled by the centrifugal brake (22).—*British Patent No. 602,298 issued to A. P. Schat. Complete Specification accepted 24th May 1948. The Shipping World, Vol. 119, 8th September 1948, p. 190.*

The Isherwood Suction Box

The problem of securing efficient suction during the final stages of tank-emptying operation is of considerable importance in vessels designed to carry liquid cargoes in bulk, as well as in modern cargo liners, many of which have deep tanks for the carriage of fuel oil, vegetable oils or other liquids. Arrangements at the suction end of a pipe-line are governed by conflicting considerations; for, while efficient drainage demands that the distance between the open end of the pipe and the bottom of the tank be reduced to the minimum, the maintenance of effective suction imposes a lower limit on this dimension, which should not be less than one-quarter of the bore of the suction pipe. Thus, with a 10-inch suction-line, the distance between the mouth of the pipe and the bottom of the tank should not be less than 2½ inch; while, for efficient drainage, a height of about ¾ inch is generally regarded as being about the permissible maximum. To reconcile these conflicting requirements, i.e., to combine adequate area with small clearance, the special type of suction box shown in



FIGS. 1 AND 2.—*Exterior and interior views of the Isherwood Suction Box*

the accompanying illustration has been developed by Sir Joseph W. Isherwood and Co., Ltd. The essential feature of the design is that the periphery of the box is fluted in such a way as to provide a number of inwardly projecting, tapered recesses or pockets, suitably dimensioned and spaced; and, as a little reflection will show, the arrangement results in greatly augmented perimeter and suction area being achieved in a box of relatively modest overall dimensions. Thus the Isherwood box for a 10-inch suction line provides a suction area (periphery of base × clearance) approximately double that of the pipe cross-section.—*The Shipbuilder and Marine-Engine Builder, Vol. 55, September 1948, pp. 568-569.*

Boiler Fuels in Diesel Engines

The problem of burning boiler oil in Diesel engines, as confirmed by the experimental work on the subject and the results which have been achieved in service, lies first in removing the water and sludge and easily separated solid matter and, secondly, in extracting any slow-burning constituents or finely divided solid matters which remain after the first purification. The manufacturers of the De Laval separator, with these considerations in view, have developed a machine which can be installed for the purification of Diesel oil in the ordinary way when the machinery burns this fuel alone, but which, with comparatively simple and readily made modifications, can be adjusted to purify boiler oil so as to be suitable for burning in the same engine. The installation normally comprises two of the machines in question, both designed to run as purifiers, and having two outlets, one for the purified oil and one for the water and sludge. This would be the arrangement adopted with both machines whilst the engine continues to run on Diesel oil, but on the change-over being made to boiler the second machine is transferred into a clarifier by changing the gravity disk and the top and bottom disks. In this way a higher purifying efficiency is attained with oil not containing water, since this has already been removed. There is then only one discharge outlet instead of two when Diesel oil is being purified.—*The Motor Ship, Vol. 29, September 1948, p. 221.*

Load Carrying Capacity of Oil Film Between Gear Teeth

The load carrying capacity of the oil film between gear teeth is usually stated to be proportional to the square root of their relative radius of curvature, and since the Hertzian load carrying capacity for direct surface contact stress is directly proportional to the relative radius of curvature, the viscosity film index of 0·5 has been invoked as an explanation of the empirical index of 0·8 to which the relative radius of curvature is raised in the methods of H. E. Merritt and the British Standards for Machine Cut Gears. The basis on which this index of 0·5 was obtained does not appear to have been published and according to the author of the present article it appears erroneous. The mathematical proof furnished proceeds from Reynold's differential equation for the pressure in an oil film in the absence of side leakages and shows that the load carrying capacity of the oil film between gear teeth, neglecting end leakage, is directly proportional to the relative radius of curvature of the surfaces and not, as has been stated, the root of this quantity. This does not, however, affect the validity of the empirical index of 0·8. The author considers a full discussion of the reasons for the adoption of the empirical index of 0·8 to be beyond the scope of the article, but he suggests that in Merritt's words, it may be due to a "relatively lower standard of accuracy of any type of gear as the dimensions increase"; or it may be due, amongst other things, to the theoretically unsatisfactory nature of the present "speed factors" based on r.p.m. only. The speed effect is twofold, since (a) the total life at any stress level is a certain number of repetitions of load so that an increased rate of repetition involves a lower life in hours at a given stress level and (b) the stresses due to any given loads at any given standard of accuracy are a function of the pitch line velocity. Thus, assuming a given maximum error in action, which means a relatively higher standard of accuracy in larger gears, at the same cyclic velocity, the larger gear would have a higher pitchline speed so that the use of the same "speed factor" would result in a stress rating which was optimistic for the larger gear if correct for the smaller. It is much more probable that the use of the same speed factor based on r.p.m. alone is the cause of the empirical curvature index of 0·8 than that it should be due to relatively lower accuracy on large gears, which is not in general true; and it has been shown that the oil film load-carrying capacity varies directly as the relative radius of curvature.—*E. Miewen, The Engineer, Vol. 186, 3rd September 1948, pp. 234-235.*

Novel Welding Method

A report from Russia refers to an unorthodox method of welding in which a concentrated heat source pre-heats and softens to a given depth the surface of the parent metal, while a liquid jet of welding metal is fed into the seam from a special fixture. Mention is made of the employment of a magnetically rotated arc and of a "dosing" fixture which sqirts liquid metal through tubes of 1·4 mm. diameter and over.—*Welding, Vol. 16, September 1948, p. 410.*

Importance of Design Factors for Marine Reduction Gears

The designer is able to calculate more or less exactly the probable endurance of gear from the point of view of contact stresses and of beam strength, but he is faced with the problem of how to balance both stresses in his design. It is quite natural that one should feel inclined to balance both stresses as far as possible. This, in general, will lead to the use of a comparatively fine pitch which from some points of view will be claimed as an advantage. This theory of balance and stresses, with approximately the same number of hours of life both for contact and bending endurance, seems to be widely accepted. And gear designs which do not agree with this rule are readily declared as poor. The author believes that this rule is entirely wrong. It may give to the calculation of a gear the satisfying aspect of an aesthetical harmony, but this is all that can be claimed in its favour. The adherents to that rule do not consider two important facts: (1) that the equations by which the endurance can be calculated are statistical laws; this means that the results obtained by the calculations do not represent more than the probability of a certain percentage of accuracy. This scattering in the results is particularly great in the one of high stresses and, therefore, low figures for hours of life and (2) that the endurance figures for beam strength and contact stresses have an entirely different importance for the safety of a gear and the machinery connected with it. Assume that a gear fails because its endurance limit due to contact stresses has been reached. This means that pitting begins to show, but it does not mean a sudden breakdown. The gear may go on running for a considerable time. If, for instance, this occurs on board ship, nothing will happen and in most cases the ship will be able to continue its voyage until the set of gears can be exchanged, particularly when the further performance will be at partial loads. Things are different when the endurance limit is reached from the point of view of beam strength. Then tooth breakage occurs which is always a breakdown of the whole unit. The basic rule for gear design ought to be that a gear never should fail through tooth breakage. The calculated life expectancy from the point of view of bending stresses ought to be so far greater than the endurance with regard to contact stresses that no gear will have to be replaced for complete breakdown. —*W. G. Stoeckicht, Journal of the American Society of Naval Engineers, Vol. 60, August 1948, pp. 332-339.*

Fatigue Tests on Crankshaft Steels

The first part of this paper deals with the effect of nitriding on the fatigue properties of a chromium-molybdenum steel with 0·20-0·25 per cent carbon and approximately 3 per cent chromium and 0·5 per cent molybdenum. The tests on the solid test-pieces showed that after nitriding for 10, 22, and 72 hours at 485 deg. C. the fatigue fractures began in the vicinity of the junction between the case and the core, but with the nitrided, hollow-with-oil-hole specimens, the fractures began on the surface of the nitrided case. From the test results obtained it was calculated that by nitriding crankshafts for 10 instead of 72 hours at 485 deg. C. a reduction in the fatigue limit of approximately 0·7 per cent would be obtained for the sections of the components which were approximately 3·0 inch diameter, without any form of stress concentration, whilst the fatigue limit of the oil-hole sections of the components would be slightly increased. Therefore, from a fatigue point of view, it appeared that the 10-hour nitriding treatment at 485 deg. C. was more suitable for crankshafts and airscrew shafts, than the 72-hour nitriding treatment at 485 deg. C. The depth of the nitrided case, as determined by a fracture test after the 10-hour nitriding treatment, was 0·004 inch, and this appeared to be quite adequate for crankshafts and airscrew shafts, from a wear-resisting point of view. It seemed highly probable that by nitriding crankshafts and airscrew shafts for 10 hour at 485 deg. C. instead of for 72 hour at 485 deg. C. the grinding operation after nitriding might be replaced by a honing or lapping operation. This appeared to be a possibility because after nitriding for the shorter period the surface hardness was increased, and the amount of distortion and growth obtained during nitriding will most likely be reduced. The substitution of a honing or lapping operation, for the grinding operation for finishing nitrided engine components, would eliminate the possibility of grinding cracks being formed, and would therefore simplify the manufacturing process. In the second part of the paper the author relates the results of tests carried out on a nickel-chromium-molybdenun steel containing 0·35 per cent carbon, 0·33 per cent silicon, 0·62 per cent manganese, 0·94 per cent nickel, 0·94 per cent chromium and 0·9 per cent molybdenum, and a chromium-molybdenum-vanadium steel with 0·39 per cent carbon, 0·28 per cent silicon, 0·58 per cent manganese, 0·17 per cent nickel, 3·07 per cent chromium, 0·98 per cent molybdenum and 0·20 per cent vanadium. The tests showed that by machining the solid, hollow, or hollow-with-oil-hole fatigue test-pieces from a heat-treated 3½-inch diameter bar on chromium-molybdenum-vanadium steel (90 tons per sq. in. maximum tensile strength) instead of from a heat-treated 1-inch diameter bar of nickel-chromium-molybdenum steel (60·0 tons per sq. in. maximum tensile strength) the fatigue limits were increased approximately 31 per cent for reversed bending, reversed torsional, or various combinations of reversed bending and torsional stresses. It appeared from fatigue tests which have already been completed on steels heat-treated to give maximum tensile strength values of between 60·0 and 113·0 tons per sq. in., that for solid test-pieces, with the standard longitudinal polish, tested under reversed bending stresses, the fatigue limit obtained in the longitudinal direction was only slightly increased by increasing the maximum tensile strength from 90·0 to 113·0 tons per sq. in. The fatigue limits of the hollow specimens machined from both the nickel-chromium-molybdenum and chromium-molybdenum-vanadium steels were approximately 1 per cent lower than the fatigue limits obtained for solid specimens from the same steel, whilst the 0·020-inch diameter oil hole reduced the fatigue limit of both steels by approximately 50 per cent for the three stress conditions. Therefore, as the percentage decrease in the fatigue limit due to the 0·020-inch diameter oil hole was approximately the same for both steels, it appeared that by increasing the maximum tensile strength from approximately 60·0 to 90·0 tons per sq. in., the stress concentration produced by the oil hole had not been increased.—*P. H. Frith, Paper MG/A/167/47 of the Alloys Steels Research Committee of the Metallurgy (General) Division of the British Iron and Steel Research Association. Journal of the Iron and Steel Institute, Vol. 159, August 1948, pp. 385-409.*

Action of Rust-preventive Oils

Paints have been long employed as protective coatings while grease and petroleum have been used extensively to provide protection when removable coatings were requird. Oil films, which are much easier to apply and remove, were inadequate for this purpose until it was found that their rust-proofing efficiency could be greatly increased by addition of certain types of polar organic compounds. In this connexion polarity means that a separation of electric charges, or dipole, is present in the molecule. It is suggested that the mechanism by which oil solutions of polar compounds protect steel is as follows: polar molecules are adsorbed as oriented multi-molecular layers at the steel-oil interface. These layers retain oil in their interstices, forming a mixed film which is more impervious to water than either the additive or oil alone. Additives with weak attractive forces forming only mono- or bi-molecular layers are not effective rust inhibitors. A minimum of about six molecular layers is required to form an effective barrier against moisture. Although rust preventives are usually applied to dry surfaces, the protection of previously wetted steel surfaces must be considered on occasion. This can be provided in one operation by the use of water-displacing preservative oils. Although straight mineral oil will not displace water, this desirable action can be obtained by adding to the oil certain polar compounds which have a greater tendency than water to be adsorbed on steel. However, water displacing oils are not always good rust-preventive additives. Conversely, some additives may be sufficiently adsorbed on dry steel to improve rust protection but may not lower the oil-water interfacial tensions sufficiently to displace water from previously wetted steel surfaces.—*E. R. Barnum, R. G. Larson, and A. Wachter; Corrosion, Vol. 4, September 1948, pp. 423-431.*

Calculation of Wave Resistance at High Speed

This paper describes an attempt to evaluate for high speeds from theoretical considerations the wave resistance for a ship of a form something like a destroyer. The method employed is the same as that used by Havelock, but the sources and sinks representing the form have partly been distributed over a surface inside the ship's sides and not all of them on the vertical centreline plane which is more usual. All the results for the destroyer are shown in the paper as Ⓒ curves to the base of the Froude number and with the speed of the vessel, in knots, indicated. The agreement between the calculated and measured resistance in the range from, say, $f=0·35$ to $f=0·65$ is fairly good, but no doubt the discrepancy which exists would increase at still higher speeds, but as $f=0·65$ corresponds to 45·3 knots for this particular vessel, any higher speed would, generally speaking, have less practical interest as far as destroyers are concerned. The agreement at $f=0·35$ or 24·4 knots is rather surprising because this is usually one of the Froude numbers where the difference between calculated and measured wave resistance is largest. The good agreement is, however, immediately lost below this value of f, but any speed lower than, say, $f=0·40$ to $f=0·35$ is not a high speed in the hydro-dynamic sense.—*Paper by J. K. Lunde, read at the autumn meeting of the Institution of Naval Architects, 21st-24th September 1948.*

The Effect of Shape of Entrance on Ship Propulsion

This paper deals with resistance and propulsion of coaster vessels, particularly the effect on the propulsion components of wide variations in shape of entrance, keeping the shape of stern constant. The principal aim of the investigations was to find the effect of bow form on wake, optimum propeller diameter and q.p.c., this influence being generally neglected. The experiments described in this paper were made at the Wageningen tank. Although tests for various ship types were envisaged, they were confined to a Dutch coaster type on account of war-time conditions. This coaster type, 137×24·5×9 feet draught, has a motor of 300 b.h.p. at 300 r.p.m. The three four-bladed propeller models tested had diameters of 2¾ per cent, 7 per cent and 11 per cent smaller than the open water optimum found with the Wageningen B. 4.40 propeller design diagrams. They absorbed practically equal powers at equal revolutions, and were used to define the optimum diameter for the various ship forms, the author's experience being that diameter is a most important factor in designing efficient screws. Three shapes of entrance were investigated. These were a normal form, a wedge form, and a bulbous bow form. The shape of run remained the same for all three shapes of entrance and was a good normal form for single-screw propulsion. The combination of this stern form with the normal bow form constituted a well-tried-out good coaster ship form, one of the best of this type. The influence on model resistance of a turbulence device was also investigated. The models of ship and propellers were made on scale 1/8, and the propeller model diameters were about 8·8, 8·3, and 8 inch respectively.—*Paper by I. L. Troost, read at the autumn meetings of the Institution of Naval Architects, 21st-24th September 1948.*

Two New American Passenger Liners

The American Export Lines have recently placed an order for two luxury passenger liners with the Bethlehem Steel Co. Each vessel will have a displacement of 30,000 tons and a gross tonnage of some 20,000 tons. The twin screws will be driven by geared turbines of 55,000 s.h.p., giving the vessel a speed in excess of 25 knots. Overall length of the ships will be 683 feet, with a moulded beam of 89 feet and a 30-feet draught at the designer's load waterline. They will operate between New York, Genoa and Naples.—*Marine Engineering and Shipping Review (New York), Vol. 53, September 1948, pp. 38-39, 76.*

New American Hull Steel Plate Specifications

The American Bureau of Shipping included in its 1948 Rules a new ship steel plate specification intended to be put into effect as rapidly as steel production conditions permit. This specification consists generally of the same physicals as heretofore specified but with the addition of chemical limitations. Such chemical requirements were applied by way of three thickness groups in such a manner as to improve the steel in an increasing degree proportional to its thickness in the expectation that the resultant notch characteristics would be generally uniform in all thicknesses. For plates over ½-inch and up to 1-inch inclusive the specified composition is 0·23 per cent carbon maximum, 0·6 to 0·9 per cent manganese with phosphorus 0·04 per cent maximum, and sulphur 0·05 per cent maximum. For plates over 1-inch thick the composition is specified as 0·25 per cent carbon maximum, 0·6 to 0·9 per cent manganese, 0·04 per cent phosphorus maximum, 0·05 per cent sulphur maximum, and 0·15 to 0·3 per cent silicon.—*J. L. Wilson, Marine Engineering and Shipping Review, Vol. 53, September 1948, p. 71.*

Motive Power for Steering

Varied types of mechanical steering require different kinds of energy to operate them. When the size of ships passed beyond the manually operated rudder, steam engines were largely employed, and are to a certain extent still being made for this purpose. Dependent upon the location of the engine in relation to the rudder, the overall thermal efficiency of the steam steering gear, with lengthy steam and exhaust piping from the source of supply, is comparatively low. The use of steam economizer valves on these engines reduces the consumption, but, in relation to the power developed, the consumption remains excessive and is quite out of the question in a high-speed passenger ship of any size. Moreover, with a steam-driven steering engine there is generally no means available for providing a stand-by or spare gear in the event of breakdown, otherwise than by the hand gear. In consequence, electro-hydraulic and all-electric steering gears have come to be used in increasing numbers. This type of steering gear is particularly useful in motorships, where a constant supply of steam is not always available. It will be realized, also, that the application of the electric-hydraulic pressure system for controlling the movements of a ship's rudder not only eliminates the use of steam piping, but permits the gear to be placed directly on the rudder head, thus rendering unnecessary a mass of mechanism, any part of which is liable to derangement. It has been claimed that efficiencies of 70 per cent have been reached with this gear when measured between the incoming mains to the motor and the developed energy on the rudder head. A further advantage of hydraulic rudder operation is its silence and the resilient effect of the fluid movement which is capable of being relieved by valves set to lift when the pressure on the rudder, due to heavy seas, exceeds the normal working pressure by about 10 per cent. In this way the hydraulic system acts as a buffer and can be considered as a shock absorber, thus taking the place of the spring shock absorbers in general use with other types of gear.—*The Journal of Commerce (Shipbuilding and Engineering Edition) No. 37,364, 7th October 1948, p. 6.*

Study of Engine Firing Orders

The state of dynamic balance of an engine and the magnitude of minor orders of torsional vibration are greatly influenced by the firing sequence of the cylinders. Investigation of this problem requires the evaluation of large numbers of vector diagrams and is therefore adaptable to the use of the "Vectorscope". This mathematical instrument automatically and rapidly adds vector quantities with about the same accuracy as a good graphical summation. This paper deals specially with techniques involved in applying the Vectorscope to the study of firing orders. Methods are indicated whereby large numbers of firing orders may be examined expediently and rapidly. It has been found possible with the aid of the Vectorscope to handle engines up to nine cylinders. The investigation of all the firing orders of a 10-cylinder engine is believed to be feasible, although so far only some 30,000 of the 181,440 firing orders have been investigated for primary and secondary moments. An 11-cylinder engine has so many possible firing orders as to involve a prohibitive amount of work for a complete study. The Vectorscope does, however, permit the rapid selection of some better firing orders by a trial-and-error procedure. The nature of the Vectorscope is such that it serves as a visual aid in the selecting of good crank arrangements, by manipulation of the weight representing the importance of the cranks. The instrument consists of a disk effectively pivoted at its centre in a cardan suspension or on a single pivot bearing. Pegs to receive weights proportional to the vector magnitudes are distributed around the disk in the same angular orientation as the vectors to be added. An adjustable pendular weight provides the equilibrating moment for the disk-and-weight system and also a means for controlling the sensitivity of the instrument. The optical system carried by the disk projects a lamp filament focussed as a spot of light on the screen, indicating the position of equilibrium of the disk. The displacement of the light spot from the zero position represents both magnitude and direction of the resultant vector.—*Paper by G. J. Dashefsky, read at the 1948 A.S.M.E. Oil and Gas Power Division Meeting; Paper No. 48-OGP-1.*

Diesel Application on Inland Waterways in the United States

The author gives a brief outline of the history of river transportation in the U.S.A., with a description of modern American towing practices and the use of Diesel propulsion plant in river craft. Beginning in about 1935, more and larger Diesel towboats have been built every year with the exception of the war years. At the end of the second world war, with the experience obtained during the war with various types of supercharging and other advances in design, the Diesel builders were able to deliver more than 800 h.p. without increasing the size of the engines. Today towboats are built with 1,600 h.p. engines on each propeller shaft. There are a number of single-screw and twin-screw towboats in operation today using engines of about 1,600 h.p. at speeds up to 800 r.p.m. and using reduction gears. The use of reduction gears is a new practice, as before the war there were only a few large towboats on the river using higher-speed engines and gears. This was mainly because the gears used before this time were not sufficiently strong to withstand the rugged operating conditions. There are in the United States about 9,500 barges and 1,250 towboats engaged in river transportation today. Of these 1,250 towboats, 983 are Diesel-powered, and 267 are steam-powered. Of the 267 steamboats, only 23 have been built since 1939. In 1947 there were 34 Diesel towboats built for use on inland rivers with a total of 34,050 h.p.—*Paper by A. R. Parsons, read at the 1948 A.S.M.E. Oil and Gas Power Division Meeting, Paper No. 48-OGP-5.*

Diesel Fuel Research at Thornton Research Centre

Discussing Diesel performance, the authors point out that both engine design and fuel quality have bearing on the problem of Diesel knock. In respect of fuel quality, the characteristic which has greatest influence upon tendency to knock is cetane rating. Essentially the cetane number affects the delay period which governs the proportion of the fuel charge present in the combustion chamber at the instant of ignition. If the proportion is large, as with a low cetane fuel, the ensuing reaction is correspondingly intensified such that the consequent rate of pressure rise is high and audible Diesel knock is evident. This knock can be suppressed by splitting the injection in such a manner that a minor charge is introduced first into the combustion chamber followed by the main part of the charge after an appropriate delay. This so-called system of pilot injection is remarkably effective in eliminating combustion noise. The absence of the usual Diesel noise is so noticeable, that one's initial impression is that the engine cannot be functioning properly. The system of pilot injection has been applied to a single-cylinder engine using an entirely separate pump and injector to deliver the pilot charge. It has also been tried out on both a single and a multi-cylinder engine using a single injector receiving fuel through a special T-piece from two separate pumps. It was found that optimum results were obtained with the first arrangement but an integrated system giving these injection characteristics is required before the method can be applied in practice to multi-cylinder engines. Comparative diagrams from the multi-cylinder of needle-lift, cylinder pressure and cylinder-head vibration are given in the paper. The effect of the preliminary injection upon the pressure and vibration diagram are shown by the needle-lift diagram. While this work has been directed towards reducing the high rate of pressure rise, a recent examination of combustion diagrams in relation to knock has shown that the form of the pressure/time curve at the beginning and end of combustion may have a major effect; and this does not necessarily depend upon cetane rating and the mechanism of combustion. Supercharging has the effect of "smoothing out" combustion and eliminating Diesel knock completely. Almost perfect combustion appears to be achieved under appropriate supercharge conditions up to loads at which the limiting factor tends to be the rate at which heat can be dissipated from the piston, rather than the usual limitation imposed by exhaust smoke. It appears that the trend in design towards greater power outputs for a given size of engine, which involves increased mass flow through the unit, especially in terms of air consumed, is likely to be achieved largely through supercharging. Other matters discussed are cold starting, cylinder wear, fouling and exhaust smoke.—*Paper by C. G. Williams, read at a General Meeting of the Diesel Engine Users Association on 21st October 1948.*

The Heat Pump with Some Notes on its Application to Air-conditioning in Land and Marine Service

In this paper the various types of heat pumps are briefly described and their application to different processes is shown. Referring to marine service the author points out that the use of sea water as an inexhaustible source of heat for a heat pump on passenger and cargo vessels is obvious. This is a potential field of heat pump applications particularly where the main propulsion machinery is either a Diesel engine or a gas turbine where steam raising is not available. This would mean that the customary steam heating would be superseded by a hot water or direct electric heating installation. In spite of the many advantages of the latter system, such as ease of control and operation, cleanliness, etc., it has, however, one serious drawback, namely that of risk of fire in the event of failure of a control thermostat. It is, therefore, quite possible that in future hot water heating may become the preferred method of heating spaces other than those which are dealt with by air conditioning plants. Most of the large ships have refrigerating equipment for their air conditioning plants and its conversion into heat pumps could be effected with a minimum of additional capital expenditure. All that is required is that the heat exchangers of the air conditioning plant be constructed and arranged in a manner that they can alternatively be used as condensers for heating purposes and as evaporators when cooling of the air is required. The combination of heat pumps-cum-refrigerator and air conditioning plant would ensure a fuller use of the existing refrigerating machines and thus result in increased overall efficiency and lowered operating costs. The same remarks apply to refrigerated cargo ships where cargo spaces have to be heated and cooled to maintain predetermined temperatures for the conservation of the cargo and to prevent the formation of condensation.—*Paper by F. Joder, Trans.I.Mar.E., Vol. 60.*

Calibration of Cylindrical Tanks with Axis Inclined

The method described in this paper provides a means of calculating the partial volumes of cylindrical tanks at any angle of slope, in a manner more or less the same as for horizontal tanks. The method is mathematically exact, but is not applicable to tanks which are truly horizontal.—*W. L. Coats, Journal of The Institute of Petroleum, Vol. 34, September 1948, pp. 627-646.*

Porous Metal Filter Elements

Porous sintered bronze compacts have been developed by a British firm for filtering purposes in connexion with oil engines. These filters have been used with success for the filtration of fuel to be injected where fuel filtration is needed to prevent any tendency to choking of the injector nozzles.—*The Oil Engine and Gas Turbine, Vol. 16, October 1948, pp. 196-197.*

Twin-screw Motorship *Norris Castle*

The conversion of a tank landing craft for passenger and cargo carrying was recently carried out by John I. Thornycroft and Co., Ltd., Southampton, for the Isle of Wight and South of England Royal Mail Steam Packet Co., Ltd. The vessel is 180-feet long and has a 38-feet beam with a draught aft of 4ft. 6in. and forward of 3ft. 1in. The fore-deck as originally built was bounded by side ballast tanks raised about 18 inch above main deck level. In the vessel as converted the main deck level was raised to give a wide unobstructed deck for the full 38 feet beam of the ship. The vessel was greatly strengthened by the addition of longitudinal girders, with intercostals closely spaced. The deck space is ample for carrying some 28 medium-size cars, and 254 passengers can be carried. The two main engines are standard Paxman-Ricardo 12-cylinder Diesels, each developing 500 b.h.p. at 1,000 r.p.m. The reversing-reduction gear is of the S.L.M. oil-operated type. Speed on trials after conversion was 8·45 knots.—*The Marine Engineer, Vol. 71, October 1948, pp. 461-462.*

Chart for the Investigation of Thermodynamic Cycles in Internal Combustion Engines and Turbines

The author refers to the fact that the development of the internal consists of a Rateau-Chantiers de Bretagne steam turbine of 4,660 h.p. thermodynamic problems associated with internal combustion engines. Graphical solutions find favour because: (a) widely varying mixtures of gases are used in modern engines; (b) the specific heats of the gases vary with temperature and pressure; and (c) the complete combustion of hydrogen, carbon, etc., cannot occur at high temperatures owing to dissociation. In the paper it is shown by suitable selection of scales how the temperature-internal energy graph may be used to indicate enthalpy, and, for engine expansions, the work done and the energy supplied. In turbines and turbo-compressors the heat drop, velocity change, losses, etc., are given by readings from the temperature-internal energy graph. The method is applied to a general cycle which embraces the Otto, Diesel, Atkinson, Humphrey, etc., cycles. To determine the work done and efficiency, calculation is eliminated entirely. An indicator diagram taken from an oil engine is examined and the heat exchange for arbitrarily chosen parts of the cycle estimated. Internal combustion turbine cycles are discussed and the advantages of stage reheating and inter-cooling demonstrated. Energy-mixture strength tables, for temperature intervals of 200 deg. C. (360 deg. F.), are supplied for mixtures between 100 per cent weak and 20 per cent rich.—*Paper by J. M. Gilchrist, submitted for written discussion to The Institution of Mechanical Engineers, 1948.*

Economy by Efficient Calculation

The author explains that he has found expert calculation of great assistance in obtaining economy, not only in the actual operation of calculation (or determining quantities) but also in saving material, effort and time in the manufacture of plate work—and in other directions. He suggests that loft floor development should be dispensed with and more accurate calculation methods substituted for the following reasons. The calculation methods are very much faster even in simple work and the more complex the work the greater this advantage. The accuracy obtained by calculation saves much expensive fitting and trimming during assembly; it will be found that the economy that may be obtained in this way is much greater than would be expected. This accuracy also makes it possible to institute an economical coding system of marking and piecework checking that saves labour costs in all operations because of firmness of control, and saves the often irksome and costly loss of pieces in a multi-part job or in a shop in which small parts are apt to be buried in piles of material. Material is also saved at the ordering stages because accurate calculation can be made in the drawing office. The special calculation methods now recommended are really mechanical and can be learned very quickly without any prior knowledge of algebra and trigonometry. If the calculation procedures now recommended are adhered to, independent checks that are included will reduce costly mistakes to a minimum. The calculation methods now recommended constitute an accurate record of the job in extreme detail and in a compact and permanent form from which at any time during manufacture or throughout the working life of the product alterations and replacement or repair parts may be freely made or supplied even when the product itself is twenty years old or thousands of miles distant. The methods will also be found to simplify geometric analysis in the drawing office.—*Paper by W. Heigh, read at a meeting of The Institution of Engineers and Shipbuilders in Scotland on 19th October 1948.*

Gas Turbine Developments

In his presidential address to the Institution of Engineers and Shipbuilders in Scotland, Dr. James McNeill, of Messrs. John Brown and Co., Ltd., Clydebank, said that trials of an open-cycle gas turbine engine had already taken place. He also stated that a 12,000 kW. gas turbine coupled to an electric generator for land use was now under construction, and he thought it was safe to forecast that the most recent developments would result in much wider application of this type of engine. Closer co-operation between the metallurgists and the engineers might well result in an early and new phase of development in which members of the shipbuilding and engineering profession would inevitably take a leading part. Dr. McNeill expressed the belief that technologists would follow these developments with interest. Increases in working temperatures, higher efficiencies and other advantages indicated the possibility of considerable advances being made against existing types of machinery within the next few years.—*The Journal of Commerce (Shipbuilding and Engineering Edition) No. 37,640, 14th October 1948, p. 6.*

Mixed Cargo Vessel *Azrou*

The recently launched mixed cargo vessel *Azrou* built by the Chantiers de Bretagne for the Compagnie Paquet is the first of a group of three vessels ordered by the French Government under the plan for the reconstruction of the French merchant marine. Length between perpendiculars is 105 m., length overall is 115·6 m., breadth is 15 m., and deadweight is 2,400 tons with a corresponding displacement of 6,240 tons. At 80 per cent of full power the speed is 15 knots and at maximum power it is 16·5 knots. The propulsion plant consists of a Rateau-Chantiers de Bretagne steam turbine of 4,660 h.p. There are two oil-fired small-tube water-tube boilers, also built by the Chantiers de Bretagne. Steam conditions are 32 kg. per sq. cm.

pressure and 400 deg. C. temperature; the boiler heating surface is 550 sq. m. The screw propeller is 4·35 m. in diameter and turns at 140 r.p.m. The second vessel of the group is the *Sidi Ferruch*, to be completed in 1949, and the third is the *Azemmour*, scheduled for delivery in 1950. These vessels are similar in design to those of the group of three vessels ordered from British yards, namely, the *Sidi Okba*, *Sidi Mabrouk* and *Djebel Dira*.—*Journal de la Marine Marchande, Vol. 30, 30th September-7th October 1948, p. 1802.*

Developments in Interrupted Surface Finishes

The author deals with the three generic types of interrupted surface finishes; (1) mechanically generated; (2) chemically generated; and (3) electrolytically generated. Any one or all of the above described methods may be used to develop a micro-roughness surface effect for only the initial run-in period until the compatibility of the surfaces is obtained; or may be used to produce deeper or so-called permanent relief of the surface to last for thousands of hours of operation. Because open pits or voids cause high oil consumption in engine cylinders, and because it is generally believed that hydrodynamic lubrication requires the maximum uniformity of wedge film, consideration of interrupted surface bearing areas must necessarily include the use of fillers for these applications. In his discussion of electrolytically generated interrupted surfaces the author refers to the extensive work which has been carried out to determine the operating characteristics required for use of porous chromium-plated piston rings. One manufacturer has established certain general conditions, as follows: a porous chromium ring to be used in the top groove on each piston, having nearly the entire face surface relieved as shown in Fig. 27, a micro-inch reading of 30 to 90, and possessing "chalk", as shown, promotes rapid seating on all rings where the cylinder bore surface is honed to 15 to 25 micro-inches of roughness on a 30 deg. helix cross-hatch. It is further considered beneficial in carrying oil during the critical running-in period. With growing interest and appreciation of the possibilities of interrupted type surface finishes as a practical approach to increased load-carrying capacity, longer life and better lubrication of bearings, it is evident that ultimately some combinations of generative methods will become defined for various applications. It is widely agreed that some degree of residual compressive stress is desirable in bearing surfaces. For many applications an actual load-bearing area comprised of a large number of peaks or plateaux separated by connected channels increases scuff and score resistance. Some coatings provide favourable chemical deposits on surfaces in addition to a substantial amount of surface interruption; also they improve wettability and lubrication during the running-in period. Solid non-ferrous metal fillers, particularly silver, are desirable constituents, especially in highly loaded bearings.—*Paper by L. S. Martz, submitted to The Institute of Mechanical Engineers, 1948.*

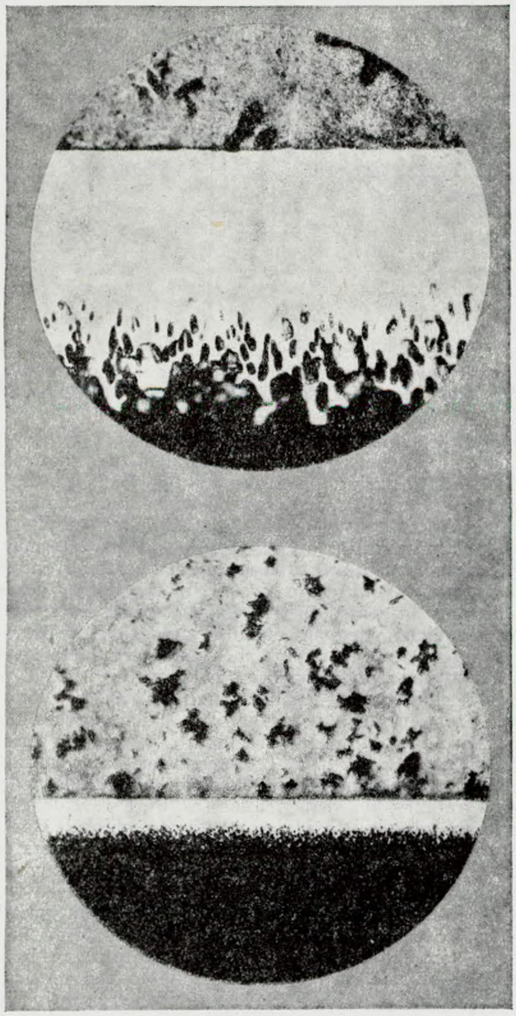
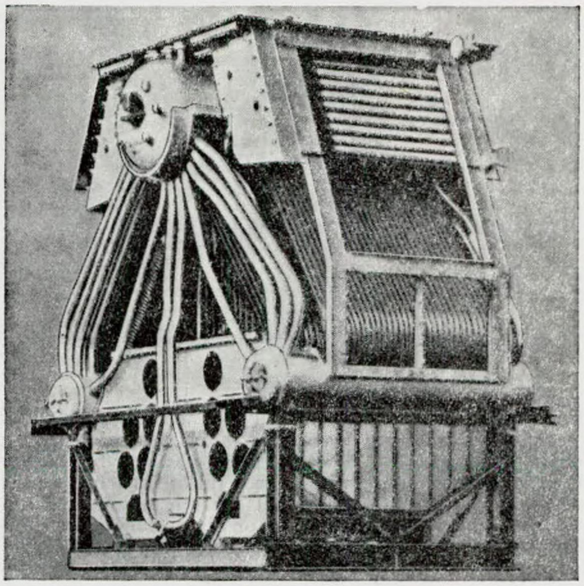


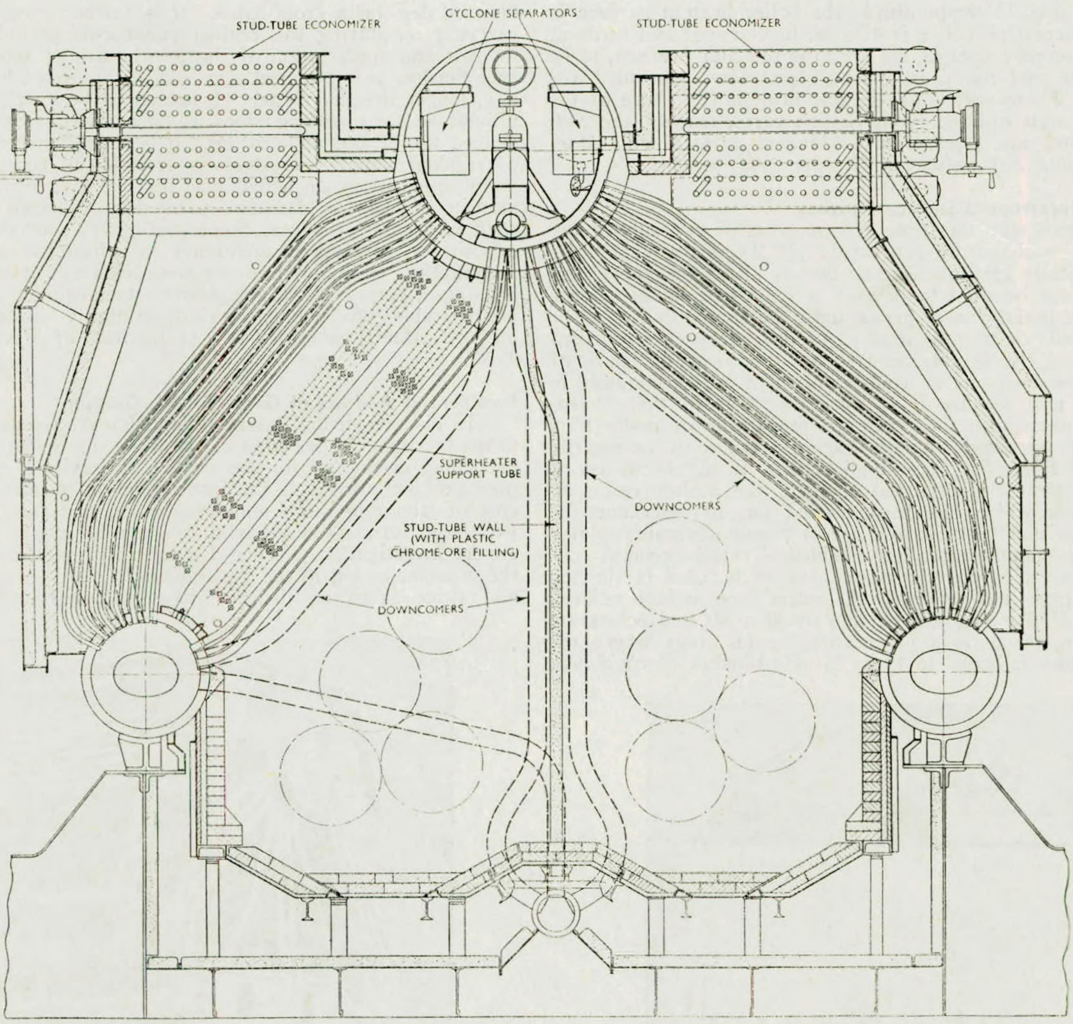
FIG. 27.—*Photomicrograph of spongy porous chromium-plated surface used in production by a piston ring manufacturer*

Presidential Address of Capt. (E) W. Gregson

In his presidential address Capt.(E) W. Gregson drew attention to the fact that the selection of the most appropriate design of marine propelling machinery for any particular service is an extremely complex problem owing to the interaction of so many variables, from cost of labour to world bunkering prices and freight rates, changing what was formerly a fairly simple matter into a very complex and expert investigation. When freight rates are high, as they are at the moment owing to the general world shortage of tonnage, weight and space saved on the machinery is immediately translated into increased earning capacity for the ship. Efforts to secure space reductions are, however, at times discounted by the peculiarities of present-day tonnage regulations. Behind this desire for highly efficient and small-capacity, light-weight plant are the ever-present prime necessities of great reliability and freedom from heavy maintenance. The total cost of a few days in port, or again of a breakdown on passage, can far outweigh any gain from reduced fuel consumption. According to Capt. Gregson's experience, the combination of 450lb. per sq. in. pressure and 750 deg. F. final steam temperature is a very happy one for powers up to 10,000 s.h.p. per shaft. For higher powers these conditions can be advanced to 650lb. per sq. in. pressure and 850 deg. F. final steam temperature, with controllable superheat to simplify manœuvring. More advanced conditions were adopted in the Canadian Pacific Steamship Co.'s new turbo-electric "Beavers" of 9,000 s.h.p. on a single screw, employing steam conditions of 850lb. per sq. in. superheated to 850 deg. F. and reheated at 160lb. per sq. in. pressure and 850 deg. F. These ships have unidirectional turbines, there being no astern turbines, as manœuvring is carried out on the electrical side. All these sets of steam conditions can be put forward with confidence. Whether it will be possible to increase successfully steam temperatures is the key to further advance in steam pressure, because the percentage of moisture at the low-pressure end of turbines must be kept within prescribed limits, which,



Double-furnace, controlled-superheat, high-pressure marine boiler



in marine practice, is normally limited to a wetness of not more than 10 per cent. The alternative solution is, of course a more general adoption of reheating, but it is doubtful whether this can be done without undue complication, with geared turbine machinery, owing to the necessity of positively cutting out the reheater completely when going astern. Unfortunately, the law of diminishing returns becomes important when the range of the aforementioned steam conditions is exceeded, and the wisdom of going beyond these figures is at present very debatable in view of increased auxiliary consumption and the greater care necessary in operation. Capt. Gregson suggests an examination of the possibility of reducing the area on the entropy diagram below the base line of work done, by cutting down the condenser loss, by which is thrown away all latent heat apart from that reabsorbed by bled-steam feedheating. Could a process of heat pumping be justified to avoid part of this loss—at the expense of negative work to operate the feed pump? This would seem to be a reasonably rational line of thought, as improvements at the upper end of the cycle are very small. Furthermore, with boiler efficiencies of the order of 87 per cent and with the turbine developed with minimum internal losses, it is improved cycle efficiencies that must be looked for.—*Presidential Address of Capt.(E) W. Gregson, delivered at a General Meeting of The Institution of Mechanical Engineers, 22nd October 1948.*

Reconstruction of the French Rhine Fleet

At the end of the war only a small part of the French Rhine fleet remained. Owing to lack of materials orders for new vessels had to be placed abroad. Ten large river towboats are now building in Holland. These are motor vessels of 60 m. length, 8 m. breadth, 1·4 m. draught. The propulsion plant consists of three 800 b.h.p. Diesel engines, each driving a screw propeller. Five of the vessels are equipped with Sulzer two-stroke single-acting Diesels of 350 r.p.m. direct coupled with the propeller. The other five boats will be equipped with MAN two-stroke single acting Diesels built under license by the Soc. Generale de Constructions Mécaniques de La Courneuve, France. These engines turn at 650 r.p.m. and will be furnished with reversible reduction gear of French make.—*S. Posthumus, De Ingenieur, Vol. 60, 17th September 1948, pp. W.114-118.*

Behaviour of H.M. Ships During the War

This paper is intended to give a general picture of technical difficulties which arose during operation of the fleets in the last war. These difficulties were increased by the widespread nature of operations in all kinds of sea conditions and climates varying from the tropics to well within the arctic circle, and by the many radical changes in fighting conditions brought about by the advent of modern weapons. The improvements in aircraft in the twenty years between the two wars had increased their menace to ships to such an extent that the provision of adequate counter measures for protection was no easy problem. Much increased H.A. armament with improved fire control systems, and the introduction of radar and W/T techniques, all had to be accommodated in ships, the majority of which had been designed ten to twenty-five years before. Such changes necessitated serious inroads into stability and freeboard and equally serious reductions in the space available for accommodation. In general, although of course there were plenty of maintenance difficulties and comparatively minor troubles, no real weaknesses were revealed in the case of the machinery, despite the wear and tear to which it was subjected, though certain new troubles arose in the case of boilers, e.g. "scab pitting" on the insides of tubes (occasioned by prolonged steaming and difficulties in maintaining adequate purity of feed-water), circumferential fatigue cracking of tubes in certain small vessels, brought about by hard steaming and rapid changes of speed (remedied by improved circulation), and the accumulation of hard bonded deposits on the outside of boiler tubes due to the presence of salt water in the oil fuel, which also led to rapid deterioration of furnace brickwork. Apart from these there were no abnormal troubles of a general nature—*Paper by N. G. Holt and Capt.(E) F. E. Clemitson, R.N. read at the autumn meeting of the Institution of Naval Architects, 23rd September 1948.*

ENGINEERING ABSTRACTS

Section 3. SHIPBUILDING AND MARINE ENGINEERING

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Conversion of Great Lakes Vessel to Self-unloader

The Great Lakes bulk freighter *Adam E. Cornelius* was recently converted into a self-unloading vessel. The cubic capacity of the cargo holds of the 600-feet overall vessel is 469,500 cu. ft. With the new self-unloading equipment the unloading rate is 1,800 tons per hour plus 20 per cent overload, based on stone at 90lb. per cu. ft. The conveyor system consists of two 42-inch hold conveyors with a speed of 380ft. per min. The hold conveyors carry the material forward and feed into transverse 42-inch cross conveyors which in turn feed a 96-inch pass conveyor. The latter has an inclination of 42 deg. and revolves a continuous chain of sixty-six interlocking buckets at a designed speed of 93ft. per min. By means of the inclined pan conveyor, material is elevated above the spar deck and discharged through a chute on to a 48-inch boom conveyor, the designed speed of which is 545ft. per min. The conveyor boom is 225-feet long from the hinge pin to the centre of the take-up pulley plus a 3-feet take-up and is arranged to swing through an arc of 113 deg. on each side of the centre-line of the ship. The conveyor drive engine is a Skinner, poppet valve, unaflow, non-reversing, three-cylinder, vertical steam engine, with each cylinder 17½ inch in diameter by 16-inch stroke. The normal rating of the engine is 700 b.h.p. at 250 r.p.m., but the engine is fitted with a constant-speed governor having a manual speed adjustment to maintain any desired speed accurately between 200 and 300 r.p.m. according to the manual setting, at any load between 500 and 800 b.h.p. With the engine operating at an estimated average rate of 600 i.h.p. with steam at throttle at 175lb. per sq. in. and exhausting to a 25-inch vacuum, the water rate will be 13·7lb. per sq. in. per i.h.p.-hr.—*G. F. Rankin and A. J. Zuehlke, Marine Engineering and Shipping Review (New York), Vol. 53, September 1948, pp. 46-51.*

Steam Gunboat Machinery

The machinery for the steam gunboats was designed and produced in a period of about fifteen months following July 1940. It was required to be to the standards of a reliable marine steam plant but less than half the weight per shaft horsepower of existing practice. The paper describes the machinery broadly, and indicates generally how the target weight figure for the installation was achieved. The difficulty of fitting suitable machinery into the space provided was not inconsiderable, but was not so great as that of getting down to the target weight. The really notable feature of the installation was the degree of lightness obtained in the plant. The weight allowed for the corresponding complete 8,000 s.h.p. installation was 50 tons—or 14lb. per s.h.p. The weight actually achieved was just inside this figure, by taking every means of reducing weight available at that time; remembering, however, that decisions were tempered by the knowledge that there was no time for prototype trials and that practically everything had to work "first time out". The boiler output was 80,000lb. of steam an hour at 400lb. sq. in. and 700 deg. F. at the stop valve and was fed through a single 5-inch pipe branching to the two sets of main turbines. The ahead turbines had a Curtis wheel followed by six impulse stages and had a full power speed of 5,000 r.p.m. An astern power of 450 s.h.p. in each shaft was provided by a single Curtis wheel at the after end of the rotors. The rotors were of the solid "gashed" type. The dual flow underslung condenser was designed to give a vacuum of 26·5in. at full power ahead. A flexible quill shaft bolted solidly to the rotor spindle passed through the pinion to a claw coupling at the after end, providing flexibility. The pinion was of 3½ per cent nickel steel; the gear-wheel was of conventional bolted-up construction, with a hollow spindle. The pitch line-speed, tooth loading, materials and other design characteristics of the gearing all had conservative values. The Michell main thrust block was incorporated in an extension of the fabricated gear case, which was suitably stiffened. Preliminary investigation of a number of designs gave a range of weights for the required output of from 20 to 28½ tons. Of these the John Thompson-La Mont and the Foster Wheeler modified D-type boilers were selected as being the two most suitable types for development. In order to reduce the weight of the boiler plant, it was agreed that 72 per cent efficiency would be acceptable at full power. On trial the La Mont boiler failed to produce its designed performance entirely because of the inability of the Admiralty oil-burning equipment to complete the combustion of the distillate fuel with the guaranteed excess air figures within the confines of the furnace. The furnace of the Foster Wheeler boiler was more conservatively rated than the La Mont design. Less trouble was, therefore, experienced with the combustion, as the flame was not over-cooled.—*Paper by Com'r(E) H. A. K. Lay, R.N. and Com'r(E) L. Baker, D.S.C., R.N., read at a joint meeting of the Institution of Naval Architects and the Institute of Marine Engineers on 23rd September 1948. Transactions of the Institute of Marine Engineers, Vol. 60, October 1948, pp. 190-203.*

Operating Procedures on Turbine Electric-drive Vessel

This paper includes a description of the operating control of turbine-electric propelled vessels as applied to T2-SE-A1 and A2 tankers, to P2-SE2-R1 troopships and P2-SE2-R3 passenger cargo vessels Fig. 1 shows schematically the bare essentials of the power and excitation circuits. The reversing lever is shown in the off position and consequently the line and field contactors are open. The propulsion generator is turning at idling speed. However, it is generating no voltage as the field circuit is open. It will be noted in this diagram that one lever operates both the reversing and field contactors which is the T2 tanker system of control. The P2 installations use the three-lever system of control in which the reversing contactors and field contactors are opened and closed by means of separate levers. In the following the two-lever systems is described. Fig. 2 shows what happens when the reversing and field lever is moved to the number one position ahead. On the P2 vessels this is accomplished by moving the reversing lever to the ahead position. Contactors 1, 3, 5, close and connect the motor to the generator electrically. It should be noted, however, that in this position no electrical power is yet transmitted to the motor since the field has not yet been applied to the generator. Fig. 3 shows the reversing and field lever in the number two position. On the two lever systems the corresponding condition would find the field lever in the number one position. At this point the generator field contactors close and the generator is excited to about 250 per cent of normal. The resulting high generator voltage gives the motor a high starting torque and the motor accelerates very rapidly. The inrush current to the motor causes the line ammeter to go off scale, about 2½ times normal. As the motor approaches its slip speed the ammeter drops back to about 150 per cent or normal and pulsates. At this point the reversing and field lever is moved to the number three run position (Fig. 4) and on the ships with the two-lever system the field lever is moved to the number two position. This closes the motor field contactors applying direct current to the motor field causing it to "pull into step" with the generated alternating current. The generator field remains over-excited for about five seconds to give the motor a high "pull in" torque and ensure its coming into step with the generator. On the tankers the excitation drops back to normal automatically after the five-second delay. On the P2 vessels the field lever is moved from position two to the run position, after a few seconds delay, restoring the generator excitation to normal. The operator is then free to advance the speed lever until the desired propeller speed is obtained. To stop the equipment the operations are reversed. The operator first moves the speed lever to its idling position. The reversing and field lever is then returned to the "off" position. On ships equipped with the three-lever system, the field lever is moved to the "off" position before the reverser lever is returned to its off position. In reversing, the sequence is the same as for ahead operation. The only difference electrically is that two of the three motor leads are interchanged. This changes the phase rotation of the power to the motor causing it to rotate in the astern direction. Fig. 5 shows schematically how interchanging of the two phases is accomplished. The time lag in moving the reversing and field lever from position two to position three is longer when making reversals with way on the ship than when starting the propeller with the ship at rest. The reason for this is that the ship in its movement tends to keep the propeller turning. The power that is exerted on the motor must first slow the propeller down. Several seconds elapse before the motor can bring the propeller to its stop

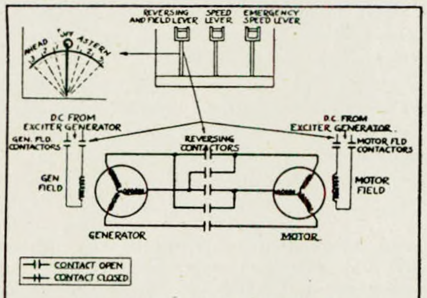


FIG 1.-REVERSER LEVER IN 'OFF' POSITION

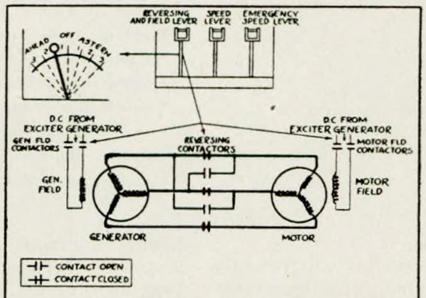


FIG 2.-REVERSER LEVER IN POSITION 'ONE' AHEAD

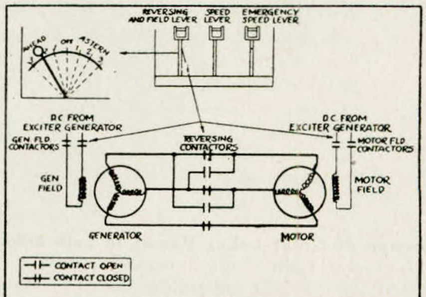


FIG 3 -REVERSER LEVER IN POSITION 'TWO' AHEAD

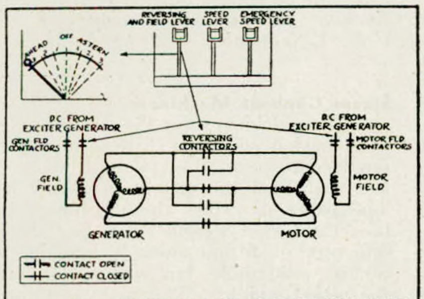


FIG 4 REVERSER LEVER IN POSITION THREE AHEAD

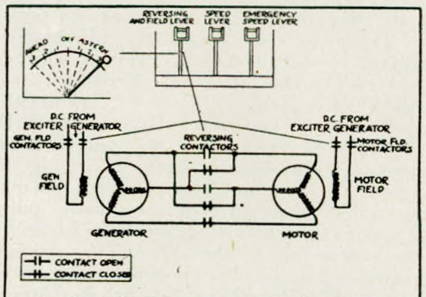


FIG 5 -REVERSER LEVER IN POSITION 'THREE' ASTERN position and then accelerate it in the reverse direction. Care must be taken, however, not to allow the lever to remain in position two after the motor has reached its maximum speed as an induction motor. This causes unnecessary heating of the generator field windings.—*Paper by H. W. Ogilvie, read at a meeting of the Society of Port Engineers, San Francisco, 1st October 1948. Pacific Marine Review, Vol. 45, October 1948, pp. 47, 49, 81, 92, 93.*

Manœuvring Platform Layout

In the new cargo steamer Mahseer of the Brocklebank Line, the manœuvring platform is of an unusually simple character. It is situated below the turbine rotor centres at the forward end of the engine-room and consists only of the usual three large diameter handwheels controlling the ahead, astern and double shut-off valves supplying steam to the respective turbines. All the essential turbine gauges are grouped on a sloped rectangular board placed in front of the operator, who faces aft. This board is sloped in order that a large direct-driven, direction and revolution speed indicator mounted between two of the three turbine cylinders can be seen clearly. The ahead handwheel is on the starboard side and is arranged at a different height from the astern handwheel, which is below the ahead control; the manœuvring valve is on the extreme right above both wheels. On a second rectangular board, to the right of the operator, the essential boiler gauges are grouped, giving both steam pressures and temperatures. Just above the engineers' platform, also in the chart room, electrically operated neon direction and speed indicators keep time with the beats of the propeller, rotating clockwise for ahead movement and anti-clockwise when the turbines are moving astern. In this way, both bridge and engine-room have a continuously visual record of both the direction of rotation and speed of the propeller. Not always is the engine-room of a turbine-driven steamer of equivalent size and power arranged in such a straightforward and at the same time effective manner.—*The Journal of Commerce (Shipbuilding and Engineering Edition), No. 37,670, 18th November 1948, p. 6.*

Speed Control and Efficient Operation of Turbines

The 6,000 and 10,000 h.p. electric drive turbines are similar in general construction to ordinary land generating sets with the exception that speed control is variable whereas on land units speed as a rule is constant and other features are incorporated for marine use. The governor on marine types has been designed to operate effectively through a broad range extending from pre-emergency governor. Limiting speed of the turbine generator is done by a very simple device. On the 6,000 h.p. sets, a spring opposed plunger which is carried in a hub on the turbine shaft remains inoperative at all speeds below 20 per cent over-speed. In case the turbine should overspeed, the spring force is overcome by centrifugal force and the plunger throws out and strikes the trip finger which releases a latch on the throttle valve which causes the throttle to close instantly. The plunger normally remains clear of the trip finger by $\frac{1}{16}$ inch, but it moves out $\frac{5}{16}$ inch while in action. Automatic controlled sealing of turbine glands is a great improvement over manual operation where hand adjustments had to be made for every change in load. The steam seal regulator is made to hold a constant pressure of 2lb. gauge on the high pressure and low pressure packing casing regardless of the internal pressures while manœuvring or running under way. The action of the regulator is very simple and once adjusted to operate at the correct pressure the need of readjustment is quite remote; in fact, these regulators might safely be made so that the original setting could not be altered. When service is called for on these regulators, they are often found to be completely out of adjustment, and correction is made by resetting the valves to the original position, which, by the way, is tram marked. The common reason for upsetting the adjustment is to provide additional sealing steam when there is difficulty in raising vacuum in port or in a loss of vacuum under way. Additional sealing steam does not improve matters. The loss is invariably due to air leakage or fouled strainers in the radojets or from a number of other causes, but for some reason the turbine glands are suspected of causing the trouble and the regulator setting is changed.—*Paper by G. Barr, read at a Meeting of the Society of Port Engineers, San Francisco, 1st October 1948; Pacific Marine Review, Vol. 45, October 1948, pp. 47-48, 83.*

Unaflow Engines for Canadian Passenger Steamships

The *Prince George* is the largest passenger vessel ever built in British Columbia. Built by Yarrows, Ltd., at Esquimouth, the ship is 350 feet in overall length with moulded breadth of 52 feet and maximum draught of 17ft. 6in., and of 5,812 gross tons. Her speed is 18 knots. Propulsion is effected by two Skinner Unaflow steam engines made by Canadian Vickers, Ltd., of Montreal. Each engine has six cylinders of 23-inch bore and 26-inch stroke, develops 3,500 i.h.p. (normal load) at 175 r.p.m. and is capable of a 25 per cent overload. The total power obtainable at overload is thus 8,750 i.h.p. Superheated steam is supplied at the throttle at 230lb. per sq. in. gauge pressure and 550 deg. F. total temperature. The high mechanical and thermal efficiency of these engines is indicated by the following performance data:—

Load	1/2	3/4	Normal	5/4
i.h.p.	1,750	2,625	3,500	4,375
s.h.p.	1,620	2,450	3,280	4,110
Mechanical efficiency ...	92·5%	93%	93·8%	94%
Lb. of steam per i.h.p.-hr. ...	10.2	10·5	10·9	11·3

All cylinders are identical and independent, thus eliminating troubles in alignment resulting from thermal expansion. The steam which passes first to the cylinder heads, which act as steam jackets, enters the cylinders at each end through patented telescopic double-seated poppet valves specially designed so that the valves remain tight at all temperatures. The poppet valves are actuated by cams located on two camshafts, the relative position of which is altered by two control levers, thus varying the cut-off, and reversing the engine in a matter of seconds. These camshafts are driven from the crankshaft through roller chains. After cut-off and expansion have taken place, the steam is exhausted to the condenser through ports arranged around the centre of the cylinder and uncovered by the piston at the end of the power stroke. Another important feature of this engine is that it is fully enclosed and force-feed lubricated, oil being supplied by independently steam-driven pump. Cylinder lubrication is also effected by engine-driven lubricators, and the removal of free and emulsified oil from the condensate is accomplished successfully by pressure leaf type filters utilizing diatomaceous earth and fibrous asbestos.—*Canadian Shipping and Marine Engineers News, Vol. 20, October 1948, pp. 37, 54.*

Rubber-covered Propellers

According to a statement published by the British Rubber Development Board, the American Goodyear Co. have evolved a rubber-covered propeller which has been developed particularly for use with outboard motors for small craft. The rubber is applied to a metal core of cast aluminium or bronze, which affords the necessary degree of stiffness; while the flexible and resilient rubber covering serves to limit the severity of shocks, due to the impact of the blades on driftwood or other obstructions which might damage the propeller or drive. It is also claimed that such propellers are less liable to become foul of weeds. The principle employed is also applicable in other fields, including flexible impellers for pumps, rubber-seat poppet valves, etc.—*The Shipbuilder and Marine Engine Builder, Vol. 55, November 1948, p. 687.*

Measuring Slipperiness of Walkway Surfaces

An adequate method for measuring slipperiness has hitherto not been available. This paper discusses the mechanics of walking as related to slipping, and the design of testing instruments is also discussed. In order to test floors in actual service a portable slipperiness tester of the pendulum impact type was designed and constructed. The instrument and test procedure are described. The effects of varying some of the constants of the instrument, such as the angle of the test heel and the walkway are discussed. Typical results obtained with both rubber and leather test heels and under both dry and wet conditions are given for various flooring and finishing materials.—*P. A. Sigler, M. N. Geib and T. H. Boone, Journal of Research of the National Bureau of Standards, Vol. 40, No. 5, 1948, pp. 339-346.*

The Coal-fired Gas Turbine

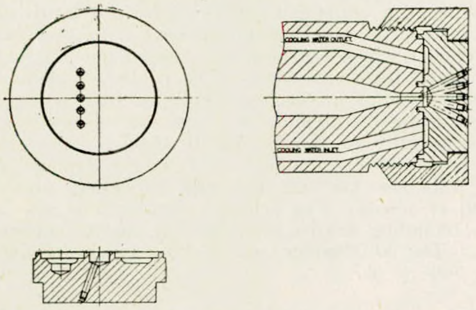
The authors consider the types of gas turbine cycle to which coal firing could be applied and the performance which could be expected. Discussing the applicability of coal-fired gas turbines to ships, it is pointed out that the open-cycle gas turbine requires five to eight times as much air as the steam cycle, which means that air ducts of considerably larger size are needed and these constitute a disadvantage on board ship. Further, for marine work the fact that the open-cycle gas turbine needs no cooling water is unimportant. Many of the smaller steamships are coal-fired, but the authors do not think that the coal-fired gas turbine is likely to find favour for ship propulsion, at least until it has become established in other fields. The fact that the steam turbine is well understood, together with its simplicity and reliability, makes it probable that for many years it will continue to be installed where coal is the fuel to be used.—*Paper by F. B. Karthauser, W. V. Battock, and F. F. Ross, presented at a meeting of the Institute of Fuel on 19th October 1948.*

Diesel Engines and Their Fuels

This paper refers to the problem of the grades of fuels required by high speed and slow speed Diesel engines. Discussing the medium and slow-speed classes, the author points out that the nature of the fuel, that is, whether it is paraffinic or asphaltic, is very important. The distillation range by itself gives little useful information, but what is left after final boiling point, i.e., its percentage and its properties, are important. These vary considerably with different crudes and the complete combustion of this residue constitutes the problem. The carbon residue, as expressed by the Conradson value, is a measure of this property of the fuel to some extent, but from the engine point of view the Conradson value is unsatisfactory. The real difficulty in burning residual fuel is to consume the hard asphalt, which is a bituminous substance probably of high C/H ratio, in colloidal solution in the fuel. It is not possible to remove it by filtration or centrifuging. The burning of hard asphalt depends on breaking up the fuel as finely as possible and applying as much heat as is feasible—that is, high compression and compact combustion chamber. Cetane number is not very important in slow-speed engines but it can, if too low or if the engine compression happens to be low, make starting difficult and give heavy knocking, which is so objectionable. Further, if by any chance a fuel sprayer permits solid fuel in its jet, then the lower the cetane number, the more chance of the fuel reaching the piston top or the cylinder liner before combustion is completed and the burning droplets will be extinguished with formation of carbon. The burning of fuel oil in a Diesel engine involves :—

(a) Cleansing the fuel oil of all water and adventitious matter.
(b) Correct combustion chamber, pump and injector.
(c) Adequate cooling of the injector tip.

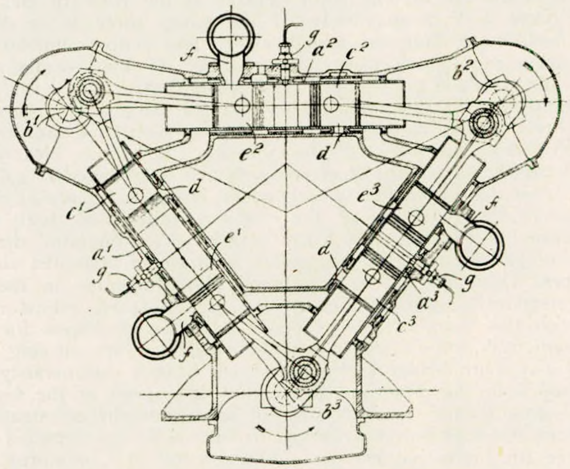
The author explains that cooling of the sprayer tip is most important and can be helped considerably by the design of the component parts being arranged to convey the heat away. Cooling, to be efficient, must be right at the nozzle tip. The best design is that used in the Doxford engine. The nozzle plate is shown in detail in the illustration. It will be noticed that cooling is very thorough and that the medium, water in this case, is brought very close to the fuel just as it is entering the cylinder. The cooling space of sprayer can be circulated with water or fuel oil—lubricating oil has been tried but found unsatisfactory. Fuel oil having only half the specific heat cannot be so efficient as water, and to get the best effect water must be used. Corrosion can be prevented by suitable treatment of the sprayer parts or by an inhibitor added to the water. The position of the sprayer in the cylinder head with reference to the combustion chamber is important, and when deciding this arrangements should be made to direct the flow of the incoming cylinder-head cooling water on to the place where the sprayer is located.—*Paper by P. N. Everett, presented to the Joint Conference of the Institute of Fuel and the Institute of Petroleum, 23rd September 1948. The Motor Ship, Vol 29, October 1948, pp. 273-275.*



Water cooled spray plug of Doxford fuel valve

Multi-cylinder Opposed-piston Engines

This invention concerns two-stroke multi-cylinder opposed-piston internal combustion engines wth compression ignition, or petrol injection and spark ignition, for ships, aircraft, or heavy vehicles. It arose out of a study of the operating conditions and requirements for engines having a triangular arrangement of cylinders, and consists in the provision of a new range of triangular positioning for the cylinders of a triple-crankshaft opposed-piston internal-combustion engine comprising one or more transverse sets of three cylinders. Each set of cylinders is arranged so that the extended cylinder axes form a triangle with corners on the axes of the crankshafts, which have crankpins each common to the two pistons of adjacent cylinder ends. The cylinder axes triangle is isoceles, with the angle between the equal sides greater than 60 deg. and not more than 90 deg. With a 90 deg. angle the firing interval angle equals the geometrical angle between successively firing cylinders in the power sector. The opposed pistons in each cylinder move exactly in phase without lead or lag of one piston over the other, each triangular set of cylinders being dynamically balanced. It is known, however, that higher efficiency can be obtained in an opposed piston engine by giving one piston a lead over the other. With any angle other than 90 deg., the firing interval differs from the angle between successively firing cylinders in the power sector, and this entails a phase difference between the opposed pistons in each cylinder. The difference, expressed as an



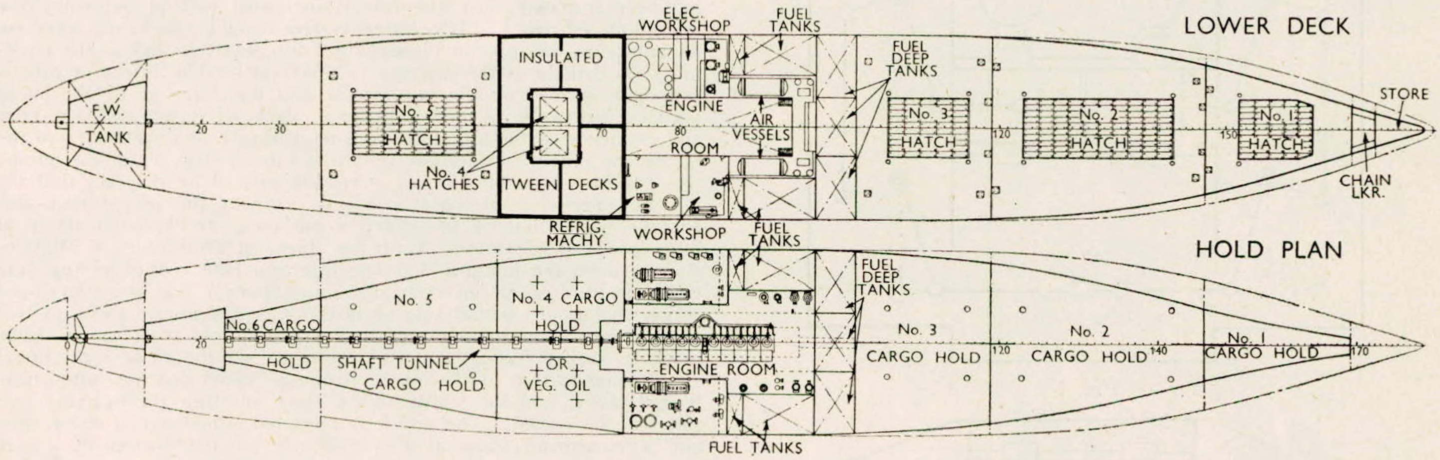
angular interval of crankshaft rotation, is one-third of the difference between the sum of the two angles of the triangle at which the crankshafts rotate in the same direction, and the remaining angle. The set of cylinders shown in the figure has a major angle of 75 deg. at the crankshaft (b^3) which entails a phase difference angle of 10 deg., as will be seen by deducting 75 deg. from the sum (105 deg. of the angles at b^1 and b^2 and taking one-third of the remainder). The phase difference means that in each cylinder one piston will lead the other in its movements towards and away from the inner end of its stroke, and, to obtain better port timing and thus higher efficiency in normal and ahead running, the leading pistons is made the exhaust piston. A 90 deg. angle gives a fully reversible engine without phase difference, and dynamically balanced in each triangular set. As the angle is decreased towards 60 deg. it passes through an optimum efficiency for one direction of rotation, with a corresponding loss for the other direction of rotation. With fewer than eight sets of cylinders, regularity of torque between the three crankshafts also becomes easier to obtain.—*British Patent No. 602,662, issued to H. Penwarden and J. Kingcome, K.C.B., Engineer Vice-Admiral, Engineer-in-Chief of the Fleet, Admiralty. Complete specification accepted 1st June 1948. Reproduced by permission of thhe Comptroller of H.M. Stationevy Office (British Patent Specification can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2. Price 2s. each inland, or 2s. 1d. abroad). The Shipping World, Vol. 119, 13th October 1948, p. 300.*

Oil Engine Exhaust Smoke

There are two kinds of exhaust smoke. One may be called "hot" smoke, since it results from the sluggish burning of fuel particles, and the other is "cold" smoke and results from fuel particles that are ignited too late or not at all. A typical example of hot smoke results from overloading, while cold smoke is likely to result from light idling. Exhaust smoke manifesting unfinished combustion may be the product either of mis-fire or of late burning, mis-fire representing the case where combustion has not yet begun when the exhaust valve opens, while the late-burning combustion is proceeding when the exhaust valve opens. Mis-fire produces cold smoke, while late burning produces hot smoke. Since the oil engine cylinder charge is not homogenized, both hot and cold smoke frequently appear side by side, because some fuel particles ignite but do not complete their combustion, and others fail to ignite at all. The most important factor causing incomplete and therefore sluggish combustion is an over-rich mixture, as when fuel is burned with a deficiency of oxygen. Short ignition lag is a less-known condition causing sluggish combustion. Any factor that causes an exceptionally short ignition lag promotes smoke, but this smoke is not nearly as dense as that resulting from other causes. Late ignition is the other general source of smoke. It can be put right by advancing the ignition timing, but if it results from long ignition lag, other means must be resorted to. The remedy lies in increasing compression temperature or pressure, while increase in compression ratio will raise both temperature and pressure. If the combustion chamber is very hot, all fuel ignites promptly, even at idling loading, and no low load smoke will occur. But if the combustion chamber is fairly cold and, in addition, the spray deteriorates at low fuel-rack setting, low-load smoke is accentuated and may even exceed the heavy-load smoke. Advancing injections should benefit combustion and counteract smoke for various reasons, principally because the fuel has more time to burn and because early injection causes explosive combustion with turbulence. If, however, injection is advanced too far, cold smoke is formed owing to spray impingement and final mis-fire. Increasing fuel volatility should reduce smoke under all conditions—*Petroleum, Vol. 11, October 1948, pp. 234-235.*

First Post-war Spanish Motorship

The *Monte Urbasa,* which is the first post-war built Spanish motorship, has a deadweight capacity of 8,700 tons, the gross register being 6,500 tons, the length overall 486 feet, and the beam, moulded, 62 feet. She and her sister ships are being built for trade to Buenos Aires, and although the designed speed is 16½ knots, the *Monte Urbasa* has been running for the time being at 17 knots. A 10-cylinder Sulzer engine is installed, designed to develop 7,300 b.h.p. at 132 r.p.m., and having cylinders 720 mm. in diameter, with a piston stroke of 1,250 mm. This is a standard design, of which large numbers are being built for French and Spanish motor ships at the present time. The total fuel consumption of the *Monte Urbasa* in service, when running at 17·15 knots, with the propelling machinery developing 5,540 b.h.p. and the generating plant supplying 168 kW. is 175·8 gr. or 0·38lb. per b.h.p.-hr. There is accommodation for fifty-two passengers.—*The Motor Ship, Vol. 29, November 1948, pp. 304-305.*



Lower deck and hold plans of the Monte Urbasa

Boiler Oil in American Diesel-engined Tankers

In a paper which C. L. Boyle, manager of the Marine Department of the Sun Oil Co., read before the Diesel Engine Panel of the American Merchant Marine Conference on 14th October, the author stated that their oldest Diesel-propelled ship equipped with 2,600 h.p. Doxford machinery was built in 1923 and is still in operation, "giving excellent service and operating at its original designed efficiency". The owners' largest Diesel-propelled ships are equipped with single-screw machinery of 8,250 s.h.p., and "the results of the operation of our Diesel fleet for the past twenty-five years show them to be efficient, reliable and economic units". It is stated that some of the ships are using Bunker C fuel, and that special centrifuging and heating equipment is installed, in conjunction with suitable fuel injection nozzles and an alteration of the engine timing. This is accomplished in both the main and auxiliary engines, and only one grade of fuel is carried—Bunker C. Many purchases of Bunker C were made from other companies. While the desirable viscosity limits are at 85 Say. Furol/122 deg. F., fuel with a viscosity as high as 105 Say. Furol/122 deg. F. could be burned. Conradson carbon and sulphur in the average run of Bunker C usually do not exceed the 5·0 per cent maximum and 1·5 per cent sulphur limits respectively.—*The Motor Ship, Vol. 29, November 1948, p. 296.*

Automatic Fuel Timing with Variable Compression

The cylinder of the engine partly shown in Fig 2 is provided with a movable head, and the gas pressure automatically times the fuel injection. The head (5) has a hollow stem (13) which works in a casing (14) secured to the cylinder by struts (15). Lubricating oil under pressure is admitted to a chamber (2) through a non-return valve (4), and the outlet from the chamber is controlled by a valve (1). When the chamber (2) is filled with oil and the valve (1) is closed, upward movement of the stem (13) is prevented and maximum compression is obtained in the engine cylinder. As the piston (7) rises, the air in the cylinder is compressed, causing the movable head (5) to move slightly against the pressure of the oil in the chamber (2), if the valve (1) is partly open. The rising head carries the fuel plunger (18) with it and compresses the fuel between the plunger and the non-return valve (22). Fuel is thereby forced down the central hole, lifting the injection valve from its seat, the degree of atomization depending on the strength of the spring (20). After the working stroke of the piston (7) has been completed, the movable head (5) is returned to its initial position by springs (30), a stop (21) being provided on the sleeve (14). Injection is thus initiated by the compression pressure in the cylinder and is continued after ignition, due to the

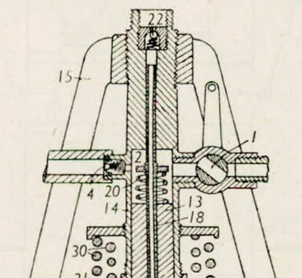


Fig. 2.

rise of pressure causing further upward movement of the movable head (5), thereby forcing further fuel down the central hole.—*Brit. Patent No. 604,343, issued to G. E. Wood. The Oil Engine and Gas Turbine, Vol. 16, November 1948, p. 253.*

Transatlantic Liner Design

This article discusses methods of reducing the space requirements of propulsion plant in trans-Atlantic liners. According to the author, present-day specific space requirements for the propulsion plant range from 190 to 200 cu. m. per 1,000 h.p. with steam turbines, 250 to 280 cu. m. per 1,000 h.p. in the case of motor ships with a single engine room, and 500 to 550 cu. m. per 1,000 h.p. for motor ships with two engine rooms. Taking the case of a 25,000-ton motor ship with a speed of 25 knots, a reduction of 50 per cent in the space

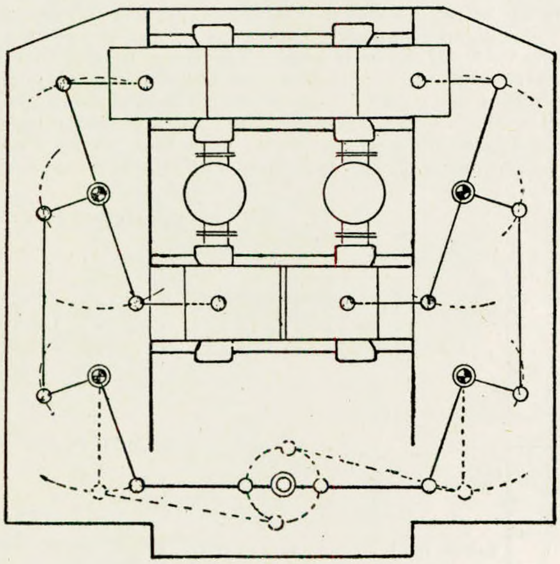


FIG. 1.

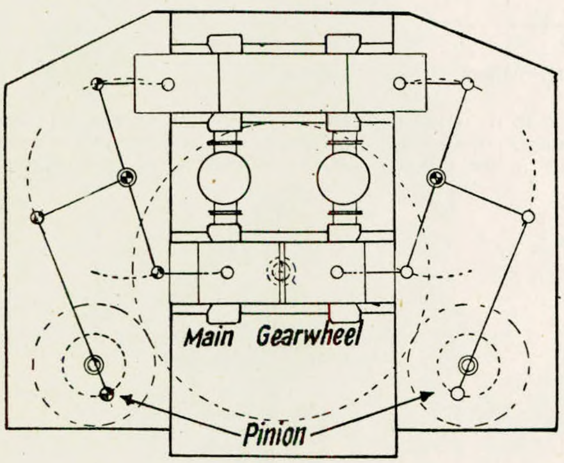


FIG. 2.

required for the propulsion plant would create sufficient space for the accommodation of 200 additional tourist-class passengers. The author suggests that a considerable reduction in the space requirements of Diesel propulsion plant could be achieved by employing Diesels with reduced head room requirements of the type outlined in Figs. 1 and 2. In both diagrams the employment of an engine of the opposed-piston type, having two banks of horizontally placed cylinders, is envisaged. In Fig. 1 direct drive is employed, while a single-reduction gear is suggested in Fig. 2. The number of cylinders to be employed per bank will depend upon the power requirements. Advantages claimed for this engine type include greater compactness of design, especially reduction in headroom requirements, as compared with the vertical engine type, simplification of cylinder construction, absence of crossheads, utilization of all the advantages accruing from the opposed-piston principle, ease of balancing, reduction in lateral piston pressures, and consequent reduction in cylinder and piston wear. Moreover, the horizontal cylinder arrangement would facilitate engine erection, maintenance and repair. The entablature would be simple and low in weight and the position of the crankshaft could be chosen in accordance with requirements. The article includes a considerable amount of tabulated data on the cost of operation, estimated revenue, etc., of various types of vessels.—*L. Calzavara, Revista Marittima (Technical Supplement), July 1948. Abstracted in The Marine Engineer, Vol. 71, November 1948, p. 515.*

Recent Research on Fuel Injection

It has been established in the development of oil engines that the rate at which the fuel is injected into the engine cylinder is of paramount importance and has a decided bearing on the combustion efficiency and "Diesel knock". The cause of Diesel knock has been described by several authorities and it has been established that by obtaining control over the injection rate, knock can be eliminated with little effect on efficiency. One of the methods of eliminating knock is the use of a pilot injection system which gives an interrupted two-phase injection, a small quantity of fuel being discharged in the first phase to initiate burning, without excessive pressure rise, and the remainder of the fuel required for power development being injected during the second phase. Another method is that of using a non-interrupted injection, whereby the initial rate is low until burning has been initiated when the rate is increased to that necessary for maximum efficiency. The latter system would appear to have an advantage as the injector closes only once per cycle and so the possibility of dribble at the injector is minimized. The injection rate is primarily decided by the cam profile and the diameter of the pump plunger, but owing to the complicated effects of spring-loaded nozzles and resilience of the pipe line and fuel, the rate of injection from the nozzle can differ considerably from the rate of delivery at the pump; this has long been known and is readily proved by the fact that the injection period at the nozzle usually exceeds the period necessary for the completion of the effective pumping stroke, particularly at high speeds of operation. With the object of establishing a relationship between the pump and nozzle injection rate and providing data to obtain ideal nozzle injection rates, an apparatus has been developed which enables the actual rate of injection at the nozzle to be plotted in cu. mm. of fuel discharged against pump camshaft angle. The machine consists basically of two rotating disks driven at a rotational speed equal to that of the injection pump. Each disk is slotted near its periphery, and the width of the clear aperture through the two slots can be varied. The nozzle is mounted adjacent to the top disk and a measuring glass at the underside of the bottom disk. A schematic layout of the essential machine parts is shown in Fig. 2. In operation, the beginning of injection is determined by a stroboscopic light source, and the leading edge A of the lower disk slot is adjusted to coincide with the nozzle spray at the beginning of injection. The upper disk is then adjusted so that the trailing edge B of its slot is 2 deg. retarded from the lower slot leading edge. This gives an effective slot width of 2 deg. With the apparatus running, the measuring glass is put into action for a measured period of time (or number of revolutions). From the amount of oil collected the quantity injected into the first 2 deg. is calculated. Leaving the lower disk

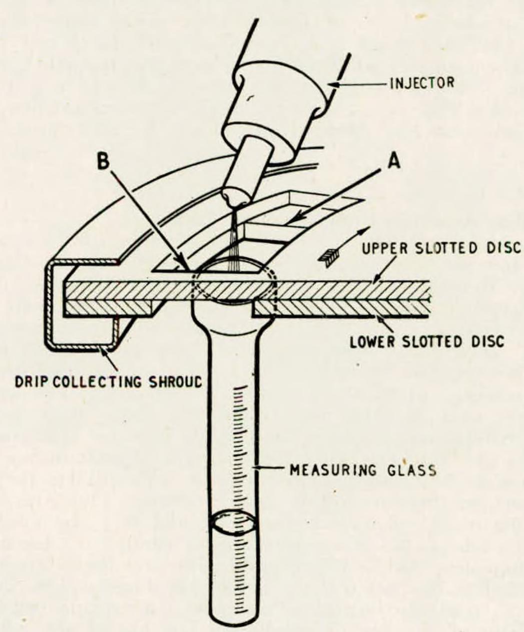


FIG. 2.—*Diagram of the stroboscopic apparatus used for the measurement of injection rate*

as before, the upper disk is adjusted so as to increase the effective slot by 1 deg. at a time until the whole injection period has been covered. At each adjustment measuring glass readings are taken as before. Results are then plotted as cu. mm. per deg. against injection period deg. (a typical result is shown in Fig. 3) and compared with the

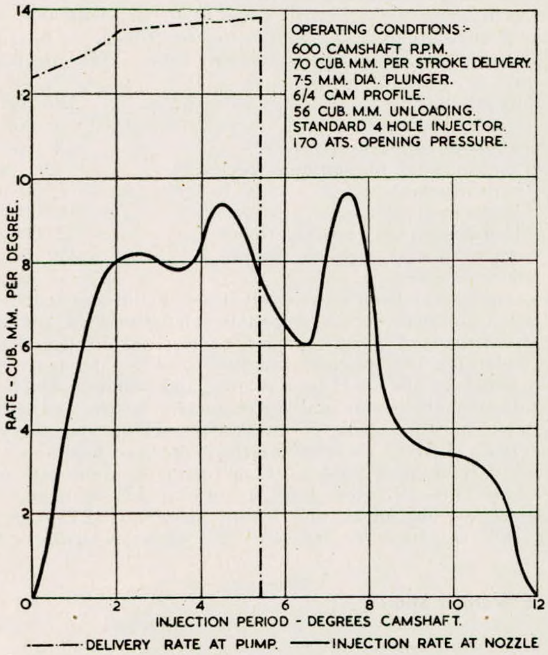


FIG. 3.—*Graph of typical test result*

theoretical delivery rate at the pump. The considerable divergence between the theoretical delivery rate occurring at the pump and the actual rate from the nozzle can be clearly seen, as also can the difference between the theoretical and actual injection periods.—*A. T. Priddle, Gas and Power, Vol. 43, Annual Technical Review Number, 1948, pp. 351-352.*

Piston Lacquer Thickness Gauge

A new instrument for the rapid and accurate measurement of lacquer deposits on engine pistons has been announced by the Beacon, N.Y., research laboratories of the Texas Oil Co. Containing two high-voltage terminals, one attached to the piston and the other touching the lacquer deposit, the new instrument measures the voltage required to burn through the lacquer. Since it takes a known amount of voltage to penetrate a given lacquer deposit, the thickness of the deposit can easily be measured. The new device eliminates the expensive time-consuming technique of removing the deposits by hand and then weighing them. It also gives an accurate reading of the lacquer thickness at any spot, rather than the overall average for the entire piston.—*Petroleum, Vol. 11, November 1948, p. 264.*

Vapour Phase Cooling for Marine Diesel Engines

Closed cooling systems eliminate most of the hazards of using sea water in the jackets and certainly contribute enormously to efficient Diesel operation. Indirect cooling is now accepted practice in Diesel operation and the heat exchanger is standard equipment in marine installations. In the patented "Vapour Phase" cooling system jacket water is maintained at 212 deg. F., the water circulating in a closed system to a flash-tank where it flashes into steam, is condensed, and passes back into the engine jackets. Since no cooling is accomplished until the engine heats up to boiling temperature, the system maintains this temperature under all conditions of engine load and ambient temperature without the use of thermostats or other heat control devices. Since in the average engine the heat of about 28 per cent of the fuel burned is rejected to the cooling water, the engine comes up to boiling temperature in a very short time, even under partial load. The "Vapour Phase" system is designed to cool engines effectively at maximum load at the highest ambient temperatures anticipated in the ship's range of operations. The formation of sludge in the lubricating oil is retarded, since the cooling water from inlet to discharge is maintained at temperatures well above the dew point of the gases in the combustion chamber. The dew point of such gases is approximately 194 deg. F. By maintaining the cooling water at 212 deg. F. condensation from the products of combustion is eliminated; thus no sludge can form, as no water will be present in the cylinders or in the lubricating oil.—*Motorship (New York), Vol. 33, October 1948, pp. 26-28.*

Centrifugal Blowers for Two-cycle Diesel Engines

The use of the motor-driven centrifugal blower as the source of scavenging air for a two-cycle Diesel engine has provided one solution to the problem of installing maximum additional horsepower into restricted space. When the blower is properly proportioned and its peculiarities are understood, it is a very satisfactory source of air. For very large engines, especially with large numbers of cylinders, a much better distribution of scavenging air is possible than with an engine-driven blower or pump located on end of the crankshaft. In ships where the machinery space is very crowded it has been found practical to locate the centrifugal blowers at almost any reasonable place and pipe the air to the engine. In studying the interrelation of centrifugal blower and Diesel engine, it is important to realize that both speed and conditions at blower inlet are variable as volume and density change. Characteristic curves must be considered for the unit as installed, allowing for increasing resistance in the intake system with increasing volume, and also decreasing motor speed with increasing horsepower. Both of these factors increase the droop of the blower characteristic curves. Fouling of the engine and of the blower impeller blades by dust and oil must also be taken into account. For most efficient operation, the air volume of a two-cycle engine could decrease as the load decreases, but no available air source has this characteristic, with the possible exception of an exhaust driven supercharger. The characteristic of positive displacement blowers and pumps is very steep, i.e., the volume delivered is almost independent of changes in engine resistance or atmospheric conditions. The power required is affected only by atmospheric density variations. The characteristics of the centrifugal blower are less favourable and because it is necessary to select the blower for maximum ambient temperature, minimum barometer, maximum load conditions, plus allowance for engine and blower fouling, it is also necessary to limit the blower power at high density (cold air) and minimum load conditions to maintain reasonable fuel consumption and to avoid overloading the motor. This is most conveniently done by throttling with a butterfly valve. This may be located in either blower suction or blower discharge. It is usually located in the discharge because it is more readily accessible to the engine operator. Automatic control has not been found necessary. Generally, the adjustment is mainly to compensate for atmospheric temperature variation and a conveniently located ammeter to show motor current is a rough but reliable guide to throttle setting. When centrifugal blowers are driven by direct current motors, as in marine installations, some compensation for atmospheric variation may be accomplished by variable speed control. —*R. Cramer, Powerfax, Vol. 26, 1948, No. 3, pp. 28-30.*

Diesel Operating Experience

The author, who is the New York representative of a Norwegian firm of ship owners, comments on the fact that American ship operators largely prefer steam-driven vessels, whereas European owners seem to favour motor vessels. The preference in favour of Diesels in Europe is attributed to the fact that the initial cost of Diesel machinery in a European yard is not usually higher than for the equivalent power of a geared-turbine plant. Also, the weight of Diesel machinery plus fuel and stores compared with the same figures for a steam plant of equal power, is usually in favour of Diesel propulsion, particularly if long voyages are involved. The average world price of fuel today based upon a large number of ports is \$28·00 per ton for Diesel oil, in comparison with \$21·60 per ton for boiler oil. This is a differential between the two types of oil of 30 per cent today, a decline from 48 per cent in 1939. A 15-knot cargo vessel of 9,000 deadweight tons, fully loaded, with 6,000 s.h.p., will have an overall consumption of 24 tons per day at sea with Diesel and about 38 tons with geared-turbine. Checking on the fuel cost in port for the same vessel, the consumption for the Diesel vessel is 2 tons daily and with steam 6 tons. In this connexion it should be mentioned that a vessel today very often spends half of its time in port. On this basis the yearly fuel cost for this Diesel vessel will amount to \$133,000 and for the steam-turbine \$163,000, based on today's price of oil.—*Paper by W. Eitrem, read before the American Merchant Marine Conference at New York on 14th October, 1948. The Motor Ship, Vol. 29, November 1948, p. 297.*

S.S. *Mobilube*

The S.S. *Mobilube,* now owned by the Socony-Vacuum Oil Co., was built in 1939 and was torpedoed near Sydney in 1943. The torpedo struck at the water line, exploding under the port boiler. Both the boiler and the engine rooms were completely flooded, but the ship did not sink. Towed to Sydney, she was requisitioned by the Navy and used as a towed floating oil storage receptacle. When declared surplus in 1946, the vessel was at Subic Bay, Phillippines, and upon being purchased by Socony-Vacuum, was towed to San Francisco for reconditioning. At first glance, the port boiler appeared to be a total loss. Closer inspection, however, revealed that the two drums and three of the five headers could be salvaged for rebuilding. The force of the explosion had lifted the water drum, pulling it from both front and rear saddles. Two wire slings, passed around the steam drum and connected to the deck above, held the port boiler in place. To prevent the cables from slipping, three pieces of 3-inch angle iron had been welded to the drum on each end. Both of the drums were subsequently repaired, stress relieved, and used in the rebuilt boiler. The starboard boiler had been used as a donkey boiler while the ship was in barge service and under the stress of war conditions had not been properly handled. It is probable that a drying out fire had not been lit for a considerable time after the fire room had been pumped out. Extensive corrosion of boiler and superheater tubes necessitated complete retubing. There was also considerable damage to refractory and insulation. The original thickness of the boiler casing was such that, despite corrosion, very little had to be renewed. The superheater outlet header was badly twisted. When the header was stripped of tubes and handhole plugs, it was found that some of the holes were distorted. These holes were plug welded, stress relieved, redrilled and reamed to their original size. This partial stripping of the boiler made it possible to seal weld the drums and other inaccessible sections to prevent gas and soot leaks. Additional modernization was provided by converting the original General Regulator Corporation's combustion control to its new all-electric system, which employs electronic amplifiers to effect a high sensitivity of control.—*Heat Engineering, Vol. 23, No. 3, 1948, pp. 42-44.*

Boilers for Whaling Vessels

The two new whale catchers KOS 31 and KOS 32, completed in Norway in 1947, have each a gross tonnage of 510 tons and a length of 158 feet. Each vessel is equipped with a triple expansion steam engine of 2,200 i.h.p. and two water-tube boilers. The speed of the vessels is 14 knots. The boilers are of the Foster Wheeler D-type and were built complete in the United States, shipped knocked-down to Norway, and assembled in the hulls by the shipbuilders. Each boiler is provided with a de-superheater for cooling the steam used in auxiliaries. The de-superheater consists of 2-inch tubing placed in the steam drum below the water level.—*Marine Engineering and Shipping Review, Vol. 53, October 1948, pp. 77-79.*

Clarkson Boiler in Exhaust Manifold

In Fig. 3 is illustrated a V-Type engine having a thimble tube exhaust gas boiler in the manifold, the unit also comprising an oil-fired boiler with a connecting pipe to the thimble tube element. Water from the boiler (21) is circulated by a pump (22) through the heat exchanger element (32) located within the exhaust manifold (5). The heated water or steam and water mixture enters the boiler drum through a pipe (24). The exhaust gases from the engine flow through separate pipes and are projected at high velocity against the studs (33). By releasing a cover plate (39) and withdrawing a tube from the manifold (5), the tube and studs are exposed for cleaning. An equalizing chamber (28) helps to ensure suitable distribution of the exhaust gases over the studs (33) and the surface of the tube (32)

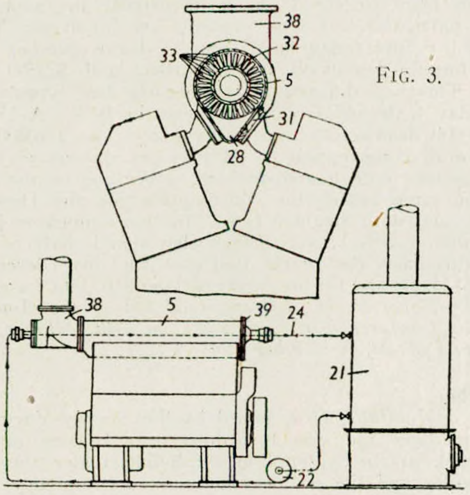


Fig. 3.

in flowing from the intakes (31) to the elbow piece (38).—*British Patent No. 603,499, issued to Clarkson Thimble Tube Boiler Co., Ltd. and H. J. Fountain. The Oil Engine and Gas Turbine, Vol. 16, October 1948, p. 217.*

Refrigerated Cargo Motorship *Hurunui*

The twin-screw refrigerated cargo motorship *Hurunui* was built by Vickers-Armstrongs Ltd., Newcastle, for the New Zealand Shipping Company and Associated Federal Line. The principal particulars are:—

Length b.p.	530 feet
Breadth moulded	70 feet
Depth moulded to main deck	39 feet
Load draught on summer freeboard	32ft. 6in.
Gross tonnage	11,150 tons
Deadweight tonnage	14,000 tons
Insulated cargo capacity (bale)	520,000 cu. ft.
General cargo capacity (bale)	250,000 cu. ft.
Service speed	17 knots

Electric welding has been extensively used in the construction of the vessel, which has been so far as practicable assembled and welded in large pre-constructed panels, under cover, and in the down hand position under the best possible conditions. Of particular interest is the construction of the shaft boss plating and framing which has been pre-assembled in the shops and is completely welded, as also are the cruiser stern and fore peak. The main propelling machinery consists of twin five-cylinder Vickers-Doxford opposed-piston oil engines capable of developing a total of 12,800 b.h.p. continuously in service at 120 r.p.m. The cylinders have a bore of 725 mm. and the combined stroke of the upper and lower pistons is 2,250 mm.—*Shipbuilding and Shipping Record, Vol. 72, 30th September 1948, pp. 390-393.*

Repair of Welded Ships

The welding procedure generally employed in repair work differs little from normal ship welding procedures. Every effort is made to achieve sound welds, the joints being designed to facilitate the welding and shipping operations. A bead-on-bead sequence, in which the first bead is quickly followed by the next succeeding bead, is usually employed in the root, followed by stringer beads to complete the joint. The block system is not favoured because of the necessity of chipping the ends of the blocks. Welds made from both sides are back-chipped to sound metal before welding the second side, and peening is employed in locked-up joints for all except the first and last beads. Preheat is used very generously and is believed to be the most important single feature of any procedure, particularly during the winter months. To be most effective, preheat should be maintained throughout the cooling cycle in order to allow sufficient time for plastic deformation and "absorption of stress". It will be noted that some of the benefits depend on the continuous application of the preheat. For this reason electric strip heaters, which furnish an even and easily controlled heat, are much preferred to the use of torches. These "heater-bars", usually of 750 or 1,000 watt capacity, and operating on 220 volt a.c. or d.c., are capable of producing and maintaining plate temperatures of up to 150 deg. F. under quite rigorous climatic conditions. For ease of application the bare strip heaters are closed in a simple sheet metal case with appropriate electrical insulation for safety purposes and with glass wool insulation to serve the dual purpose of preventing heat loss through the case and directing the heat into the structure to which it is attached. The sheet metal cases may easily be attached to the structure to be heated by the use of metal clips which are tack-welded to the structure and extend over the flange of the case or by tack-welding the metal case directly to the structure. Usually these bars are connected in groups of two or three and wired to a common receptacle plug in order to simplify the required electrical connections and to reduce the number of electrical outlets necessary. Portable receptacle boxes are located in the immediate work area to eliminate the necessity for long extensions. The accepted practice in applying these strip heaters is to parallel the joint to be welded with two lines of the units placed end to end, and about 6 inch to each side of the joint.—*L. F. Bledsoe, The Welding Journal (New York), Vol. 27, September 1948, pp. 690-694.*

New Turbine Ship for South African Service

The twin-screw turbine steamer *Clan Mactaggart*, recently launched from the Greenock Dockyard Co., Ltd., is the first of two sister ships being specially built for the Clan Line's South African service. This vessel is of the open shelterdeck type with tonnage opening aft and with a deadweight tonnage of 10,550 and a service speed of 16½ knots. Her cargo handling equipment is arranged to ensure rapid loading and discharging when the vessel is unable to use shore equipment. In addition to the twelve 5-ton derricks, two 7-ton, two 15-ton and two 30-ton derricks, it is interesting to note that a heavy derrick capable of dealing with loads up to 125 tons is fitted at the forward end of No. 2 hatch. The propelling machinery comprises two sets of three-stage double reduction geared turbines supplied by Parsons Marine Steam Turbine Co., Ltd. Steam to the main machinery, which is designed to operate at 9,400 s.h.p. is supplied from two main water-tube boilers by Babcock and Wilcox at 450lb. per sq. in. and at a temperature of 750 deg. F.—*The Shipping World, Vol. 119, 20th October 1948, p. 316.*

Twin-screw Passenger Steamship *Himalaya*

The twin-screw geared turbine steamship *Himalaya* recently launched at the Barrow-in-Furness shipyard of Vickers-Armstrongs, Ltd., for the P. and O. Steam Navigation Co., Ltd., is the sixth large passenger ship built by the shipbuilders for the P. and O. fleet, and is intended primarily for the express service between the United Kingdom, Bombay and Australia. The principal particulars of the *Himalaya* are:—

Length, overall...	709 feet
Length, b.p.	668 feet
Breadth moulded	90ft. 6in.
Depth moulded to "E" deck	50 feet
Draught	31 feet
Speed	22½ knots
Horse power	42,500 h.p.
Gross tonnage (approximately)	31,000
First-class passengers	770
Tourist passengers	390
Crew	620

The vessel will have one funnel of streamlined form and a single pole mast. There are eight continuous decks, seven of which are for passenger and crew accommodation. The ship will be propelled by twin screws, each driven by a set of geared turbines of Parsons type, designed for a normal shaft horsepower of 34,000 and an overload of 42,500 s.h.p. at 130 and 140 r.p.m. respectively. The astern turbines will be capable of developing not less than 65 per cent of the normal ahead power. Steam will be supplied by two large and two small water-tube boilers of Foster Wheeler's controlled superheat design arranged to give a superheat control from 850 deg. F. to 600 deg. F. when manœuvring. The steam pressure at the superheater outlet will be 525lb. per sq. in. The drum shells are of seamless hollow forged steel with closed ends. The boilers are fitted with approved type of economizers arranged for a feed water inlet temperature of 280 deg. F. and an outlet temperature of about 400 deg. F. The boilers are arranged to burn oil fuel only under the balanced system of forced draught. Suitable electrically driven forced and induced draught fans are fitted for this purpose. Air preheaters of the vertical tubular type are fitted in the uptakes from each boiler and arrangements made for by-passing the air to the preheaters of all boilers when steaming at slow speed or in harbour. The oil fuel installation consists of two sets of pumping and heating plant, each set being capable of dealing with all the oil fuel required when running at full power.—*The Shipping World, Vol. 119, 13th October 1948, pp. 301-302.*

New Bow for Barges

A new bow for barges has been developed by The Ingalls Shipbuilding Corporation to meet the demands for speedier, more efficient equipment. Curves have been plotted based on tests in the Experimental Naval Tank at the University of Michigan, and these indicate that there is a marked improvement of this bow over the conventional spoon bill type. Exceptionally smooth wave formation was noted ahead of the barge, and there was slightly less disturbance preceding the barge in shallow water than in deep water. Supplementary tests are being made in connexion with both the spoon bow and the Ingalls one with the idea of plotting curves to show the exact percentage of improvement.—*Motorship (New York), Vol, 33, September 1948, p. 51.*

All-Diesel Derrick Barge

Trials of a 110-feet self-propelled derrick barge were recently carried out on the Tennessee River. This is one of two barges built by the Ingalls Shipbuilding Corporation of Birmingham, Alabama. These vessels have a moulded length of 110 feet, a moulded breadth of 46 feet and a moulded depth of 9 feet. The hull shaping is such that considerable reduction in water resistance is achieved over the conventional barge pattern without sacrificing stability in hoisting operations. The two propulsion Diesels develop 115 h.p. at 900 r.p.m. These each turn a 36-inch, 3-bladed wheel at 600 r.p.m. through a 1½/1 reduction gear. Each engine is equipped for 32-volt electric starting and pilothouse control. Auxiliary power is supplied by a 7½ kW., 120-volt d.c. Diesel generating set. The barge derrick mounted on deck has a capacity of 40 tons at a radius of 40 feet. The 90-feet boom is supported by a mast locked to a 38-feet A-frame with a 36-feet spread and may be swung by a 20-feet bull wheel. Fully extended to a radius of 85 feet, the derrick has a capacity of 15 tons. The three-drum derrick hoist is powered by a 6-cylinder Caterpillar Diesel rated 140 h.p. at 950 r.p.m. This power plant gives the hoist a rating of 18,000lb. single line pull at 190ft. per min. All operating levers are mounted on the starboard side of the mast, and the elevated control position gives the operator clear vision of hoisting operations.—*Motorship (New York), Vol. 33, September 1948, pp. 36-37.*

Technical Progress Report of American Ship Structure Committee

The recently published first technical report of the Ship Structure Committee is a sequel to the Final Report of the Committee's predecessor, i.e., The Board to Investigate the Design and Methods of Construction of Welded Steel Merchant Vessels. The report states that the incidence of cumulative major failures on all-welded Liberty ships has been reduced to one-tenth by rounding the hatch corners, and fitting a riveted gunwale. This record justifies the various structural changes made. The evidence that cleavage fractures do not pass riveted seams is now based on 15,000 ship-years of service. The results of laboratory tests on hatch corner specimens, incorporating design modifications used on ships for the purpose of increasing the resistance to brittle fracture, substantiate ship service records. Based on the energy absorption to failure, design changes improve the performance of hatch-corner specimens more than superior materials and fabrication procedures. However, it is possible to introduce structural or metallurgical notches even in non-critical areas that can cause premature failure of the structure. The incidence of failures resulting from such notches, which cannot be eliminated by the control of design, can be reduced through the use of less-notch-sensitive steel. No significant difference exists in the deflexions or the over-all and local strains measured on two sister ships (tankers), one welded and one riveted, when subjected to hogging and sagging tests to normal stress levels. Plates with machined holes, or with holes flame-cut and ground or heat treated, show superior resistance to fracture under cyclic loading compared to those in the flame-cut condition. Substantially all Liberty ships originally built with welded shell seams, which are operating today, have been fitted with riveted gunwale straps or bars and rounded hatch corners. The record of structural failures in Liberty ships which has been showing a steady improvement seems to have reached, at present, a fairly uniform rate on the basis of cumulative major structural casualities per hundred ship-years in service. The rate, as of 1st January 1948, is 1·45 for all Liberty ships built with welded shell seams, 0·42 for Liberty ships built with welded seams and having riveted gunwales and rounded hatch corners, and 0·22 for Liberty ships built with riveted shell seams. The rate for T-2 tankers is 1·82. In May 1946, a complete failure of a T-2 tanker the *Fort Sumter,* followed in March 1947, by the breaking of the *Fort Dearborn* (which was the sixth), indicated the desirability of taking steps to prevent further failures. A meeting of the T-2 tanker operators was held at New York in April 1947, at which time it was decided to fit at least four riveted crack arrestors on each vessel (one on the bottom shell on each side near the lower turn of the bilge and one on the deck, on each side of the wing tanks). The complete failure in December 1947, of the seventh T-2 tanker, *Ponagansett,* accelerated this programme. As of January 1948, 150 T-2 tankers have been modified and the balance of 356 are scheduled to have straps fitted within the near future.—*Marine Engineering and Shipping Review, Vol. 53, September 1948, pp. 52-58.*

A Large Passenger Liner Re-engined

The 16,700-ton passenger liner *Rangitiki* of the New Zealand Shipping Co. was originally fitted with two five-cylinder two-stroke single-acting Diesels of the blast-injection type with an output of 9,300 b.h.p., giving the vessel a speed of 14½ knots. These engines have now been replaced by two six-cylinder Brown-Doxford opposed-piston engines which develop a total of 15,000 b.h.p. For the time being it is proposed to run the machinery at 14,000 b.h.p., giving an average speed, at sea, of 16 knots. This speed will be maintained on a fuel consumption of about 58 tons per day, and an estimate of 50 gallons a day may be made for the expenditure of lubricating oil. As the propeller shaft speed has been increased to 120 r.p.m. for the maximum rating, new screws are fitted. The original shaft revolutions were 88 per min. with the engine developing 9,300 b.h.p. Bibby-Doxford detuners are fitted, and with these in the free position there are no dangerous critical speeds to be avoided. With the detuners locked, criticals occur at 67·6 r.p.m. and 90·2 r.p.m. It is arranged not to run the engines continuously between 22 r.p.m. and 32 r.p.m. The revolutions fixed for periods of running in harbour are 90 per min., full speed; 65 per min., half-speed; 45 per min., slow; and 35 per min., dead slow. Thus the flexibility of the engines, with their maximum revolutions of 120 per min., is apparent. An indication of the progress made with marine Diesel construction in the past twenty years is that the new engines and auxiliaries of the *Rangitiki* with a far greater power than the original plant, represent a saving in weight of not less than 700 tons.—*The Motor Ship, Vol. 29, October 1948, pp. 250-252.*

The 23,000 ton Tanker *Atlantic Queen*

Of approximately thirty big motor tankers of 23,000 tons and upward on order in European yards, the *Atlantic Queen* is the first one to be launched. This vessel has machinery of higher power, and her speed, loaded, 14¾ knots, is larger than that of any tankers of the class being built in Europe, apart from her sister ships. This involves the installation of a single engine of 10,000 i.h.p. The following are the main details of the ship :—

Deadweight capacity	23,000 tons
Length overall	592 feet (180·43 m.)
Length b.p.	560 feet (170·685 m.)
Moulded breadth	74ft. 6in. (22·707 m.)
Depth moulded	42·3 feet (12·877 m.)
Loaded draught	31ft. 11in. (9·728 m.)
Capacity of cargo tanks	103,000 cu. ft.
Capacity of dry hold	60,000 cu. ft. (grain)

The hull is divided into ten centre tanks and six wing tanks on each side, and there is a dry cargo hold forward, under which is a deep tank for fuel oil or water ballast, with an auxiliary pump room forward of this tank. The main pump room is between Nos. 6 and 7 centre tanks. There is a cofferdam aft of No. 10 tank, and between that and the engine-room are wing tanks for fuel oil or water ballast and a deep tank. Fuel oil or water ballast is also carried in tanks under the engine-room, where are the lubricating-oil tanks; fresh water is accommodated in a tank under the boiler room. The total fuel capacity is 2,150 tons. A Götaverken two-stroke single-acting engine is installed, having nine cylinders 760 mm. in diameter, with a piston stroke of 1,500 mm., and developing an output of 10,000 i.h.p., or about 8,250 b.h.p. at 112 r.p.m. It has uniflow scavenging with a centrally placed exhaust valve in the cylinder cover, the valves being actuated by rods connected to levers in the crankcase, operated from cams on the crankshaft The under parts of the working cylinders are utilized as scavenging pumps, working in conjunction with smaller pumps driven from the crossheads, to obtain the requisite quantity of surplus scavenge air. The elimination of the crankshaft driven scavenge pump has shortened the engine to a marked extent. The normal mean indicated pressure at rated load is 6·5 kg. per sq. cm., or 93lb. per sq. in., and on the test bed the fuel consumption is 160 gr., or 0·35lb. per b.h.p.-hr., with an exhaust temperature of 270 deg . C. The lubricating-oil consumption for cylinder and bearing lubrication is 0·5 gr. per b.h.p.-hr., and the average liner wear based on the results of a considerable number of engines amounts to about 0·10 mm. for 1,000 hours' running.—*The Motor Ship, Vol. 29, October 1948, pp. 246-248.*

Experiments with Models of High Speed Ships

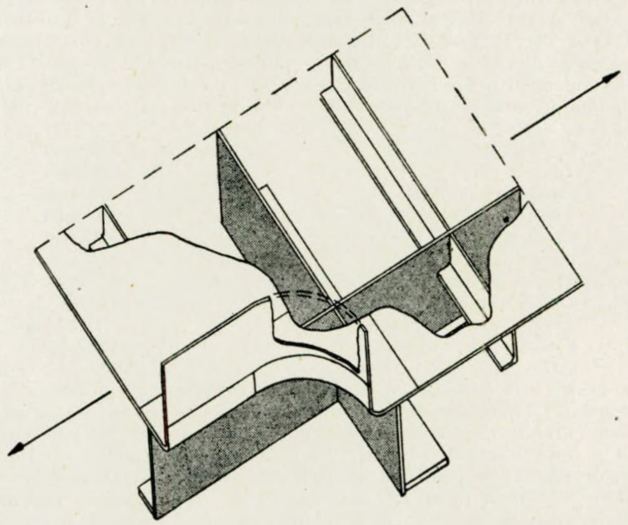
This paper refers to experiments which have recently been carried out with a group of models of high-speed ships. The models have block coefficients varying from 0·555 to 0·625 and have been tested at speed-length ratios from 0·80 to 1·0. The following questions have been the main objects of the research :—

(1) How does the longitudinal centre of buoyancy affect the resistance?
(2) Which total block coefficient can economically be used?
(3) How should the displacement be divided between the fore-body and the after-boly, i.e. which δF and δA should be selected?

Models of six fore-bodies and seven after-bodies have been made with different block coefficients. By joining these half models together in various combinations several groups of series have been developed. Of the forty-two possible combinations that can be made twenty-eight have been selected to form the various series that have been tested. The tank tests were carried out with 20-feet models, which on a 1/20 scale represent a 400-feet ship.—*Paper by A. F. Lindblad, read at the autumn meetings of the Institution of Naval Architects, 21st-24th September 1948.*

New Factors in Design and Welding of Ships

The highly publicized failures of T-2 tankers and Liberty ships have led to large scale research and scientific investigations into the characteristics of steel, the effect of welding and the standard of design for welding. In the past design was based upon a rather static point of view, and it was estimated that each component part would carry its proportion of the load regardless of the discontinuity in the design. This is the reason why hatch covers were designed square and were felt to be safe if the scantlings were sufficient. It has long been known, and experience has shown that sharp discontinuities concentrate stress in a relatively small area, and that this concentration of stress can exceed the fracture strength of the material in way of the notch. Thus the structure can fail at a load far below its design strength; and it has been rather well established that square hatch corners can fail at relatively low stresses in the neighbourhood of 24,000lb. per sq. in. Therefore this type of discontinuity should be avoided at all possible locations in the development of ship design. Most of the improved designs, which have already been

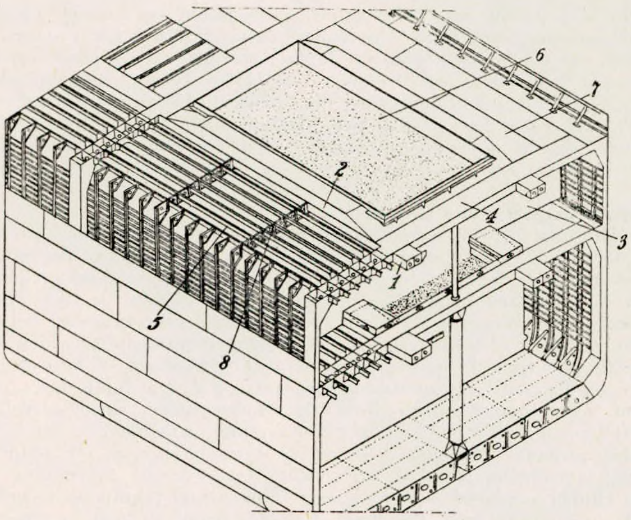


Hatch corner, Kennedy design

applied to ships, maintain some aspect of the inherent square corner. Some individual characteristics of the square hatch corner design have been improved. In one case, improved performance was achieved by only extending the longitudinal coaming for one frame space, retaining the square hatch corner as such. In all of the altered designs, improvement is achieved because more favourable conditions were developed for the transmission of stresses by the avoidance of the full concentration of stresses at the square corner itself. In all cases, except the Kennedy design, a reinforcing doubler plate is proposed. The most effective new design presented completely eliminates all characteristics of the square corner. This is the hatch corner designed by Harry E. Kennedy. Here, no doubler plate was fitted in way of the corner itself. Instead, a rounded corner was incorporated in the vertical and horizontal members. Complete ductile behaviour resulted and the specimen failed at some distance from the corner. But the Kennedy design has not yet been used in ship construction.—*M. Forman, The Welding Journal (New York), Vol. 27, September 1948, pp. 671-678.*

Improved Ship Construction

It has already been proposed to provide, on either longitudinal side of a row of hatchways and between transverse bulkheads, longitudinal arch-shaped girders composed of plates, or built on the lattice principle, and provided along the hatchways with upwardly directed extensions which constitute the coamings for the hatchways Longitudinal box girders with upwardly directed reinforcements forming coamings for the hatchways have also been proposed. This invention proposes the use of longitudinal beams to support the deck plates between longitudinal upwardly reinforced box girders and the walls of the ship, carried by transverse box girders on each transverse side of the hatchways and connected with the longitudinal box girders. This forms a particularly rigid structure as the longitudinal continuous box girders are connected to the side and to the bottom through frames which are practically indeformable. The reinforced longitudinal box girders and the above-mentioned longitudinal beams in conjunction with the box girders increase the longitudinal stiffness of the ship. It is thus possible to reduce further the height of the box girders and consequently to increase the available space for cargo in the holds. The accompanying drawing shows a perspective view of a ship built according to the invention. Two longitudinal box girders (1) are provided on either side of the row of hatchways (6). Transverse box girders (4) are placed on each transverse side of the hatchways and are connected to the longitudinal box girders at their crossing points. The longitudinal box girders (1) are provided along the hatchways (6) with upwardly directed reinforcements (2) which com-



pensate for the loss of longitudinal resistance caused by the gaps formed by the hatchways. The longitudinal beams (5) carrying the deck plates (7) are arranged on either side of the hatchways (6), between the longitudinal girders (1) and the lateral walls of the ship, the beams being supported by the transverse box girders (4). The beams may be interconnected by crosspieces (8). It is easily apparent that the longitudinal reinforcements (2) and the longitudinal beams (5), together with the box girders (1), increase the longitudinal rigidity of the vessel.—*British Patent No. 602,472, issued to R.S.V.E. Guilloton. Complete Specification accepted 27th May 1948, The Shipping World, Vol. 119, 24th November 1948, p. 430.*

International Conference of Ship Tank Superintendents

Among the various conclusions reached at the fifth Conference of Ship Tank Superintendents held in London in September were the following. Methods are required for measuring the degrees of turbulence in water. This matter arises in many applications of hydrodynamics, including ship propellers and hulls. Methods are required to ascertain the effect of dissolved and entrained air on the physical properties of water, including viscosity. This is important in propulsion research, including cavitation. It is desirable to study in detail the characteristics of the friction belt in model and full-scale hull and propeller, particularly with regard to the extent of laminar flow under various test conditions. Opinion was in favour of departing from Froude's coefficients and finding substitutes in line with modern concepts of skin friction, but there was no unanimous agreement to accept as a final decision any particular line as the minimum turbulent friction line. In view of the division of opinion, it was the recommendation of the conference that results may be published using either Froude or Schönher coefficients, and whenever possible information should be given to make easy the translation of the results from one system to the other.—*The Motor Ship, Vol. 29, November 1948, p. 294.*

The Indian Liner *Jaljawahar*

The twin-screw steamship *Jaljawahar* recently completed by Swan, Hunter and Wigham Richardson, Ltd., Wallsend-on-Tyne, is operated by the Scindia Steam Navigation Co., Ltd., in the new passenger and cargo service between India and the United Kingdom. The principal particulars of the vessel are:—

Length, b.p.	430 feet
Breadth, moulded	61ft. 6in.
Depth, moulded to shelter deck	39ft. 2½in.
Draught, loaded	25 feet
Deadweight	7,500 tons
Service speed	14 knots

The propelling machinery for the *Jaljawahar* is of the four-crank triple-expansion reciprocating design. The engines, together with the boilers and other contingent parts, were constructed by the Wallsend Slipway and Engineering Co., Ltd., Wallsend-on-Tyne. Each main engine has cylinders respectively of the following sizes: h.p. 24 inch, m.p. 42 inch, two l.p. each 47 inch in diameter, with a common stroke for all cylinders of 29 inch. The machinery has been designed to develop about 7,780 i.h.p. at about 130 r.p.m. on trial, when working with steam at a pressure of 225lb. per sq. in. The bedplate is of box form, cast in two sections, which are bolted together. Steam distribution to the h.p. cylinders is controlled by piston valves, the m.p. and l.p. cylinders by Andrews and Cameron's balanced slide valves. The six boilers are of the ordinary single-ended multi-tubular type. The diameter of the boilers is 16ft. 6in., the number of furnaces is twenty-four and the total heating surface is about 20,000 sq. ft.—*The Shipping World, Vol. 119, 3rd November 1948, pp. 374-375.*

Proposed 35-knot Ship for Marseilles-Algiers Service

In this article the author points out the several factors bearing upon the choice of speed for a ship; he gives examples of recent increases in speed and then refers to the proposal made by M. P. de Malglaive for a 35-knot ship for the Marseilles-Algiers service. The power requirements of between 70,000-80,000 s.h.p. would have to be met by three independent groups of either gas turbines or geared steam turbines. In the latter case, steam would be supplied from high-pressure forced circulation boilers installed in the engine-room itself and connected directly to the high-pressure turbine. The use of double-reduction gearing or magnetic couplings is suggested. M. de Malglaive is against the adoption of electrical propulsion because the fine lines of the hull aft make it difficult to fit in the electric motor; but in the author's opinion this reasoning neglects the possibility of using high-speed motors geared in American fashion to their respective shafts.—*A. C. Hardy, The Journal of Commerce (Shipbuilding and Engineering Edition), No. 37,652, 28th October 1948, p. 5.*

The *Presidente Peron*

The twin-screw passenger and refrigerated cargo steamship *Presidente Peron*, which was recently launched from the Barrow shipyard of Vickers-Armstrongs, Ltd., is a vessel of 529ft. 6in. length overall with other principal particulars being as follows: length between perpendiculars, 495 feet; breadth moulded, 71 feet; draught, 27ft. 6in.; speed on trials, 19 knots; power (maximum), 14,500 s.h.p.; gross tonnage, 14,500 approximately. The vessel is propelled by twin screws, each driven by a set of geared turbines of Parsons type, capable of developing 13,500 s.h.p. continuously at sea under service conditions with the propellers making 130 r.p.m., and a maximum output of 14,500 s.h.p. The astern turbines are capable of developing 9,000 s.h.p. Steam is supplied to the turbines at 470lb. per sq. in. gauge and at a temperature of 750-800 deg. F. Each set of gearing is of the double-reduction articulated type and comprises two first reduction gears, one for the high pressure turbine and one for the low pressure turbine driving secondary reduction pinions on the main wheel. Each first reduction gear is enclosed in a separate casing bolted to the second reduction gear case. The h.p. turbines are of the all impulse type with impulse wheels forged solid with the rotor shaft. The l.p. ahead turbine is of the single-flow all reaction type, having twelve rows of blading fitted segmentally and five rows fitted individually on a solid forged steel rotor. An astern 3-row impulse wheel is incorporated in l.p. ahead turbine casing and is forged solid with the rotor. All impulse blading is of chromium iron. The reaction blading is of Monel metal for segmentally fitted blades and of chromium iron for the individually fitted blades. Each turbine is connected to the gearing by a flexible coupling of the claw type, and secondary pinions are driven through "quill drive" couplings from the primary gears. Steam is supplied by two water-tube boilers of Foster Wheeler's controlled superheat design, arranged to give a superheat control of from 800 deg. F. down to 600 deg. F., when manœuvring, the steam pressure at the superheater outlet to be 500lb. per sq. in. The boilers are to be fitted with economizers arranged for a feed water inlet temperature of 280 deg. F., and an outlet temperature of about 376 deg. F. One auxiliary boiler, supplied for harbour service purposes, is of Foster Wheeler single furnace "D" design. The steam pressure at the superheater outlet is 500lb. per sq. in. and the temperature 750 deg. F. The boiler is fitted with an economizer arranged for a feed water inlet temperature of 210 deg. F. and an outlet temperature of 325 deg. F.—*The Shipping World, Vol. 119, 10th November 1948, pp. 391-392, 395.*

Heavy Cargo Motorship

The 4,500 tons d.w. single-screw motorship *Belbetty*, recently launched by Burmeister and Wain's Shipyard, Copenhagen, for the Belships Co., Ltd., is specially constructed for carrying heavy cargoes. The vessel has dimensions of 315 feet by 51 feet by 32 feet, with a draught to summer load line as a closed shelter-decker of 23 feet. She has a raked "soft nose" bow, cruiser stern, and machinery aft. There are two cargo holds. In view of the special service for which she has been designed the ship is equipped with very strong loading and discharging gear. There are four 5-ton, two 10-ton, one 40-ton, and one 125-ton derricks. The decks, also, have been specially strengthened to withstand heavy loads. The propelling machinery, consisting of a 5-cylinder direct reversible, single-acting two-stroke crosshead Burmeister and Wain Diesel engine with airless injection, has cylinder diameters of 500 mm. with stroke 1,100 mm. It is believed to be the first of its type with these cylinder dimensions. The normal output is 2,250 i.h.p., corresponding to 1,800 b.h.p. at 145 r.p.m. to give a speed of 12 knots.—*Shipbuilding and Shipping Record, Vol. 72, 21st October 1948, p. 500.*

Twin-screw Motor Tanker *Salomé*

The twin-screw motor tanker *Salomé* had been ordered in 1938 by the Compagnie Auxiliare de Navigation de Paris from the Ateliers et Chantiers de France at Dunkirk. The vessel was still under construction at the time of the German invasion in 1940 and attempts were made to tow the vessel to England. When this attempt proved unsuccessful heavy sabotage was carried out. In 1941 the vessel was towed to Rotterdam by the Germans. At the date of the order the vessel was the largest tanker in the world, the principal dimensions being:—

Length, b.p.	166·2 m.
Length, o.a.	175·0 m.
Breadth, moulded	21·8 m.
Load draught	9·425 m.
Deadweight	18,807 tons
Register tons	13,500 tons
Propulsion plant	8,000 s.h.p. max.

External repair work was carried out at Schiedam and last June trial runs were successfully completed. The propulsion plant consists of two six-cylinder single-acting four stroke cycle Burmeister and Wain Diesels, having a cylinder diameter of 740 mm. and a stroke of 1,500 mm. At 123 r.p.m. each engine develops 3,000 h.p. The auxiliary plant includes two oil-fired Scotch boilers of 2231 sq. m. surface, each operating at 12·5 atmos. Provision is made for operating these boilers with the exhaust of the main engines.—*H. J. van der Laan, Schip en Werf, Vol. 15, 15th October 1948, pp. 401-406.*

Largest Australian Built Ship

Trials were recently carried out of the cargo steamer *Iron Yampi*, first of four sister ships building at the Whyalla shipyard of the Broken Hill Proprietary Co., Ltd. Constructed for the company's own shipping fleet, the vessel is intended for the carriage of iron ore between Cockatoo Island, Yampi Sound (N.W. Australia), and the company's steelworks at Newcastle, N.S.W. The principal particulars of the vessel are:—

Length, b.p.	495ft. 0in.
„ , overall	525ft. 0in.
Breadth, moulded	66ft. 0in.
Depth, moulded to shelter deck	41ft. 3in.
Draught loaded	25ft. 11in.
Gross tonnage	9,440
Net tonnage	5,427
Deadweight tonnage	12,500
Service speed	12 knots

Cargo handling gear consists of eight 5-ton, two 10-ton, and one 30-ton derricks, fitted on three sets of twin derrick-posts. The 30-ton derrick serves No. 2 hold, and the 10-ton derricks No. 3 hold. Steering gear is of Brown's electro-hydraulic type. The propelling machinery was designed by the Parsons Marine Steam Turbine Co., Ltd., Wallsend-on-Tyne, and comprises high, intermediate and low reaction type turbines, each driving a separate pinion meshing with the main gear on the propeller shaft. This single-reduction gear wheel weighs 19 tons. Power developed is 5,500 s.h.p. at 115 r.p.m. Superheated steam is supplied at 240lb. per sq. in. and 630 deg. F. by three Babcock and Wilcox water-tube boilers. The boilers, which are fitted with automatic mechanical stokers, are primarily designed for coal firing, but oil fuel can be used as an alternative. A closed feed system with de-aerator is fitted, ensuring that the oxygen content of the feed water is kept at a minimum. The ship's bunkering and coal-handling equipment enables coal to be fed to the bunker entirely by mechanical means. Coal is stowed in a large self-trimming bunker at the fore end of the boiler room, which extends across the full breadth of the ship. Built into the bottom of the bunker is a series of saw-tooth recesses, each with "controlled doors". When these doors are opened the coal passes from the bunker through feeder plates on to a conveyor belt. The belt travels to the boiler room and up the ship's side, depositing into hoppers on the forward side of the boiler room bulkhead. From here it gravitates via fan-tailed chutes into the stoker hoppers on the boilers.—*Shipbuilding and Shipping Record, Vol. 72, 14th October, 1948, pp. 453-455.*

World's Largest Tuna Clipper

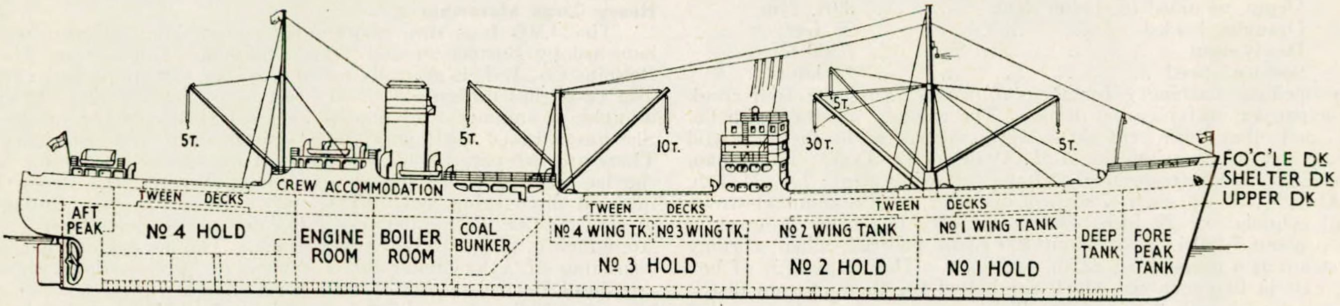
The tuna clipper *Scarlet Queen* is the conversion of an ATR fleet rescue tug originally propelled by a 1,800 h.p. reciprocating engine. The latter was replaced by a Fairbanks Morse opposed-piston Diesel. The unit has ten cylinders of 8½-inch base, each with two 10-inch stroke pistons powered from the central combustion chamber between them. Upper and lower pistons drive separate crankshafts which combine their output through gears and a vertical shaft. These engines were used extensively in submarines, being rated at 1,800 h.p. at 800 r.p.m. The manufacturer rates the engine more conservatively at 1,600 h.p. at 720 r.p.m. The main engine turns an 8ft. 6in. four-bladed propeller through a planetary gear having a 3/1 reduction giving a propeller speed of 265 r.p.m. Of necessity the engine in a tuna clipper is placed well forward. This would require a long drive shaft of some 60 feet, the shaft diameter being 10 inch in this case. Because of the small space requirements, it was possible to locate the Western planetary reduction gear used in the *Scarlet Queen* in the shaft alley over 60 feet aft of the engine. The drive shafting between the engine and the reduction gear is only 5¼ inch in diameter and weighs, exclusive of couplings, bearings, etc., approximately, 4,680lb. If the reduction gear had to be located in the engine room, this additional 60 feet of shafting would weigh approximately 16,980lb. or 12,300lb. more than the present installation since the 10-inch size would be required. The vessel is 165ft. 5in. long overall, has a breadth of 17ft. 3in. and a fish cargo capacity of 625 short tons.—*M. D. Pugh, Motorship (New York), Vol. 33, October 1948, pp. 18-21.*

Improved Cargo Handling

Inefficient cargo handling, by holding ships longer than necessary at the dock, increases the cost of operation alarmingly without increasing the ship's earning power. According to Admiral Smith, Chairman of the U.S. Maritime Commission, American cargo handling methods in use today have not changed much in the last fifty years. Since to a ship operator cargo handling is at once pure overhead and an indispensable part of operations, he must keep its cost as low as possible through the use of the most modern methods and equipment. One of the most important innovations in the handling of cargo is the development of the unit load system of shipping. A unit load consists of materials assembled for shipment on a pallet or skid or any other way that allows the whole unit to be picked up, carried and stacked mechanically. The load is usually held on a pallet by steel strapping or special glue. With regard to ship-side methods of cargo handling, improvements are being made in cargo handling gear aboard ship as well as in ship design, such as the twin-hatch incorporated in the Maritime Commission's proposed C3-S-DB3 design, which is a re-design of the standard C3 vessels. These hatches, placed side by side, are intended to permit easier and faster loading of cargo in the wings. Another is the proposal for side ports to hatches to permit fast loading by the use of fork lift trucks, overhead conveyors, conveyor belts, or any advantageous combination thereof.—*Motorship (New York), Vol. 33, Ovtober 1948, pp. 40-43.*

Modern Requirements in Ice Breakers

The author calls attention to the fact that plans are now in hand for the construction of ice-breakers in Finland, Norway, Sweden and Denmark. Some of the important design requirements of this par-



Profile of Iron Yampi

ticular type of vessel are discussed, and actual vessels are referred to. Mention is made of the fact that the Swedish Government has instructed the Navy Department to place orders for materials for an ice-breaker of 2,000 tons displacement, with two propellers aft and one forward, the propelling machinery to be Diesel-electric, comprising three oil engines of 1,450 b.h.p., each at 325 r.p.m. and direct coupled to a 440 volt d.c. generator, the propelling motors to be of 1,450 h.p. each at 145 r.p.m. The Norwegian Government has prepared plans for an ice-breaker of 3,500 tons displacement to be equipped with Diesel-electric propulsion plant totalling 7,500 s.h.p. to drive two propellers aft and one forward. In Denmark a vessel of 1,500 tons and 5,000 s.h.p. is stated to be under consideration.—*A. C. Hardy, The Journal of Commerce (Shipbuilding and Engineering Edition), No. 37,670, 18th November 1948, p. 5.*

C-3 Type Vessel *America Transport*

The *America Transport,* which was built for the Matson Line in 1941 and had been lend-leased to Britain as the *Empire Fulmar,* is a modification of the standard C-3 type vessel and represents the best in heavy freighter design of the American Merchant Marine from the point of view of speed, cargo capacity, cargo-handling equipment and stowage. The work was carried out at the yard of the Moore Dry Dock Co. The ship was built in 1941 under contract for Matson Navigation Co. by the Federal Shipbuilding and Drydock Co. Her specifications are: length overall, 490ft. 8⅝in.; length between perpendiculars, 465ft. 3in.; beam moulded, 69ft. 6in.; depth to shelter deck, 42ft. 6in.; load draft, 28ft. 7⅝in.; displacement to load draft, 17,615 tons; gross tonnage, 7,771; net tonnage, 4,562; deadweight, 12,328; bale capacity, 709,245 cu. ft. The most apparent departure from the standard C-3 vessels is the flush forecastle. This gives an exceptionally clear main deck for stowage of deck cargo. Propulsion equipment includes De Laval turbine with double-reduction gear drive, normal shaft horsepower of 8,500, with propeller diameter 21ft. 8in.; 80 r.p.m. There are two Foster-Wheeler D-type water-tube boilers (H.S. 16,494) with 465lb. per sq. in. working pressure. Two new Coffin feed pumps were installed, in line with the latest developments in boiler water control. Her speed is 18 knots.—*Pacific Marine Review, Vol. 45, October 1948, pp. 37-43.*

Cattle Transport Vessel

A river vessel for the transport of cattle was recently completed by the Astilleros Argentinos Rio de la Plata. The length of the vessel is 35·5 m., breadth is 9·0 m., draught load is 1·6 m., and the displacement is 380 tons. Provision is made for the transport of 350 head of cattle. The vessel is propelled by two Lister-Blackstone five cylinder reversible four-stroke cycle engines of 200 b.h.p. at 600 r.p.m. Each engine drives a bronze propeller of 1·38 m. diameter and 1·22 m. through a 2/1 reduction gear. Speed of the vessel is 8·65 knots.—*Navi Tecnica, Buenos Aires, Vol. 2, September 1948, pp. 148-50, 161.*

Twin-screw Steam Tender *Granuaile*

The recently completed twin-screw steam tender *Granuaile* was built by A. and J. Inglis, Glasgow, for the Commissioners of Irish Lights. The vessel has an overhanging bow with a large roller for handling buoys up to 10-feet diameter, the windlass on the forecastle head having a large central fleeting barrel capable of exerting a direct pull of 25 tons at 10 feet per min. The windlass is driven by a vertical steam engine placed on the deck below, and connected to the windlass by spur and bevel gearing. The principal particulars are:—

Length, overall	230ft. 0in.
Breadth, moulded	37ft. 4in.
Depth, moulded (amidships)	18ft. 0in.
Gross tonnage	1,100 tons
Net tonnage	402 tons
Speed	14 knots

The propelling machinery consists of two sets of Lobnitz totally enclosed pressure lubricated steam engines of the 4-cylinder triple expansion type. The engine cylinders have a bore of 13½ by 23 inch and the piston stroke is 18 inch.—*Shipbuilding and Shipping Record, Vol. 72, 18th November 1948, pp. 601-603.*

New British India Liners

The new twin-screw passenger and cargo steamships *Kampala* and *Karanja,* built by Alexander Stephen and Sons, Linthouse, for the Indian Ocean service of the British India Steam Navigation Co., are the largest vessels in the Indian Ocean service. The principal particulars are: length, 480ft. 0in.; breadth, 66ft. 0in.; depth, 41ft. 0in.; gross tonnage, 10,294 tons; service speed, 16 knots. The main propelling machinery, constructed by the shipbuilders, consists of a twin screw installation of high pressure impulse-reaction turbines supplied with steam from three Babcock and Wilcox water-tube boilers and driving the main propeller shafting at 125 r.p.m. at full power through single reduction gearing. The machinery is arranged in three compartments, boilers in one, main turbines and auxiliaries in another, and the Diesel generators, and their associated auxiliaries, in a third. Fabricated steel construction has been adopted for the main gear wheels, and the main gear cases are also fabricated from mild steel plates. The turbines at their forward end are supported on flexing beams, which allows for expansion of the turbine casings, and these take the place of the more normally accepted sliding feet. Main condensers are of the regenerative type and are underslung from the l.p. turbine with spring supports. The three main boilers are of normal Babcock and Wilcox small tube air encased type with air heaters. Steam is supplied at 500lb. per sq. in. gauge and a final temperature of 750 deg. F. at the superheater outlet. Babcock "C" type de-superheaters are fitted.—*Shipbuilding and Shipping Record, Vol. 72, 28th October 1948, pp. 521-523; 4th November 1948, pp. 544-548.*

Developments in Fuels, Lubricants and Lubrication

Diesel fuels and fuel oils have been in general a by-product of gasoline refining, but with the increasing employment of catalytic cracking processes their production by these processes must also be accepted. A resulting advantage is a higher calorific value and there may easily be advantages in ignitability. Disadvantages are lower stability in blends which have given rise to deposits in storage tanks, to the clogging of filters and to deposits on burner and boiler surface. However, the refining operation can be readjusted to make highly stable fractions and some of the latest fuel oil blends containing 50 per cent catalytically cracked material show as good a burner performance as 100 per cent straight-run. Straight-run oils, chiefly paraffinic and naphthenic molecules, appear to burn directly to carbon dioxide and water vapour; but catalytically cracked oil containing high olefins and aromatics, appear to burn by a kind of two-stage process. First there occurs a partial oxidation of some of the material to resinous or gummy material—a kind of cracking with oxidation. These intermediate components appear to have a high ignition point; and if the furnace parts or refractories are not hot enough to ignite them, they will deposit as gum or resin, fouling the burner parts or shortening the starting electrodes. The second stage of combustion extends, so to speak, from the first when these by-products are in turn ignited. Designers of gas turbines are urged to consider designing for normal fuel oils. The gas turbine does not pose any new lubricating problems and only extends the factors of temperature and speed. All other conditions should be easier than in reciprocating internal combustion engines, because lubrication is not carried out in the presence of combustion and combustion products.—*R. J. S. Pigott, SAE Journal, Vol. 56, August 1948, pp. 17-24.*

Lubrication and Friction Research

Among the papers read at the Seventh International Congress of Applied Mechanics recently held at London, the contribution by E. D. Tingle entitled "The Formation of Lubricating Layers on Metal Surfaces" dealt with the behaviour of oil and fat molecules in lubrication. The interesting fact was revealed that a freshly cut surface of metal does not help lubrication, friction being relatively high. This, of course, is irrespective of the smoothness, being a phenomenon associated with the absorptive energy of the unoxidized metal. No less valuable a contribution to the subject was the paper "The Influence of Liquid Films on Adhesion" by J. S. McFarlane and D. Tabor, where the adhesion of clean metal surfaces was described. Some fundamental views on the mechanism of wear were put forward by D. Tabor in his paper "Collisions Through Liquid Layers". It was shown that a metal surface could be plastically deformed even when separated from the deforming force by a liquid layer. This is an important suggestion, and may help to clear up some anomalies. A practical tip was offered in the advice to use lubricants whose viscosity increased with pressure or high rates of shear.—*Practical Engineering, Vol. 18, 12th November 1948, p. 477.*

Flow Patterns Photographed

A method of taking underwater photographs that reveal the flow patterns about surface vessels has been developed by the Experimental Towing Tank Laboratory of Stevens Institute of Technology. The method, similar to the "tuft" technique used in wind-tunnel and flight testing of aircraft, utilizes limp threads attached to the model itself, or to fine wires extending from it. The technique can be employed in locating the optimum position of the rudder and the propeller, and such appendages as bilge keels, scoops, overflow pipes, and propeller struts or bossings. In addition, its application may also effect a reduction in the amount of repetitive testing required in steering and turning investigations. The flow in the region of the rudder is studied so that it can be placed in the best location for steering. The study of the location of the propeller on the hull by this method will assure its most effective location, so that the flow of water to the propeller itself is unimpeded by obstructions. Underwater flow photographs might also be useful in studies of the basic hull shape. Sharp corners and knuckles often introduce confused flow which adds to the resistance of the hull. Photographs will indicate such regions of confused flow, and redesign of the hull shape may eliminate them.—*Motorship (New York), Vol. 33, October 1948, p. 46.*

Flow of Liquid Through Hollow Revolving Shafts

The authors point out that the character of the flow of a liquid passing through a hollow revolving shaft has not heretofore been investigated, although it is a matter of importance in a considerable number of cases, as e.g. the supply of lubricating oil through the hollow crankshaft in high speed reciprocating machinery, or the circulation of cooling water through the hollow blades of gas turbines, etc. The specific problem treated by the author is the establishment of the liquid level in the bore of the rotating shaft in cases where the flow rate is insufficient to fill the bore completely. In the first part of the article a mathematical expression for the longitudinal contour of the liquid level in the revolving bore is given. The second part describes tests conducted on a hollow shaft of 1 m. length and 32 mm. internal diameter, made of "Plexiglass". The highest possible speed of the experimental installation is given as 12,000 r.p.m., but the test figures refer to a speed range from 680 to 1,800 r.p.m. The maximum flow rate of water available is given as approx. 1·12 kg. per second. Good agrement between theoretical and observed data was obtained, the water level decreasing in the direction of flow owing to the wall friction. The entire investigation is based on the assumption that the body of liquid in the revolving shaft rotates at the same speed as the shaft itself. This can be enforced by the installation of helical vanes in the bore. The centrifugal force created assists in passing the liquid from the central bore into radial passages in the shaft through which passages the liquid is conveyed to this point of destination. This applies also to cases in which the liquid completely fills the bore.—*K. Bammert and J. Sehren, VDI Zeitschrift, Vol. 90, March 1948, pp. 81-87.*

Turbine Bridge Gauge and Bearing Replacement

A turbine bridge gauge consists of a U-shaped piece of metal or "bridge" to extend across the turbine or reduction gear bearing journal. It is used for the purpose of ascertaining bearing wear in the bottom crown of the bearing. Contact points are provided on the gauge, two of which bear on each flange and one in the centre of the gauge directly over the centre of the journal. The gauge is drilled in order that the ends will fit over the flange studs for centering purposes. A thickness gauge is inserted between the centre bearing point of the gauge and the journal. The clearance found is the bridge gauge reading. Pinion gear and bull gear bearings also may be checked by bridge gauges. However, it must be borne in mind that, as the high-pressure pinion journal tends to ride in the cap, in the ahead motion of the turbine, and the low-pressure pinion gear journal in the astern motion, pinion bearing cap clearance must also be taken into consideration. This clearance is generally determined by the use of leads. When bearing tolerance in turbine or reduction gear bearings has been reached, as indicated by bridge gauge readings or leads, they must be replaced before damage to the installation occurs. Spare turbine and pinion gear bearings generally are carried on board. These must be carefully measured before application. For instance, if the bearing to be renewed is 0·0015 inch low by the bridge gauge reading, the replacement bearing should have a bottom (half) crown thickness of 0·0015 inch more than the one removed in order to obtain the original bridge gauge reading.—*Marine Engineering and Shipping Review, Vol. 53, October 1948, p. 76.*

Silicone Rubber

As a result of rapid developments in the field of organosilicon chemistry during the last few years, a whole new class of high-polymeric materials has been made available to product and design engineers. This group includes such products as silicone rubber, oils, resins, greases, and water-repellent films. The members of the silicone family naturally vary as to properties and potential applications. However, they all offer an outstanding characteristic, namely, thermal stability from −70 deg. F. to +500 deg. F. Silicone rubber, the elastomeric member of this family, shows its temperature stability by not only retaining its flexibility, resiliency, and surface hardness over this entire temperature range but also by resistance to long periods of heat-aging. The availability of an elastomer with these heat-resistant properties immediately suggests new design possibilities where elastic materials are needed in equipment operating at elevated temperatures. However, mistaken conceptions of this material will arise if it is merely substituted for conventional rubbers in existing designs. The properties of silicone rubber do not match those of natural or synthetic rubber at room temperature. On the other hand, at operating temperatures of −70 deg. F. or at +500 deg. F., the properties of other elastomers generally fall short of silicone rubber. As to where the properties of silicone rubber may be put to use, the field of gaskets and packings immediately suggests itself. In the design of seals, engineers are looking with greater favour on moulded elastomeric materials. It is pointed out that silicone rubber is in no way a substitute material or just another elastomer. Its properties of thermal stability offer to the materials engineer a brand new product and a new range of temperature conditions where elasticity can be obtained. Its flexibility range of from −70 deg. F. to 500 deg. F., its resistance to oxidation, excellent heat-aging, low compression set, and good electrical properties are factors which can be put to use in a variety of applications.—*Paper by G. S. Irby, W. Goss and J. J. Pyle, presented at the 1948 A.S.M.E., Vol. 70, 1948, Paper No. 47-A-126.*

A Method of Calculating the Temperature Distribution in Non-uniformly Heated Tubes

In the paper presented to the Seventh International Congress of Applied Mechanics, F. Salzmann discusses the temperatures distribution in a tube cross-sectional area for the distribution of heat transfer through the tube wall to a gaseous medium flowing within, as occurs in the practical cases of heat exchangers, gas heaters, etc. Two main cases are dealt with, both of which are common in cross-current designs. The first case is that of a tube subjected to external radiation, and the method derived is then extended to cover a second case where an actual flow takes place across the outer surface and with the heat transfer coefficient from fluid to tube wall varying in value around the tube periphery. The flow in the direction of the tube axis is neglected. The temperature-levelling effects of the circumferential heat flow in the wall and of the inter-radiation at the inner surfaces are quantitatively demonstrated. For the purpose of direct calculation, a number of tables and curves are included. The method is demonstrated with some numerical examples of the temperature distribution in an air-heater tube, and the results of the calculations are found to be in sufficient agreement with those obtained by experiment. —*Journal of The British Shipbuilding Research Association, Vol. 3, October 1948, p. 465, Abstract No. 2138. F. Salzmann. Paper presented to the Seventh International Congress of Applied Mechanics in London, September 1948.*

Rubber as Stress-carrying Material

The purpose of this paper is to give some indication of the mechanical properties of rubber, its behaviour under stress, and also some its shortcomings. The various points which have to be taken into consideration in designing a rubber unit are discussed, and the point is made that rubber is best used as a stress-carrying medium either in a unit made on the "pre-stressed rubber principle" or in a component of the "bonded" type. A unit using "pre-stressed rubber" is typified in the "Silentbloc" bush. It comprises inner and outer metal sleeves with the rubber in a stretched condition between them. The rubber component is moulded in the form of a bush, and when assembled between the sleeves is considerably extended in its original dimensions. The rubber is held in position by the frictional resistance between the rubber and the metal parts and it is found that if the outer sleeve is removed the rubber rolls back to its original dimensions, as moulded. Very careful process control is necessary when rubber is to be bonded to metal; under commercial operating conditions bonds having a strength of 1,000lb. per sq. in. in tension can be obtained, while an average value of 700 to 800lb. per sq. in. on test can be relied upon. There are two different schools of thought on the use of rubber in compression and shear. It is claimed for rubber used under conditions of shear, that greater deflexions can be obtained than with rubber used in compression. Against this, however, a greater area of rubber for a given load must be used as the unit loadings which can be carried by rubber in shear are much lower than those allowable with rubber in compression. It was claimed for rubber used in shear that sound isolation of machinery could be achieved much more effectively, but it has been shown that equally effective noise reduction can be obtained with well-designed compression mountings. When using rubber in compression, however, stresses up to 500lb. per sq. in. are permissible for normal applications, and loadings up to one ton per sq. in. can be dealt with as shock or momentary loads without fear of failure. Even higher stresses have been applied without apparent detrimental effect upon the rubber, but at loadings of over 500lb. per sq. in. the effects of permanent set may become pronounced under continuously applied loads.—*Paper by S. W. Marsh, read at a General Meeting of the Automobile Division of The Institute of Mechanical Engineers, 9th November 1948.*

Boundary Friction

The lubrication of a journal bearing falls into two distinct phases: "boundary conditions", leading to "fluid film conditions". The two phases are separated by a critical point, the position of which is determined by bearing design and working conditions. A close observation of the friction values obtained in a bearing under carefully controlled working conditions should reveal the numerical laws governing boundary lubrication. The work carried out at the University of Liége, Belgium, aims at delineating the factors involved which might serve to indicate such laws or to lay down guiding principles. This investigation comes to the conclusion that the boundary and fluid phases of lubrication in a journal bearing are separated by a "critical point", which, in effect, is the minimum coefficient of friction for the particular operating conditions. The "critical value", which represents the change over from boundary to fluid conditions, is expressed by the approximate relation $\frac{\mu V}{\sqrt{P}}$ where μ is the absolute viscosity, V the peripheral speed, and P the load per unit length of bearing. This critical value varies with the ratio of the bearing length to diameter, l/d, and diminishes with the degree of finish of the rubbing faces. If this ratio is incorporated into the above expression one obtains $\frac{\mu V}{\sqrt[4]{P\frac{d}{l}}}$ which leaves only the degree of finish of the rubbing surfaces as a variable. The best possible finish, obtained by careful running-in, gives a critical value of about one-quarter of that for new surfaces. This value is quite independent of the nature of the lubricant other than that of viscosity. For boundary conditions the friction is expressed by the above, but when such friction reaches a value of the order of 0·02 to 0·03 friction becomes a function of μV. The rate of change of the friction factor f is governed by the ratio of bearing length to diameter, the state of the bearing surfaces and the nature of the lubricant.—*Petroleum, Vol. 11, October 1948, pp. 226-228.*

Luminous Paints Aid Safety in the Dark

Luminous paints on shipboard serve as light sources which help reduce not only the usual deck accidents but also the hazards of major catastrophes involving many lives. The luminous pigments are available for use on ships, docks, piers, etc. They are, for instance, incorporated into plastics which in turn are fabricated into such articles as signboards. Or the pigments are made into suitable paints for application by brush, spraygun, etc. They can effectively warn of dangerous objects or obstruction and thereby permit safe movement on deck and efficient performance of duties. Lowered accident hazards improves morale and increase efficiency of night operation and decrease operating costs. It is essential that different objects, obstructions, and points that are to be identified in the dark by luminous paints and plastics should be marked by special shapes or patterns. For under conditions requiring dark-adapted eyes, one cannot distinguish colours and one finds it difficult to read words unless the letters are large. Fire fighting stations, for example, could be marked with a hose-like coil. While such markings largely tell their story, an explanation should be made to the ship's personnel so that the meaning of each sign is unquestionably clear to all—*Paint Progress, Vol. 7, No. 2, 1948, pp. 8-9.*

Welding Applied to Repair Work

Discussing the application of welding to the repair of ship machinery, the author points out that some of the most difficult welding work has been carried out with complete success upon condensers. Due to unequal expansion and contraction the problems involved are often most complex. 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 a tubular design with a steel shell, whilst the tube plate is 2-inch thick, a dimension the reason for which will be understood better when it is realized 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, it then took 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. The operators had to face the added obstacle of not interfering with the tubes in any way. When the welding was finished a pressure test was applied. This proved the horizontal weld to be quite sound but there was a slight leak in the vertical section. It was re-welded and further tests showed the results to be completely satisfactory. In another instance a series of six condenser pumps were all damaged. As these had to be re-assembled with the flanges in absolutely accurate register, the slightest distortion would have prevented a satisfactory outcome. The job was done faultlessly and within a remarkably short space of time.—*C. W. Brett, The Naval Engineering Review, Vol. 31, October 1948, pp. 63-64.*

Sprayed Iron and Steel Coatings on Light Metals

An exhaustive investigation has been carried out in France in co-operation with official bodies into the possibility of providing light metals with protective coatings of iron or steel. A large range of ferrous coatings extending from soft iron coatings to 18-8 stainless steel and 13 per cent chromium iron was produced on aluminium surfaces by the spray method. It was found that the layers produced by spraying adhered solely by mechanical action, no alloying between the spray metal and the light metal being produced. The iron coatings possess a certain porosity and appear to have certain self-lubricating properties, with the friction coefficient being smaller than that found for the same ferrous material in rolled form. Coatings of this type are claimed to impart to light metal, which may be aluminium or magnesium alloy, a surface wear comparable with that of a corresponding steel surface.—*Revue de l'Aluminium, Vol. 25, November 1948, p. 361.*

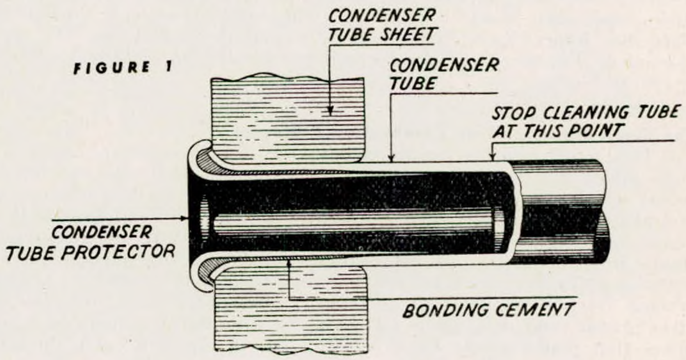
Hardfacing Technique

In this article which represents an abstract from a book entitled "Hardfacing by Welding" a comparison of modern methods in this field is given. The author includes reference to powder-weld depositing. In this recently developed process, the powdered hardfacing alloy is fed on to the component through an oxy-acetylene flame. The powdered alloy (with flux, if necessary) is conveyed and projected through the flame by an auxiliary gas such as carbon dioxide, nitrogen or hydrogen in a suitably designed spray gun. The temperature of the oxy-acetylene flame is adjusted so that the deposit is fused continuously or braze-welded on to the component. The process is thus akin to oxy-acetylene depositing, as the component is prepared in the same manner and must be preheated and heat treated similarly. One of the advantages claimed for the process is that a layer as thin as 0·010 inch can be deposited; $\frac{1}{16}$ inch thick deposit are usual and up to 0·150 inch has been applied; the rate of deposition is claimed to be more rapid than depositing with rod. As the deposit is completely melted, there is a satisfactory bond with the base metal and the deposit is claimed to be homogeneous.—*Welding, Vol. 16, November 1948, pp. 477-480.*

Performance of Steam Condensers Aboard U.S. Naval Vessels

The excellent service rendered by copper-nickel (70:30) tubes employed in the construction of all types of heat exchangers designed for salt water service, for example main and auxiliary condensers, distilling plants, lubricating oil and jacket water coolers, Freon-12 condensers, etc., was a deciding factor in assuring the success of naval operations during the recent war. To date there has been no record of retubing a main condenser outfitted with copper-nickel tubes aboard a combatant vessel since 1933. Although the thermal conductivity of copper-nickel is considerably below that of Admiralty tubes, the Bureau of Ships, U.S. Navy Dept. has established the fact that copper-nickel tubes in service for a reasonable operating period yield heat transfer rates at least equal to that of Admiralty tubes because the scale formed on the copper-nickel tubes does not reach the proportions of that for Admiralty tubes, which is probably aggravated by the dezincification present in the case of Admiralty tubes. During the war when vessels were operated at full power for prolonged periods it was found desirable to protect the inlet ends of

FIGURE 1



(70:30) copper-nickel condenser tubes, which are admittedly softer than Admiralty or aluminium brass tubes, from the severe erosion-corrosion effect of high velocity sea water saturated with oxygen and carrying entrained air impinging directly on to the tube ends. The erosion-corrosion action is greatly aggravated by the turbulence and air liberation existing in the vicinity of the approach to the inlet tube ends. For combating this destructive action the Bureau resorted to the use of plastic condenser tube inserts, about 2¼ inch long as shown in Fig. 1 which are cemented into the inlet ends of the condenser tubes, after the vessel has completed its shakedown trials in order to be assured that all tube joints were tight and free from leakage. Aside from affording protection to the inlet tube ends the presence of the plastic condenser tube inserts owing to their slight contraction in flow area, with no appreciable effect on flow through the condenser, will minimize the tendency of a foreign particle from becoming lodged in the tubes. In order to improve the corrosion resistance and increase the hardness of (70:30) copper-nickel, the Bureau recently modified the tube and tube sheet specifications to require an iron content of 0·25-0·65 per cent. Other recommendations of the Bureau are that the employment of monel water boxes of sectionalized type, wiped with a coating of solder of adequate depth should be continued. The design water velocity in the tubing should be increased from 7 feet per sec. to possibly 10 or 12 feet per sec. under full power conditions. Expanding of the tubes should be carried out by using an electronically controlled tube expander.—*Paper by H. E. Bethon, presented at the Annual Meeting of the National Society of Corrosion Engineers, 1948. Corrosion, Vol. 4, October, 1948, pp. 457-462.*

Chromizing of Iron and Steel

Chromizing is a process in which chromium is diffused into the surface of iron or steel producing a chromium-rich surface layer. The significance of this process is that the chromium diffusion layer produced on the surface of the steel is extremely corrosion resistant owing to the high chromium content generally obtained. In the production of a chromized layer two basic processes are involved, namely (a) the supply of chromium to the surface to be treated and (b) the diffusion of chromium from that surface, forming a chromium-rich layer. With regard to (a), there are three methods available for supplying chromium to the surface to be treated, namely (1) the solid phase method, (2) the gaseous phase method, and (3) the liquid phase method. The advantages of the solid phase method are few, lying probably only in its simplicity. The disadvantages are the inherent non-uniformity of the layer produced, the extremely high temperatures and prolonged times necessary, and the increase in dimensions which take place. In the gas phase method a special carrier substance is used which is capable of absorbing chromous chloride ($CrCl_2$) and subsequently gives it up in the process, the articles to be chromized being packed in active mass and heated to 1,000-1,050 deg C. in a hydrogen atmosphere. The great advantage of this method compared with solid phase methods is that deeper chromized layers can be produced with lower temperatures and shorter times (4 hours). The disadvantage is that special steels, usually containing titanium, are necessary for the process. In the liquid phase method the chromous chloride is contained in a salt bath containing the chlorides of barium, calcium, or magnesium. The great advantage of the liquid phase processes over the gaseous is that thicker layers can be produced under the same conditions of time and temperature. The concentration of the chromous chloride can be varied at will and special agents added to accelerate the processes, depending on the composition of the steel being treated. Extremely uniform layers are produced as compared with the other methods. Because the chromizing process involves diffusion, the layer is intimately connected with the steel base and is therefore essentially free from the cracks and pits associated with electro-plated layers. The layers have good resistance to salt spray, steam and atmospheric conditions. The heat or scale resistance is high, the upper limit being generally placed at 800 deg. C.—*M. Marmack, The Australasian Engineer, Vol. 41, 7th September 1948, pp. 39-48.*

The Gas Turbine and its Combustion Problems

This paper gives a condensed account of the technical considerations underlying both the many fields of application and the many forms which a gas turbine may take. Turning to the field of marine propulsion, the authors point out that the marine Diesel engine has made immense strides and, so far as fuel economy is concerned, stands unchallenged. Current practice shows that for powers up to 8,000 s.h.p. the Diesel engine is being favoured. Above that the steam turbine is chosen. The gas turbine, on the other hand, has found little favour, and the fact is all the more remarkable when one considers that many orders have been placed, in the U.K. and abroad, for gas-turbine sets for power production, in which field the competition of the modern steam set is even greater than in the marine case. Criteria for marine power plant differ from locomotive in that mechanical reliability and fuel economy are of greatest importance. The lack of initiative shown by commercial shipowners precludes detailed discussion of the former, since no gas turbine of any size is yet in regular service for commercial uses. As for fuel economy, the decrease in differential between marine Diesel and fuel oils in recent years has had a profound effect. Considerations of fuel cost per s.h.p. point to the use of gas turbines for high power units, while in the field of moderate powers, the expected lower maintenance cost of the gas turbine should influence owners to experiment with this power unit. Further, it is generally accepted that the weight and space occupied by the gas turbine will show a saving over the Diesel and steam sets.—*Paper by I. Lubbock and I. G. Bowen, read at a Joint Conference of the Institute of Petroleum and the Institute of Fuel, 23rd September 1948. The Motor Ship, Vol. 29, October 1948, pp. 276-278.*

Handling and Stowage of Ships' Perishable Cargoes

The author of this article, who has been refrigerating engineer with the Matson Navigation Co. gives a list of points to be observed by ships' operators in handling perishable cargo. He first points out the conditions peculiar to marine transport and then lists the classes of refrigerated ships. There are numberless arrangements for refrigerated compartments aboard ship, and they usually reflect the trade in which the vessel is engaged. Apart from fishing and processing ships, there are two general classifications: (1) with totally insulated hull subdivision in which the lower holds and corresponding 'tween deck spaces above are separately or collectively compartmented with the hatch opening common to all, or (2) with multiple compartmented arrangements, usually confined to 'tween deck spaces and accessible through doors. The so-called "all refrigerated" ship is generally of the first classification and it is principally employed in the banana, citrus, apple, and meat trades. Formerly it was used for high temperature services (low temperature meat excepted) and was made suitable for carrying general cargo on return voyages. In the more modern application, any or all compartments are available for freezer, chill, or general cargoes to meet varying or seasonal trade demands. The multiple room ship is without exception being designed for all services from sharp freezer to high temperature. This arrangement has many advantages and represents the trend in private construction. It is usually found on the combination vessel engaged with others of her type in frequent sailings on scheduled routing. The insulated spaces are unsuited for carrying general cargo because of the higher cost of handling, through entrance doors and restricted spaces. However, unless the refrigerated spaces are of excessive total volume, it is seldom found necessary to employ them, there being ample dry cargo spaces for allowable deep draught loading. In the typical composite ship described by the author, the refrigerator rooms are located in upper and lower 'tween decks and the lower holds are totally insulated. Referring to refrigerator equipment, the author states that the employment of non-toxic refrigerants was greatly expanded during the war for reasons of safety. The associated characteristics of the compressor equipment have made these units particularly well adapted to high-speed drives, simulating shore conditions. They were practically the first belt-driven sea-going auxiliaries to find acceptance. The influence of the factors governing land installations was markedly felt in government-built marine plants and the direct expansion systems were installed almost exclusively for all types and sizes of cargo installations. However, brine systems are rapidly regaining the position they lost to war-time expedience. The same shore side influences also directed the selection of the cooling units in the rooms, and direct expansion evaporators with small tubes and closely spaced fins were the accepted design. Experience with this type of cold air diffuser, particularly at sub-frost evaporation temperatures has been such that the post war trend in private construction is towards the use of indirect or brine systems, and prime surface coils in the various types of coolers. However, there are many direct expansion plants in service and they give creditable performance with close attention to their mechanical features and with proper cargo stowage. A singular mark of progress was made toward the close of the war-time shipbuilding programme—the installation of centrifugal compressors. This type of machine usually employs Freon 11 as refrigerant and, the cycle being considerably below atmospheric pressure, the package unit is found necessary, and the use of brine is mandatory. It must not be said that the wall coil or the cold air bunker system is obsolete. There is a possibility, if not a probability, of a partial return of these applications.—*L. L. Westling, Refrigerating Engineering Application Data, Section No. 43, Section 2 of Refrigerating Engineering, N.Y., Vol. 56, October 1948.*