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President: Sir PERCY E. BATES, Bt., G.B.E.

The Manufacture of Large Drums for Water-Tube Boilers.

By P. W. McGUIRE (Member).

The following is necessarily a brief description of the method employed by The Chesterfield Tube Company for the manufacture of hollow forgings as used for the drums for water-tube boilers.

The method employed is first to place a hot solid steel billet in a circular bush and punch it vertically in such a way as to leave a solid end on the bottom of the resulting bloom. This bloom, after withdrawal from the punching press, is put on a bar on a horizontal draw bench and pushed through dies to reduce the thickness by the required amount. This gives a forging of dimensions suitable for either immediate use or for machining to finished sizes. This process will be referred to as the "Chesterfield" process.

The drums, as stated, can either be supplied in the condition as hot-drawn or they may be machined internally and externally. They may be produced with one end solid (formed as described above, during the punching of the original billet), or the solid end may be cut off leaving an open-ended drum. Even in the as-drawn condition such drums can be made to reasonably close limits, and the machined drums can be satisfactorily produced to tolerances customary in machining operations on vessels of this size. All drums are suitably heat treated after completion of the hot working operations. At that stage test rings are parted off to be tested in accordance with the relevant specification.

The billets are of Gothic, octagonal or round section and are generally designated by their across-corner dimensions in inches and by their weight. The across-corner dimensions coincide with the diameter of the bush in which the billets are to be punched.

The process adapts itself to the use of many types of steel, and although mild steel of a tensile strength of 28/32 tons is generally used, many large forgings have been produced in various alloy steels.

The solid steel billet for hot punching and drawing by the Chesterfield process is heated in a continuous bogie type heating furnace. With billets of the weight employed this is necessarily slow, and great care is taken to ensure that conditions are as uniform as possible when the material is passing through its critical range. The billet temperature is then raised more quickly to about 1,260/1,280° C. (varying however with the class of steel used) and the material is thoroughly soaked to be sure of being evenly heated. At that temperature it is transferred to the bush of the vertical punching press and fits as shown in Fig. 1.

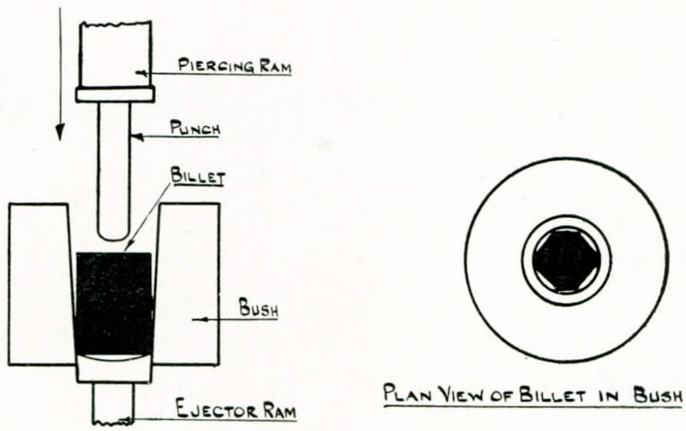


FIG. 1.

The bush is then traversed under the punch by means of a hydraulic mechanism and the punch then forced down by hydraulic power to produce a hole in the billet as shown in Fig. 2.

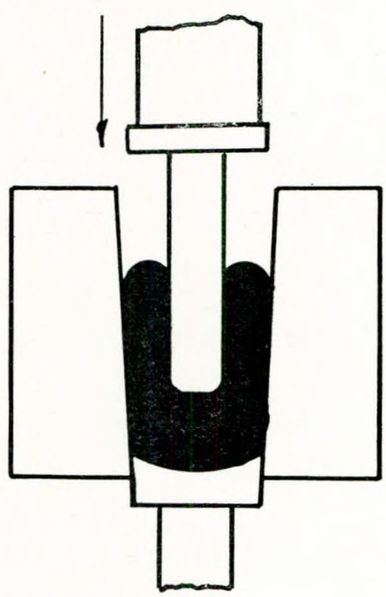


FIG. 2.

The punch does not travel right through the billet: the press is set to leave a thick base which may form one end of the resulting drum. This base also takes the thrust of the draw bar during subsequent hot drawing. After the punch has travelled to its limit it is extracted by reversing the stroke of the press. The bush containing the punched bloom is then withdrawn from under the punch and the bloom is ejected by lifting with a hydraulic ram.

For the next operation the bloom is lifted by crane and allowed to fall into a horizontal position, inspected internally and loose scale is removed from the bore. It is then transferred by the crane to the horizontal draw bench. Here the bloom is put on to a drawing bar which is attached at its back end to a moving crosshead. The drawing bar carrying the bloom is pushed forward by means of hydraulic power through a series of dies, which reduces the outside diameter and thickness of the bloom and increases the length.

If necessary the bloom is reheated and again drawn through a further series of dies of successively smaller diameter until the bloom is of the size required for service or for machining. The action is shown diagrammatically in Fig. 3.

The purpose of the back stop shown in the upper portion of the sketch is to prevent movement of the punched bloom on the first insertion of the drawing bar, an operation which enlarges the hole originally made by the punch.

The method of cooling the drum after completion of hot drawing depends on the type of steel used. If the steel does not air harden, or if the section of the drum is not excessive, the forging may be cooled in air free from draughts; but if alloy steel possesses strong air-hardening properties, or if the section of the drum is abnormally large, then it is advisable to put the forging into a furnace at about 700° C. to 750° C., allow it to soak at about that temperature and slowly cool in the furnace until below 200° C. The object is to eliminate

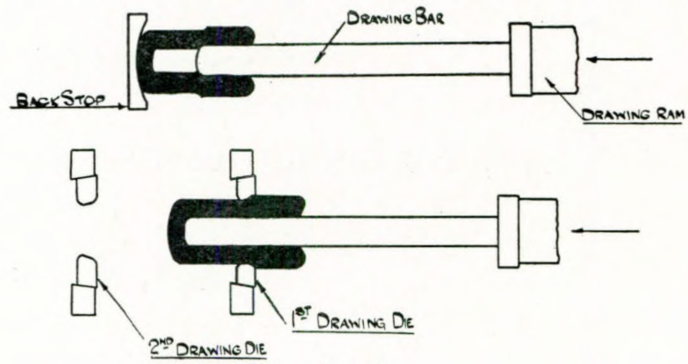


FIG. 3.

the possibility of forging cracks due to undue thermal stresses.

The drum is then heat treated to refine the crystal structure of the material, to eliminate all stresses, and to ensure that the specified tests are obtained and that the drum is in a condition suitable for service. The treatment of course depends in detail on the steel used, but generally consists of three stages:—

(1) *Annealing.*

This operation is carried out by charging the drum into a furnace below 200° C., slowly heating to the required temperature and soaking at that temperature for a sufficient length of time to ensure that the drum is evenly heated throughout. The drum is then cooled in the furnace until the temperature has dropped to below 500° C., after which the second stage of heat treatment is carried out.

(2) *Normalising.*

This operation is done by charging the still hot drum into a furnace having a temperature of between 500° C. and 600° C. It is heated slowly and uniformly until the normalising temperature is reached (say 950° C. or less, depending on the steel), soaked at that temperature until uniform, after which the forging is withdrawn and cooled in still air until the temperature has fallen to below 500° C.

(3) *Stress relieving treatment.*

The drum is then charged into a furnace having a temperature of between 500° C. and 600° C., heated to 650° C./680° C., thoroughly soaked at that temperature until uniform and then cooled in the furnace until the temperature has dropped to below 300° C.

After heat treatment has been completed and before any machining is done the necessary tests are carried out in accordance with the requirements of the specification. Such tests usually consist of transverse tensile tests and bend tests.

The tensile tests are invariably taken on the British Standard machined test piece "C", *i.e.* having a diameter of 0·564in. (area = ¼ sq. in.) and a 2in. gauge length, whilst the bend tests are of rectangular section 1in. × ¾in. and are bent on the 1in. face.

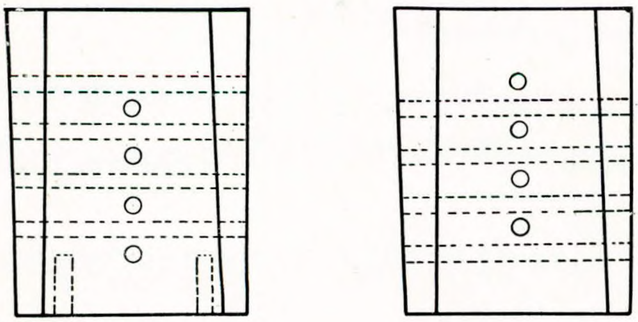
Obviously the tensile, elongation and angle of bend depend upon the steel used, but a typical result taken from a mild steel drum is as follows :—

	Top of forging.	*Bottom of forging.*
Yield point	16 tons/sq. in.	16 tons/sq. in.
Maximum stress ...	30 tons/sq. in.	31 tons/sq. in.
Elongation	35% on 2in.	34% on 2in.
Reduction of area ...	55·8%	50·7%
Bend over ¼in. radius	180°	180°

Upon completion of the tests, the drums to be used in the as-drawn condition are simply cut to length. The Chesterfield process gives a satisfactory surface in the as-drawn condition and for all but the most severe service the drums could be used in this state. The limits of wall thickness are plus or minus 10 per cent., and the deviation from circularity is very small, say, plus or minus 1 per cent.

Machined drums are bored and turned to the required dimensions and cut to the specified length; very little springing occurs on drums that have been carefully heat treated, indicating that the stresses have been satisfactorily relieved.

Considerable attention has been paid to the question of the flow of the material during hot drawing and a detailed examination was made of one of the early boiler drums produced by this method. The flow of the material has been studied by the working and subsequent sectioning of billets which have been drilled and pegged with a dissimilar steel in pre-determined positions. By so doing the relative situation before and after working of any



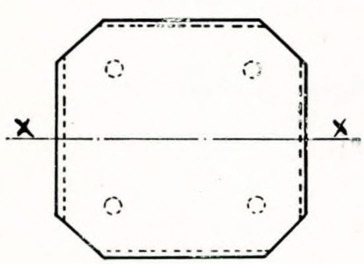


FIG. 4.—*Sketch showing billet drilled and pegged with dissimilar steel.*

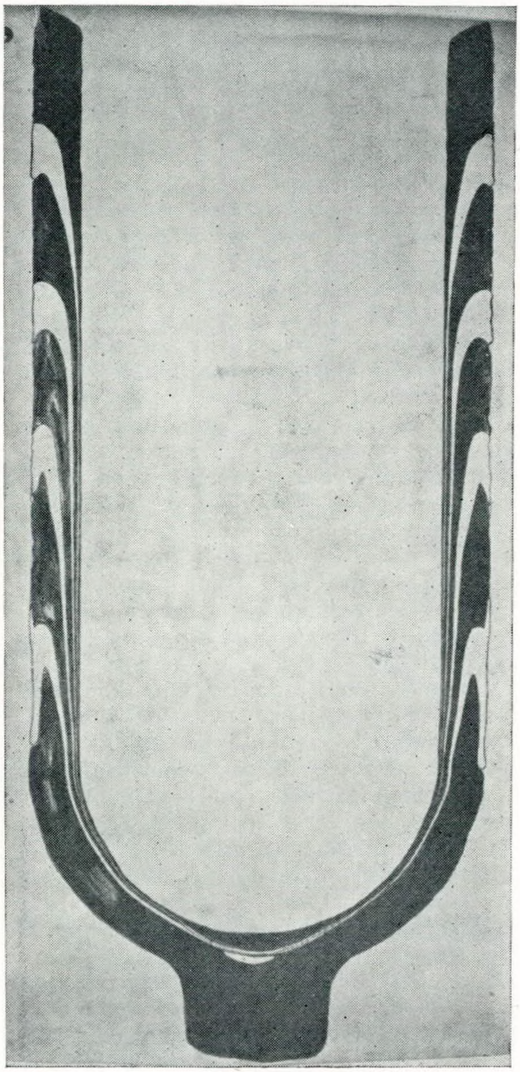


FIG. 5.

particular portion of a billet is definitely known. Fig. 4 is a sketch giving the position of the pegs in the original billet, whilst Fig. 5 is a photograph of a longitudinal section through the bloom after hot punching, which section was the plane $X-X$ in the original billet in Fig. 4. This gives a very clear indication of the flow of the material.

Similar longitudinal sections on other planes demonstrate plainly the even flow which takes place during hot working of the steel by the Chesterfield process.

The flow at the end of a punched bloom is very

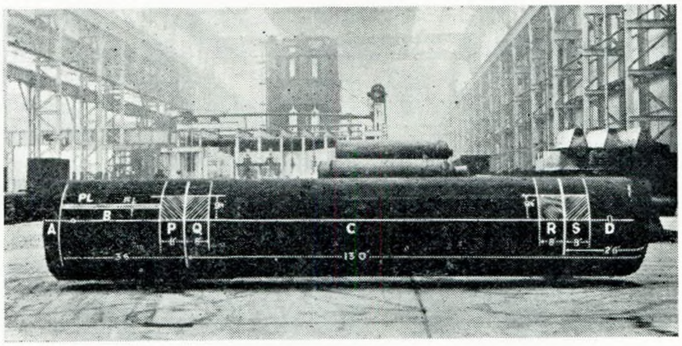


Fig. 6.

interesting. Whilst the material at the centre of the end both on the internal and external surfaces has remained practically stationary, the remaining material further away from the centre and also that in the middle of the thickness of the end shows considerable flow. This stagnant condition of the centre surfaces is due to the chilling effect of the punch end and the bush bottom on the hot steel, resulting in a definite resistance to flow. There is, however, no indication of unsoundness or cracking on this account.

A drum which was subjected to thorough examination is shown in Fig. 6.

The first stages of examination were in the condition in which the drum was forged, whilst the second stages were after heat treatment, *i.e.* sections *A, B* (which included ring *P*) and *D* (which included ring *S*) were examined before treatment and rings *Q* and *R* from section *C* were examined after heat treatment. The base end at *D* after the removal of ring *S* was sectioned longitudinally and half this section, after tests had been taken in the as-forged condition, was heat treated with section *C* and further tests taken.

Macro-examination consisted of transverse sulphur prints taken from rings *A, Q, R* and *D,* a longitudinal sulphur print from ring *B* and longitudinal macro-prints from ring *B* and through the centre of the base. These prints were normal, but the macro-print through the centre of the base was most interesting as it confirmed the results obtained with the pegged billet. This print is reproduced in Fig. 7.

As was shown in the case of the pegged billet, macro-examination of the various sections of the water drum demonstrates the regularity of flow obtained by this

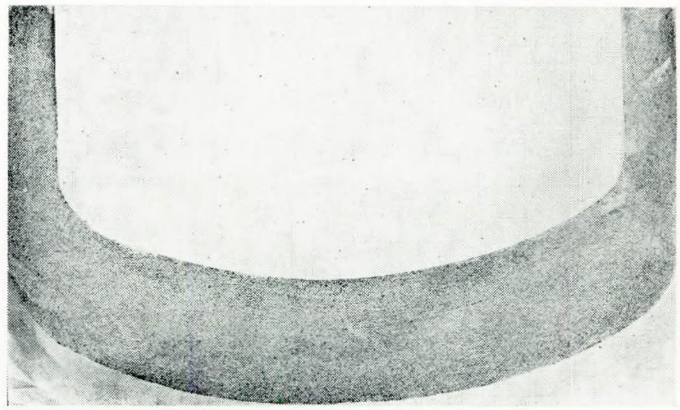


Fig. 7.

method of production. This is entirely due to the fact that all parts of a cross-section are being subjected to an almost identical amount of work at the same time, and also that throughout the whole length of the body of the forging the amount of work done during any one or all of the operations is practically the same. This fact

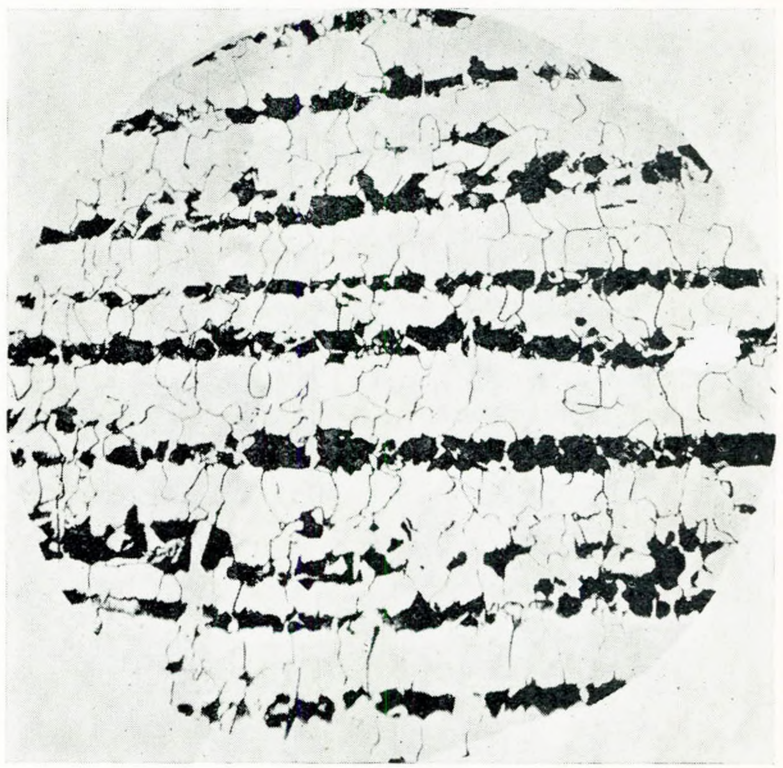
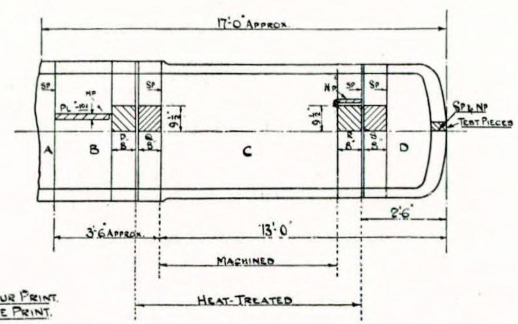


Fig. 8.

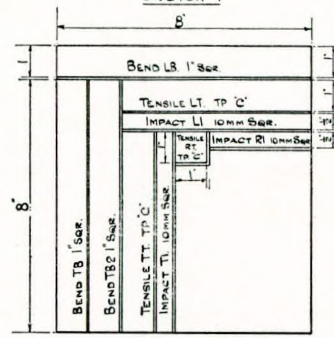
Showing the structure in the as-forged condition.
($\times$ 100)

SKETCH X.



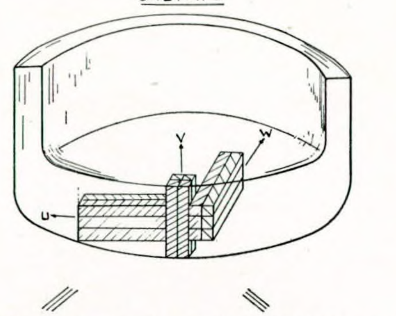
SP.- SULPHUR PRINT.
NP.- NATURE PRINT.

SKETCH Y



SHOWS ALLOCATION OF TEST PIECES FROM RINGS P. Q. R. & S.

SKETCH Z



TEST PIECES FROM BASE

TESTS ON RINGS.

RING	CONDITION	LONGITUDINAL TESTS										TRANSVERSE TESTS													RADIAL TESTS							BRINELL 3000/10 AVERAGE OF THREE TESTS.	
		TENSILE TP 'C'					IMPACT 10MM SQR.		BEND 1" SQR.			TENSILE TP 'C'					IMPACT. 10MM SQR.		BEND 1" SQR.						TENSILE 0·291" DIA. × 1" GL.					IMPACT 10MM. SQR.			
		CODE	YIELD PT. TONS/□"	MAX STRESS TONS/□"	ELONG. % ON 2"	R OF A %	CODE	RESULT FT.-LBS	CODE	ANGLE	RESULT.	CODE	YIELD PT. TONS/□"	MAX. STRESS TONS/□"	ELONG. % ON 2"	R OF A %	CODE	RESULT FT.-LBS	CODE	ANGLE	RESULT.	CODE	ANGLE	RESULT.	CODE	YIELD PT. TONS/□"	MAX. STRESS TONS/□"	ELONG. % ON 1"	R OF A %	CODE	RESULT. FT.-LBS	Nº	UTS.
P.	AS DRAWN	PLT.	16·6	29·4	34½	52·2	PLI.	33, 33, 30.	PLB.	180°	UNBROKEN	PTT.	15·8	29·0	37	49·7	PTI.	25, 22, 24.	PTB	180°	UNBROKEN	PTB2	152°	BROKEN	PRT.	16·05	28·75	20*	19·7*	PRI.	23, 14.	133	30·8
S.	AS DRAWN	SLT	16·9	29·0	32	49·7	SLI.	28, 34, 35	SLB	180°	UNBROKEN	STT	16·4	29·4	31	41·9	STI.	24, 18, 21.	STB	180°	UNBROKEN	STB2	102°	BROKEN	SRT	14·8	27·75	21*	37·9*	SRI	13, 18, 19.		
Q.	HEAT TREATED	QLT	16·8	30·0	39	61·5	QLI	36, 43, 50	QLB	180°	UNBROKEN	QTT	16·5	29·8	36	47·2	QTI	32, 31, 34.	QTB	180°	SLIGHT TRANSVERSE CRACK	QTB2	180°	UNBROKEN	QRT	15·5	30·1	32	41·9	QRI	27, 25, 29.	137	32.
R.	HEAT TREATED	RLT	15·2	28·6	39½	60·5	RLI	45, 40, 25	RLB	180°	UNBROKEN	RTT	15·6	29·3	36	53·4	RTI	22, 22, 25.	RTB	180°	UNBROKEN	RTB2	180°	SLIGHT TRANSVERSE CRACKS	RRT	14·7	28·6	20*	33·6*	RRI	17, 14, 21	129	29·6

* - BROKE NEAR POP - MARK.

TESTS ON BASE.

CONDITION	U							V					W						
	TENSILE TP 'C'				IMPACT. 10MM SQR.	BEND 1" SQR.		TENSILE TP 'C'				IMPACT. 10MM. SQR.	TENSILE TP 'C'				IMPACT. 10MM SQR.	BEND 1" SQR.	
	YIELD PT. TONS/□"	MAX. STRESS TONS/□"	ELONG. % ON 2"	R OF A %	RESULT FT.-LBS	ANGLE	RESULT.	YIELD PT. TONS/□"	MAX. STRESS TONS/□"	ELONG. % ON 2"	R OF A %	RESULT FT.-LBS	YIELD PT. TONS/□"	MAX. STRESS TONS/□"	ELONG. % ON 2"	R OF A %	RESULT FT. LBS	ANGLE	RESULT.
AS DRAWN	13·3	25·7	36	54·5	16, 16, 23.	180°	UNBROKEN	14·2	25·9	27	46·3	28, 19, 18.	12·0	26·2	31½	52·2	31, 26, 31.	180°	UNBROKEN
HEAT TREATED	15·2	27·0	38	59·5	38, 40, 40.	180°	UNBROKEN	16·0	27·3	32 O.M.H.	57	30, 28½, 17	15·2	27·0	37	60·5	40½, 40, 39	180°	UNBROKEN

FIG. 10.—*30in. water drum—schedule of test results.*

also results in the forging maintaining a very even temperature throughout the body. The speed of working also ensures that the forging is not worked at too low a temperature—a finishing temperature of approximately 1,000/1,050° C. is usual.

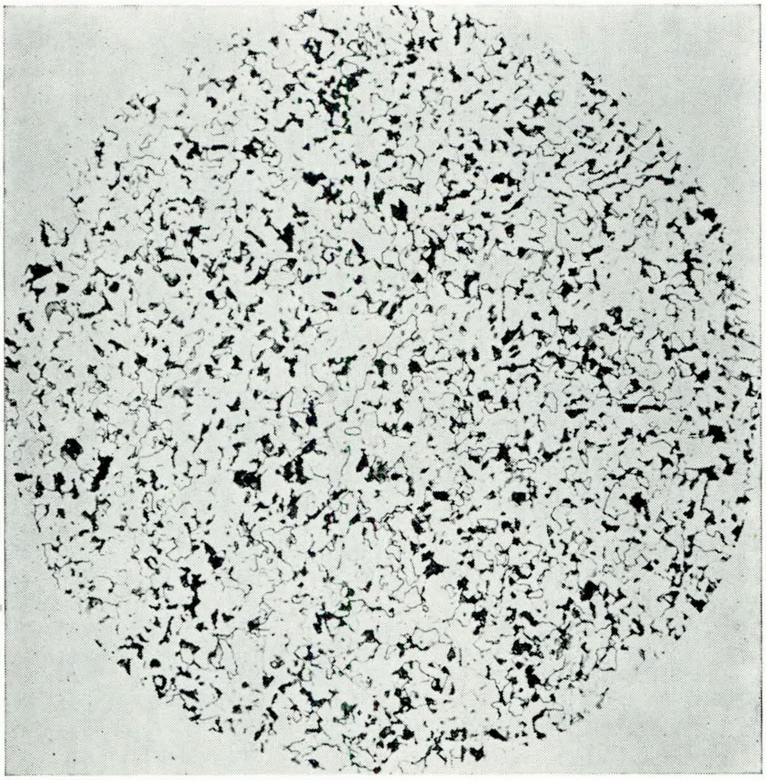


Fig. 9.
Showing the structure in the heat treated condition.
(× 100)

Micro-examination was carried out on sections from every ring cut from the drum illustrated in Fig. 6. The consistent structure obtained on all these sections both in the as-forged condition and also after heat treatment again demonstrates the advantage of the even thermal and mechanical conditions obtained by the Chesterfield process. The structure before treatment is perhaps somewhat on the coarse side but this is a definite indication that the hot working of the material has been finished above the upper critical point of the steel and no working has been carried out at a dangerously low temperature. This fact, coupled with the even thermal conditions, ensures a forging which when cooled carefully is more likely to be free from any undue stresses and what slight stresses remain are efficiently removed by the subsequent heat treatment.

The micro-examination carried out after heat treatment shows the ready response of the steel to this treatment, resulting in a well refined structure. Representative photo-micrographs are given in Figs. 8 and 9.

The good conditions demonstrated by macro- and micro-examination are further confirmed by the mechanical tests taken.

Whilst it is usual in meeting specification requirements to give only the results of tensile and bend tests, the drum examined was also subjected to Izod impact tests. Fig. 10 gives the results obtained.

The section *C* in Fig. 6 after the removal of rings *Q* and *R* was machined both externally and internally leaving a rib on one side extending the full length of the forgings and two short ribs practically opposite. Full dimensions were taken and checked during this machining and the amount of distortion was at the most 0·015in. on a 30in. dimension. These clearly demonstrate the efficiency of the method of forging and the subsequent heat treatment in producing a drum free from internal stresses.

A considerable number of drums have been manufactured by the Chesterfield process and the mechanical test results have always been well within the specification requirements.

The method of manufacture enables drums to be supplied satisfactorily in the hot-drawn condition, in the semi- or completely-machined condition and with one end solid or with both ends open.

Whilst the drum subjected to detailed examination was of mild steel, similar forgings have been produced in various grades of carbon and alloy steels.

ADDITIONS TO THE LIBRARY.

Presented by the Publishers.

Power Pumps. By C. Edwards. The Draughtsman Publishing Co., Ltd., "Mansefield", Rugeley, Staffs., 39 pp., 23 illus., 2s. net.

For the purposes of this pamphlet the somewhat vague definition of power pumps has been extended to include similar crank-driven types of pumps, and including in that class hydraulic pumps at least as far as principles of operation are concerned. Direct-acting steam, flywheel and borehole or deep-well types of pumps are however excluded. After the first section which is descriptive of the main types of pumps, the author deals with pumping head, design principles, installation, design data, suction lift, sealing stuffing boxes and pistons, proportions of important parts, miscellaneous design notes, and finally a worked example is given.

Determination of Scantlings for Masts, Derrick Posts, and Their Fittings. By D. M. Carnegie. The Draughtsman Publishing Co., "Mansfield", Rugeley, Staffs, 62 pp., copiously illus., 2s. net.

Although the scantlings for masts are generally indeterminate, it is necessary to use some approximate methods to arrive at a practical solution. The contents of this pamphlet are intended to give ship draughtsmen and others interested who are not acquainted with the design of masts, etc., an idea of how to use these approximations and hence arrive at a result not very far away from the truth. Sections of the publication deal with (1) design of masts which are stayed; (2) design of masts or derrick posts which are unstayed; (3) scantlings of a mast to take a heavy derrick load; (4) scantlings of heavy derrick; (5) design of mast deck bracket connections; (6) design of cross trees; (7) design of derrick tables; and (8) design of mast and derrick fittings.

JUNIOR SECTION.
Naval Architecture and Ship Construction (Chapter V).

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

Pillars, Girders, Hatchways.

Pillars.

Pillars are the vertical supports to the several decks. They serve to keep the decks in position, and are undoubtedly valuable as local supports. When the ship is *hogging* the pillars will be in *compression.* When, however, the ship is *sagging* the effect of heavy loads in the bottom of the ship is to bring the pillars into *tension.* It is for this reason that a material must be chosen which is capable of withstanding both tension and compression. The classification societies permit the use of wrought iron or mild steel, but in no circumstances may cast iron be employed. The latter, although very strong in compression, is notoriously weak in tension, and therefore manifestly unsuitable. The diameter of a pillar will depend upon its length and its position in the ship. Thus, a lower hold pillar, because it has to support the loads transmitted from all the decks above, will need to have a larger diameter than the 'tween-deck pillars, apart from the fact that it is longer. Actually, it is not the practice to design from first principles, but to make use of the special numerals set out in the scantling tables provided by the classification societies.

When a single line of pillars only is deemed sufficient, it will of course be situated on the centre line of the ship, and the pillars will be fitted to *alternate* frames. The effect of a prop at the centre of the beam is to reduce the bending moments therein, and hence to make it safe to carry far larger deck loads than would be possible without it. This is a point which should be carefully studied. The prop is the simplest and most economic way of increasing the load carrying capacity of a beam. Its one disadvantage in a ship is that it introduces a certain amount of broken stowage. Some designers, to overcome this objection, dispense with pillars, and endeavour to restore the strength of the beam by heavier bracketing at the ends, or by introducing heavy webs (or partial bulkheads) at intervals. The wisdom of this expedient is open to some doubt. Nevertheless, with the increase in the size of ships and the necessity of additional side rows of pillars, sympathy must be extended to the stevedore who has to stow the ship. Probably the most effective compromise is the introduction of deck girders situated close to the hatch coamings, extending from bulkhead to bulkhead and supported at widely spaced intervals by large tubular or girder type pillars. This system is known as *massed pillaring.*

Fig. 48 illustrates different methods of fixing the heads and heels of small solid pillars. A point to notice is that the shoulder of the pillar must fit close up to the beam. In this way, when the pillar is in compression the rivets securing it to the beam will be relieved of shear. In tension the rivets will be put into a state of shear, but clearly the more serious condition of alternating stress will be avoided. Modern regulations require runners consisting of two angle bars back to back to be fitted extending from bulkhead to bulkhead and secured to the beams by means of angle lugs. The head of the pillar is riveted to the runners (Fig. 48B). Many general cargo carrying vessels have the centre line row of pillars staggered, so that should it be required to carry a bulk-grain cargo, shifting boards can be housed between them. In Fig. 48C a suitable method of working these pillars is shown. The heads are secured to a channel bar, which also serves as a runner, and is connected to the beams by short angle lugs. In modern practice it is quite convenient to dispense with rivets and weld both head and heel to the adjoining structure.

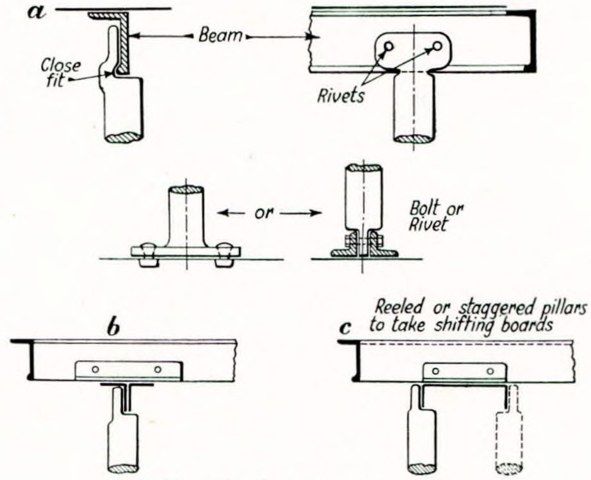


FIG. 48.—*Heads and heels of pillars.*

As already pointed out, *massed pillars* are large tubular or girder type pillars, fitted at widely spaced intervals and associated with deck girders which may be situated above or below the deck. For this system it is claimed that there is much less broken stowage, and the strength of the deck should be even superior to that obtained with closely-spaced pillaring. On the debit side there is the probability that the system may prove to be somewhat heavy. It is not possible to say what is the best method of providing deck support, without making a close study of the size of the hold compartment, the size of the hatchway and the nature of the loads to be carried. Fig. 49 depicts the usual types of massed pillars, viz. the tubular section, four angle bars back-to-back, and the double channel bar. In Fig. 50 an attempt is made to portray the head and heel attachments for a double-channel type pillar. The tubular type will be seen

FIG. 49.—*Types of massed pillars.*

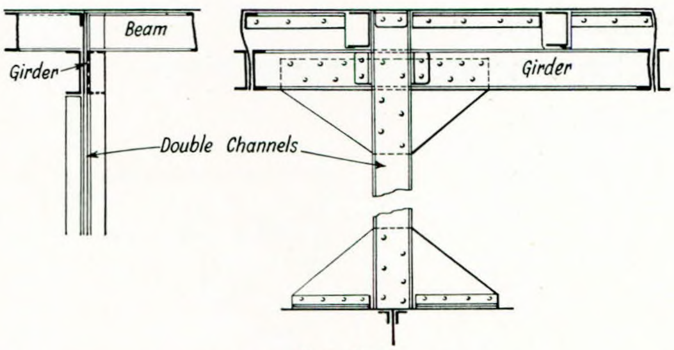


FIG. 50.

in the subsequent drawings of a hatch section. It might be advisable to encourage the reader at this stage to supplement his study of these drawings by a little observation of the real thing on board ship. It is the only way to obtain a genuine appreciation of the methods of arranging structural attachments.

Hatchways.

A hatchway is a large opening cut in the deck, to provide access to the hold spaces. From the point of view of loading and discharging, the larger the hatchway the better. Certain limiting conditions will obtain however, due to the fact that the strength of the deck must be maintained, and the hatch itself must be made strong enough and tight enough to withstand the action of the seas. A normal hatch might be about 24ft. in length and some 16ft. in breadth, although such sizes are quite frequently exceeded. As a protection against the action of the sea, and partly as a means of providing deck compensation, deep vertical plates are fitted along the sides and across the ends. These are known as coamings. Lloyd's require the coamings of weather deck hatches to be not less than 24in. in height above the deck, except for vessels of the complete superstructure type (shelter deckers for instance), which are to have 24in. coamings for the quarter length forward, and 18in. coamings abaft this point. There are no objections to these values being exceeded and they frequently are, 36in. being not uncommon. In the upper 'tween deck of complete superstructure vessels, however, where the upper deck is not officially watertight, the coamings are to be 9in. in depth. In lower 'tween decks, coamings need not extend above deck level, although all hatches are to be *framed.*

Needless to say, weather deck coamings have to be substantially constructed; their thickness is not to be less than ·44in., and when the length exceeds 10ft. angle-bulb stiffeners running lengthwise are to be fitted as near to the top of the coaming as is practicable. These bulb angles are to have a minimum depth of 7in. The coamings should be well connected to the transverse hatch-end beams and to the half beams. Furthermore, deck girders should be fitted within 18in. of the side coamings, or the latter should be so stiffened and supported that they may constitute efficient girders. The attachment to the deck plating is through the medium of a very strong angle bar (about 6in. × 6in. × same thickness as coaming) both edges of which are caulked. To avoid fraying of ropes the bottom edge of coaming plates should be flanged, and it is also desirable to round the corners of the hatch. In-

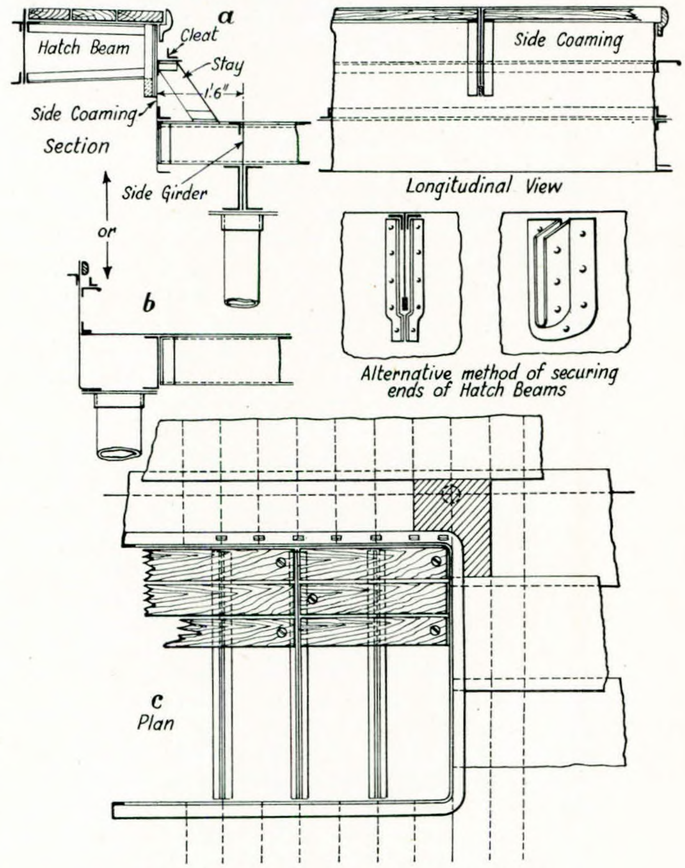


FIG. 51.—*Details of ordinary hatchway.*

cidentally, flanging a plate adds materially to its stiffness. Fig. 51 (*a*), (*b*) and (*c*) give some details of normal hatch construction. No attempt has been made to be exhaustive, but the illustrations should suffice to give a practical idea of how a hatchway is framed and supported. There are numerous ways of cross framing the hatch in order to support the covers, but in the interests of brevity and simplicity one system only will be described here.

In no case are transverse hatch beams to exceed 10ft. in spacing. They will consist of web plates with double angle stiffeners top and bottom. The upper angles must continue right out to the coamings, but 3in. or 4in. of the horizontal flanges of the lower angles may be removed from the ends so that the beams will house suitably in the carriers. The ends of the webs are to be flushed up on each side with doublings having the same thickness as the attaching angles and not less than 7in. wide. In the system herein described, no fore and afters will be fitted, and consequently the alternate web plates are to extend above the level of the upper angles so as to come flush with the tops of the wood covers. All hatchway beams are to be supported at their ends by steel carriers, having a bearing surface of not less than 3in. The carrier may be constructed of two angle bars not less than ·5in. thick, which are to be fitted close to the sides and throat of the hatchway beam. The bottom of the carrier is to be solid or efficiently secured by not less than two ⅞in. rivets. Details of suitable carriers are illustrated in Fig. 51. Hatch covers will be of wood having a finished thickness of not less than 2⅜in. associated with an unsupported span of 5ft. Where this span is increased to 6ft. Lloyd's require the thickness of the wood covers to be at least 3in.

It will be noticed that an angle iron is fitted around the top edge of the coaming on the inside or, alternatively as shown in Fig. 51, a special moulding such as the Tyzack hatch moulding is employed. This is known as a *hatch rest* and its purpose is to provide a bearing surface for the wood covers. This bearing must be at least 2½in. in width.

Cleats, Battens and Tarpaulins.

Quoting Lloyd's Rules, cleats not more than 2ft. centre to centre are to be fitted on all hatches on or above the upper deck. The end cleats are to be not more than 6in. from the hatch corners. They are to be of strong pieces of angle iron at least 2½in. wide, secured to the angle bulb stiffener on the outside of the coaming by two rivets. Where the hatch is in an exposed position two tarpaulins are necessary, and these are to be thoroughly waterproofed and free from jute. The tarpaulins are of course kept in position by means of efficient battens and wedges. Where the hatch has a breadth exceeding 60 per cent. of the breadth of the deck, and where the coaming is required to be 24in. in height, special lashings are to be provided for securing the covers after the tarpaulins are battened down.

Bunker Hatches.

The regulations relating to the coamings, hatch beams and covers for bunker hatches are identical with those for ordinary hatches, and the same attention must be given to battening down, etc. so as to ensure complete seaworthiness. *Flush bunker scuttles* are permitted on bridge decks, poops, and upper decks of complete superstructure vessels, and on decks within superstructures provided they are always accessible. They are to be of iron or steel, strongly constructed and either screw or bayonet jointed. When not hinged there must be a permanent chain attachment.

Watertight Hatches.

Access to *deep tanks* is provided by fitting watertight hatches about 6 or 8ft. square. The presence of the washplate or divisional bulkhead makes it convenient to fit these hatches in pairs abreast of one another. They must be very strong in order to withstand the pressure which comes upon them when water is standing in the air pipe—in fact it is customary to reinforce the steel cover with angle irons on the underside at intervals of about 2ft. The coaming is usually in the form of an angle bulb bar riveted to the deck. Hinged bolts and butterfly nuts are used to secure the cover, and watertightness is secured by employing either spunyarn or rubber. Small manhole covers may be fitted in the cover to afford access without the necessity of removing the whole of the hatch top. Fig. 52 illustrates the construction of a typical watertight hatch, and an alternative method of closing and making tight is indicated.

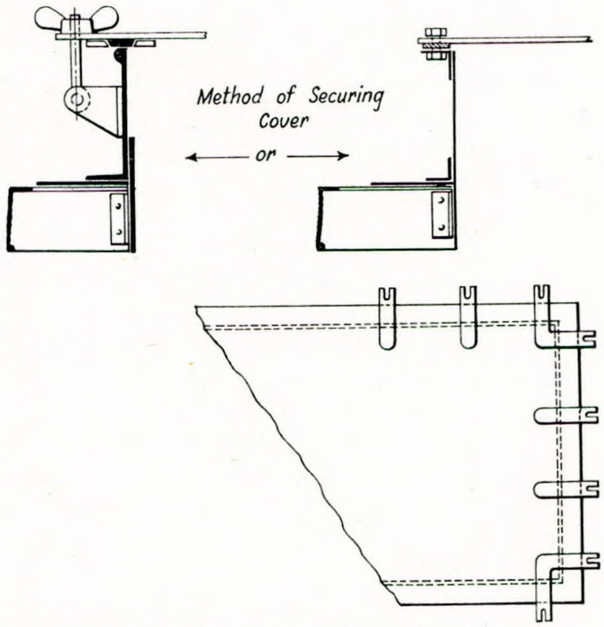


Fig. 52.—*Corner of watertight hatchway.*

Manhole Covers.

There are numerous methods of fitting manhole covers to the crowns of double bottom and other tanks, some consisting essentially of a plate secured by means of some form of strongback, others being simply plates fitting back over studs and bedded on red lead. It is a good plan to grease white hemp with tallow and press it into the red lead, winding it "figure-eight" fashion

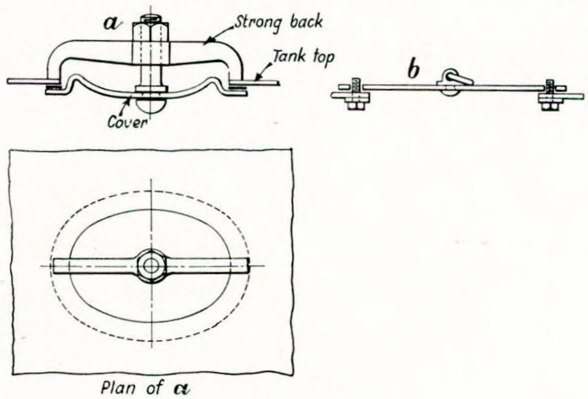


Fig. 53.

round the studs before putting the plate in position. Fig. 53 (*a*) and (*b*) depicts two suitable arrangements for such covers. The drawings are self-explanatory and need no further explanation.

The Tonnage Hatch.

Provided that certain most peculiar regulations be observed, the shelter 'tween deck space in a ship may be exempt from tonnage measurement. One of these regulations demands the fitting of a small hatch on the shelter deck having its after coaming not less than one-twentieth of the vessel's length forward of the after side of the sternpost, and its forward coaming not less than one-fifth of the vessel's length from the fore-edge of stem. The hatch is to be 4ft. in length, its width is to equal that of the after cargo hatch, and it is to be fitted with a coaming extending 12in. above the wood or steel deck. It is closed by wood covers which may be lashed from underneath by hemp. Tarpaulins may *not* be used,

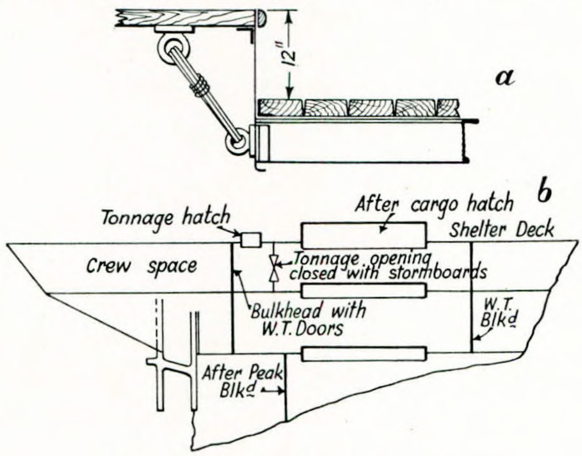


FIG. 54.—*Details of tonnage hatch.*

neither may stanchions be fitted so close to the coamings as to make an improvised method of battening down possible. In Fig. 54 a section of a tonnage hatch is shown, and also a part profile of the after end of the ship indicating its usual position. In this drawing it will be noted that bulkheads are fitted before and abaft the hatch. If this be done, openings measuring 4ft. × 3ft. must be cut in the bulkheads, having storm boards or possibly plates secured by hook bolts, as the only means of closing them. When the space abaft the tonnage well is utilized as a crew-space watertight doors may be fitted on the after of the two bulkheads. Approved scuppers and washports (with no permanent means of closing) are to be provided. Circumstances can easily be imagined whereby the strict observance of these regulations may impair the seaworthiness of the ship. It would not be politic to discuss the means employed to overcome such difficulties, but two possibilities suggest themselves. The first is slightly irregular and more or less involves some avoidance of the rules. The second method is to close the hatch completely and forego the tonnage exemption. By way of compensation some 6in. or so increase in draft will become permissible under the International Load Line regulations. The whole subject will be discussed more fully in the chapter dealing with tonnage.

Steel Hatch Covers.

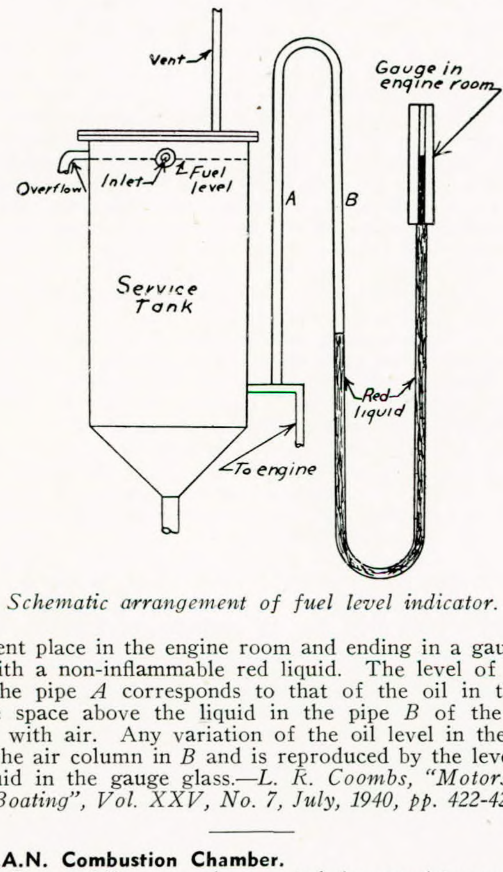
From time to time suggestions have been put forward with a view to the employment of steel hatch covers. The simplest form consists of large hinged steel plates secured in a manner not dissimilar to that in use with an ordinary watertight hatch cover. Tightness may be secured by placing tarpaulins over the top in the ordinary manner, or side canvas flaps may be used. The corrugated hatch cover is another type which has attracted a good deal of attention. It claims to be exceptionally strong and relatively light. The great disadvantage seems to be the difficulty in making the sides weathertight. To this end a packing consisting of white hemp steeped in tallow can be layed on the rests, and the covers bedded and screwed down thereon. The steel covers described above are too heavy to be manhandled, and it becomes necessary to utilize one of the winches and a tackle secured to the mast. Yet another form of steel cover is occasionally met with, in the form of steel plates which run on rollers. Such an arrangement facilitates the opening and closing of the hatch, and there is little difficulty in effecting watertightness. It will be appreciated that the ordinary wooden hatch cover can be made weathertight, but in no circumstances watertight. With reasonable care a well-designed steel cover can be made thoroughly watertight; add to this its great additional strength and ease of handling, and it is somewhat surprising that so many still cling to the old-fashioned idea. One reason for this may be the idea that steel covers are rather more difficult to stow, and are apt to clutter up the deck, and get in the way of handling appliances.

By way of explanation it might be pointed out that a deck (or a hatchway for that matter) is said to be weathertight if it will prevent water from entering the ship. It is not necessary that it should be so constructed as to prevent water getting out. A watertight deck would be one which was so constructed as to preclude the passage of water in either direction. Such an arrangement is scarcely practicable, and although it is common to refer to the freeboard deck in a ship as being watertight, the appellation is manifestly incorrect. No deck in a ship could withstand water pressure from below, for a number of reasons. Not only would the hatches fail, but the deck-plating itself would open up, and water would rise in the ventilators. A little consideration of these matters will make it very clear how important it is to insist upon thoroughly sound watertight bulkheads, carried up to the uppermost continuous weathertight deck, and a ship side which is also sound and tight up to the weather deck.

Abstracts of the Technical Press

Simple Form of Fuel Level Indicator.

The accompanying sketch shows the arrangement of a simple oil fuel service tank level indicator made by the E.R. staff of a small motor vessel at Vancouver, B.C. The purpose of the indicator is to show the fuel level in the service tank at a convenient place in the engine room without infringing the local regulations prohibiting the fitting of gauge glasses containing fuel oil, paraffin or petrol, in a ship's engine-room. Referring to the sketch, the pipe *A B* forms a U which extends above the tank and has its lower end connected to a pipe led to any

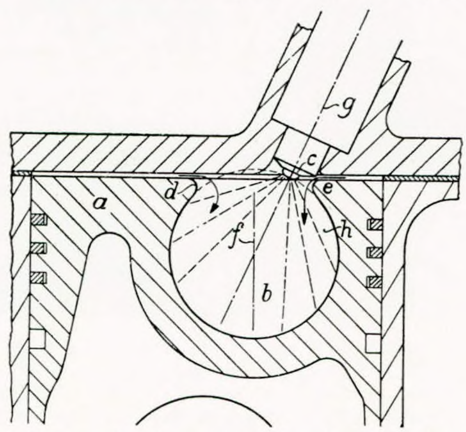


Schematic arrangement of fuel level indicator.

convenient place in the engine room and ending in a gauge glass filled with a non-inflammable red liquid. The level of the fuel oil in the pipe *A* corresponds to that of the oil in the tank, and the space above the liquid in the pipe *B* of the U-bend is filled with air. Any variation of the oil level in the pipe *A* affects the air column in *B* and is reproduced by the level of the red liquid in the gauge glass.—*L. R. Coombs, "Motorship and Diesel Boating", Vol. XXV, No. 7, July, 1940, pp. 422-423.*

New M.A.N. Combustion Chamber.

The Patent Office recently accepted the complete specification of an approved form of combustion chamber for Diesel engines developed by the Maschinenfabrik Augsburg Nürnberg. Its object is stated to be to enable high efficiency and correspondingly low fuel consumption to be attained. Referring to the accompanying drawing, the combustion space (*b*) is cut in the piston (*a*) and the fuel is injected through the nozzle (*c*). The combustion space is symmetrical, both with respect to its vertical axis (*f*) and to the inclined axis (*g*) of the nozzle, which is outside the combustion chamber. The complete sphere of the combustion space intersects the upper portion of the piston head in a circular section, the edges being rounded off at (*d*) and (*e*). The diameter of this opening is about 0·7 of the diameter of the sphere, this proportion being important. The fuel jet, which is indicated by the dotted lines and covers an angle of 90°, impinges against the wall of the combustion space all round at the same angle, and there is only a small air space (*h*) which is not filled with fuel. The fuel cone is thus impinged upon everywhere by the

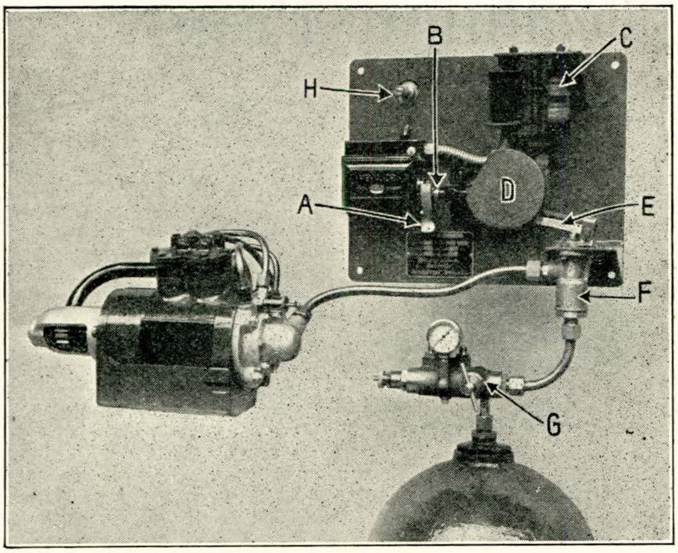


Arrangement of combustion chamber and nozzle of new M.A.N. engine.

air forced from the chamber into the combustion space towards the end of the piston stroke, and carried upwards to the interior of the combustion space. The designers' most important claim would appear to be that the cone of fuel or its prolongation strikes the spherical wall along a circular line symmetrical with respect to the axis, in spite of the inclined position of the axis, and that there remain in every vertical cross-section between the wall and the cone of fuel, equal spaces not reached by the fuel if the fuel cone does not fill up the whole of the space. It is claimed that these features are not possessed by any other shape of combustion chamber having an inclined nozzle.—*"The Oil Engine", Vol. VIII, No. 87, July, 1940, p. 77.*

Automatic Air Starting for Auxiliary Generators.

Whereas most automatically-started oil engines rely upon electrical means for setting them in motion, the equipment shown in the accompanying illustration is operated by compressed air. It is intended for starting up an engine of about 100 b.h.p. of the medium-speed or high-speed type used for driving auxiliary generators, and comprises three principal components, *i.e.*, the control panel; the air receiver; and the air motor. Referring to the illustration, A is the control switch for the automatic system; B is a safety catch for the retention of a weight (D) which is operated by A; C is a solenoid; D is the weight which actuates the air-starting lever E; F is the air-starting valve; G is the shut-off valve on the air receiver; and H is an indicator lamp for the automatic system. The air motor is on the left and its pinion may be arranged for either inboard or outboard engagement. In normal working conditions electrical energy from the mains circuit energises the solenoid C, but if the current fails this solenoid is de-energised and releases the actuating weight D, which falls and makes contact with the free end of the control lever E of the air-starting valve F. This allows air from the receiver to flow through the valve to the air motor, the pinion of the latter engages with the flywheel gear, and the engine is set in motion; when firing begins the starter pinion disengages and the engine speeds up; current from the Diesel-driven generator builds up rapidly and energises the solenoid again, thus raising the weight and closing the air valve, which shuts off the motor. For larger engines of about 200 b.h.p. and running



at 600 r.p.m., an air jack and small solenoid are used instead of a larger solenoid which would necessitate an excessive consumption of electric current for holding up the weight. In the larger design the solenoid releases this weight, which actuates the air jack and this, in its turn, opens a duplex air valve supplying air to two motors of identical type. The switch A can be placed so as to cut out the automatic feature if desired, when the starting valve may be operated by hand for testing purposes without disturbing the automatic gear. When the switch is set for unattended or automatic starting the panel indicator lamp H lights up. Among the advantages claimed for the use of an air motor in an automatic air-starting installation is the fact that the engine can be started from any position of the cranks and that starting up is effected on full compression. Moreover, as no air is admitted to the engine cylinders other than that normally induced, the compression temperature is higher than in a directly air-started unit, thus facilitating a getaway. No air-starting valves are necessary on any of the engine cylinders and the air motor is installed in exactly the same way as an electric starter. Engagement with the flywheel is effected by a sliding pinion which incorporates a cone clutch. This allows a certain amount of slip to take place during the engagement motion, so as to minimise shock. A small amount of oil for the pinion assembly is provided by that present in the air exhausted from the cylinders of the air motor. The latter has four cylinders arranged in pairs at 90°, the pistons being connected to a two-throw crankshaft and full torque is available at any crank position of the stationary engine. As the speed of the air motor rises, the air cut-off becomes earlier, ranging from three-quarter stroke at low speed to about one-third at full speed, thus economising air. The air receiver may be charged by an independent compressor or by back-charging from the engine.—*"The Oil Engine", Vol. VIII, No. 88, August, 1940, p. 93.*

Coal Supplies in Arctic Regions of the U.S.S.R.

According to N. P. Stepanov, Assistant Director of the Marine Department of the Northern Sea Route Administration, more than 100 ships are employed in Soviet Arctic waters during the present navigation season. Returning vessels now carry commercial cargo from the Arctic for intermediate ports, and not ballast as in former years. Coal, in particular, is being shipped this year from Arctic ports in large quantities. The mining of coal in the Far Northern districts of the U.S.S.R. has increased to such an extent that last year practically the entire fleet of the Northern Sea Route Administration was run on Arctic coal. At the present time the Sangara mines on the Lena River, the Norilsk mines on the Yenisei, and the Ziryansk mines on the Kolyma River not only produce enough coal for all vessels plying in Arctic waters, but are also supplying neighbouring districts with substantial amounts. While existing collieries are increasing their output, prospecting in Arctic regions has established the existence of new deposits of coal and other fuel.—*"Fairplay", Vol. CLV, No. 2,989, 22nd August, 1940, p. 225.*

Steam Turbine Development.

An article entitled "The Thermodynamic Trend in Steam Turbine Practice" in the house journal of one of our large turbine manufacturing firms, deals with the theoretical gains which follow the adoption of high initial steam pressures and temperatures, and then goes on to discuss some of the factors which militate against the obtaining of these gains in actual practice. In the first place, the author points out, there is the influence of the size of the unit upon the performance under given conditions, as the smaller the unit the less advantageous does the use of H.P. steam become. This is due to the much smaller specific volume of the steam and the small blade height it entails, with correspondingly greater clearance losses. Again, with increased pressure, the superheat temperature must be raised considerably in order to limit the moisture content of the steam as it approaches the L.P. stages of the turbine. H.P. steam starting with an initial temperature of (say) 950° F. has a moisture content of about 26 per cent. by the time it has expanded adiabatically to a 29-in. vacuum, whereas L.P. steam with a superheat temperature of 550° F. contains only about 19 per cent. of moisture when expanded to the same vacuum. The evil effects of excessive moisture are well understood and this is why the necessity for reheating the steam between stages is so much greater when high initial pressures are employed. In the case of large marine turbine installations continuously operated at their normal designed load, it is probable that the higher first cost involved by the employment of H.P. steam is justifiable, more especially if electric drive is adopted and the current from one large generator is available for driving propulsion motors on two shafts. Furthermore, the use of H.P. steam leads to a substantial reduction in the size and weight of the turbines and boilers for a given power output. Taking all these factors into consideration, however, the author reaches the conclusion that a working pressure of 600lb./in.^{2} with a superheat temperature of the order of 850° F., employed in installations of up to about 40,000 s.h.p., represents the optimum conditions under present-day circumstances. Future developments must to a great extent depend upon the progress made in the economic production of high-grade alloy steel capable of successfully withstanding very high pressures and temperatures. In this connection attention is drawn to the effect of the addition of 0·05 per cent. of molybdenum upon the creep properties of ordinary carbon steel, the safe working stress for a creep limit of 0·001in. per inch in 100,000 hours at a temperature of 850° F. being increased from 3 up to 8 tons/in.^{2}.—*"Shipbuilding and Shipping Record", Vol. LVI, No. 8, 22nd August, 1940, p. 189.*

Improved Control Equipment for Watertight Doors.

A recently-published British patent concerns apparatus of the kind in which all W.T. doors are controlled in unison from the bridge, with additional local control for each indivivdual door. The local-control valve is a modified form of a well-known pattern and consists of a double-faced slide valve (10)—see

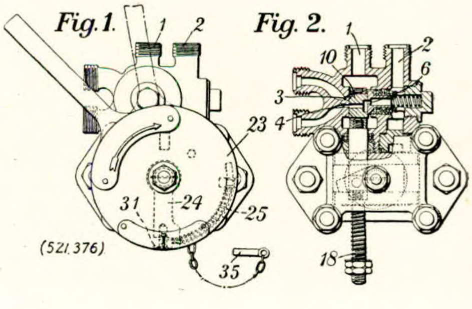


Fig. 2—with a transverse through-port which registers at one face with two ports (3, 4) and at the other face with a passage (6) in a spring-loaded tubular fitting. In the normal position of the valve the through-port establishes communication between the door-closing port (4) of the door cylinder, and the passage (6) which is open to a main (2) and normally connected to exhaust when the remote control is set for all doors open, but to pressure for all doors closed. In this normal position the door-opening port (3) is open, via a bevelled edge of the slide valve, to the main (1) which is normally under pressure, but is connected to exhaust when the remote control is set for closed doors. In the operated position of the door valve the connections are reversed, the valve being so arranged that, whereas the pressure in the main (1) acts on the valve stem and biases the valve to the normal position, the pressure in the main (2) does not bias the valve in either direction. The valve stem has a tail surrounded by a helical spring (18) which also biases the valve to the normal position. The valve is moved to the operated position by handles, one on each side of the bulkhead near the door, each handle being connected to a large disc-like hub (23)—see Fig. 1—and a lever (24) pinned to the spindle behind the hub. A compression spring (25) connects a lug on the back of the hub to the lever (24), the spring being stiff enough to enable the handle to move the slide valve (10) against its biasing spring (18) alone, but not against the spring and the pressure in the main (1) acting on the end of the valve stem. The lever (24) is shorter than the radius of the hub (23) and, in their normal positions, the end of the former fits inside an eye (31) on the back of the latter, the two parts being bored to register. A coupling pin (35) is a very loose fit in the bores and is normally accommodated in a concealed but readily accessible position behind the hub (23). To open the door locally when it is closed and the remote control is set for all doors closed, it is only necessary to pull the handle to the operated position. As the only resistance is that of the valve-biasing spring (18), the spring (25) moves the slide valve (10) to the operated position and the individual door opens. When the handle is released, all the components are returned to their normal positions by the spring (18) and the door is reclosed. If, however, the door is open and the remote control is set for all doors open, pressure from the main (1) biases the slide valve (10) to its normal position by the pressure on the end of its stem (the loading due to this may be of the order of something like 400lb.). Movement of the handle now merely compresses the spring (25), and the slide valve (10) remains in the normal position. In these circumstances a door cannot be closed accidentally by the inadvertent movement of the handle. To close the door locally in case of emergency, the coupling pin (35) is inserted in the bores, and, by a strong pull the handle is moved, thus moving the valve (10) to the operated position. On releasing the handle, the components return to their normal positions and the pin (35) drops out so that the control is not left in a condition in which it might be operated by accident. The door then re-opens.—*"Engineering", Vol. 150, No. 3,894, 30th August, 1940, p. 180.*

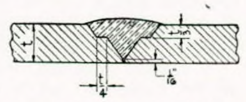
Watertight Bulkheads and Doors in the U.S. Liner "America".

The "America" is a three-compartment ship both as regards flooding and stability, under all anticipated service conditions, the lightest of which is considered as being one-third cargo, fuel oil and fresh water. To provide sufficient stability when flooded, some water ballast is required under certain operating conditions. The double bottom is 6ft. in depth for 373ft. of its length, increased to 8ft. forward and 15ft. 6in. aft. There are altogether 35 D.B. tanks, water being carried in those forward and aft, while those located amidships are for fuel oil or oily ballast. The ship is primarily of riveted construction, but the bulkheads are welded, with riveted boundary bars. There are 14 transverse W.T. bulkheads, which extend to "A" deck over the machinery spaces and to the main deck forward and aft of the latter. The shaft alleys are connected by passages for cross flooding. Due to the numerous power-operated W.T. doors in the transverse bulkheads and to these cross passages, the E.R. staff can walk the entire length of each shaft alley on either side or cross over at three places, so that convenient access is provided to all the shaft bearings. Compartments abreast of the shaft alleys, except tanks, are fitted with small doors to permit cross flooding and to minimise any heeling moment caused by underwater damage. There are 59 watertight doors, all but two of which are power operated from the bridge. The 57 power-operated doors are of the horizontal sliding hydraulic type. To ensure safety there are two independent hydraulic systems of piping, each having its own accumulator tank and motor-driven hydraulic pump. Each system is arranged to operate the doors on alternate bulkheads. The accumulator tanks, which are normally half full of air and half full of liquid under 700lb./in.^{2} pressure, have sufficient residual power to operate the system as required by the rules when the pump is inoperative. The pumps and tanks are installed in the E.R. casing, together with a storage tank and an air compressor for charging the tanks. Both systems are cross connected so that, in an emergency, doors on either system may be operated by the other system. All the doors are arranged to be closed together by means of a single control in the wheel-house, but each door may also be worked locally from either side of the bulkhead, either by the hydraulic system or manually, and by means of an extension shafting from above the bulkhead deck. When the control on the bridge is in the "close" position and a door is opened locally by the hydraulic system, the door will close automatically when the local control is released. A pre-warning electric bell at each door rings when the door is operated from the bridge, and a mechanical warning bell rings while the door is in motion. The two doors which are hand-operated only, are located in the longitudinal bulkheads separating the shaft alleys and are normally locked open with padlocks. In the event of hull damage on one side these doors serve as cross-flooding doors to prevent excessive list due to flooding one side only. If both shaft alleys should be flooded, these doors make it possible to send down a diver to unlock and close them, after which the undamaged side may be pumped dry, keeping the ship upright by means of appropriate counter-ballasting.—*H. J. Norton and J. F. Nichols, "Engineering", Vol. 150, No. 3,893, 23rd August, 1940, pp. 145-148.*

Welding a Cylinder Head.

Particulars of a very skilful welding repair to a heavy-oil engine cylinder cover appear in the May-June issue of *Canadian Diesel Power and Traction.* The short description of the repair relates to a fairly large two-stroke cycle cast iron cylinder cover having a central aperture for the fuel and starting air valves. Four cleaning doors and one aperture for use when water-testing the cover at manufacture represented the openings into the water space. Two cracks had developed in the 30-in. diameter casting, one extending across the outer rim and through the bolt holes. The casting was prepared by chipping, care being taken to see that no sharp corners were left. Any corners which did exist were removed by filing, not grinding. The edges were bevelled as a "shear-vee" joint, similar to that recommended for bronze-welding cast iron pipe, as shown in the accompanying

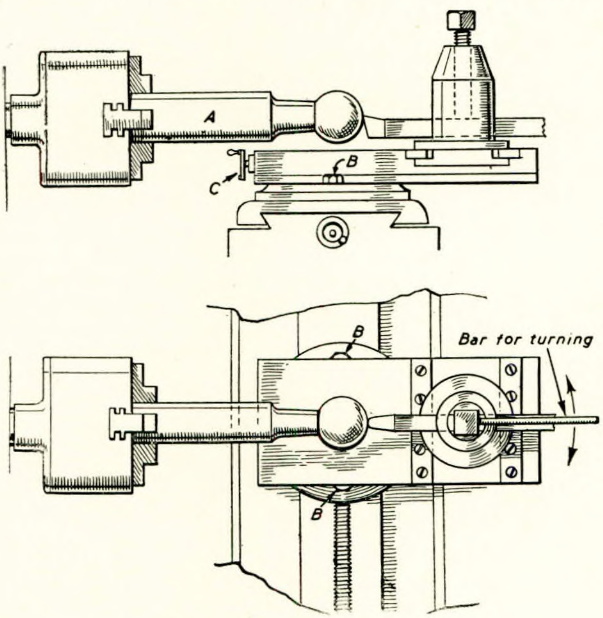
How the casting was prepared for welding.



sketch. When shearing stresses are encountered, the "shelf" in this design provides for increased bond between the bronze and cast iron and the joint develops the full strength of the section. The strength of a regular vee joint in bronze-welded cast iron, when subjected to shear, varies from 75 to 90 per cent. of the strength of the section. After the preparation of the joint, the casting was placed in a coke-fired heat-treating furnace, equipped with a pyrometer, and brought to an even temperature of 900° F. Preheating required approximately 1½ hours. When everything was in readiness, the casting was removed from the furnace and supported with fire bricks on a large steel plate directly in front of the furnace door. Asbestos paper was used as a covering, with an opening just large enough to permit welding. Commencing at the interior of the break, or the point farthest away from the rim, welding proceeded until the larger of the two cracks was completed. The casting was then reheated in the furnace, and the smaller of the two cracks was welded in a similar manner. Approximately 15lb. of bronze rod and ¼lb. of flux were used for the repair, while the total time for welding was three hours. After the completion of the welding operation, the head was replaced in the furnace and cooled slowly by letting the fire die out gradually. When the casting was subsequently chucked in a lathe, it was found to be less than 0·001in. out of alignment.—*"Gas and Oil Power", Vol. XXXV, No. 419, August, 1940, p. 176.*

Turning a Ball in a Centre Lathe.

It is sometimes necessary to turn a perfect ball on the end of a shaft and it is difficult to do this in a centre lathe by means of two handles. By using the method and tool illustrated, the author states that he has turned good balls from 2in. to 3½in. in diameter in a 7½-in. lathe. The job is first roughed out between centres and about 1/16in. left on the diameter of the ball, after which it is set to run true in a four-jaw chuck. The nuts for the adjustment of the angle on the compound rest (BB)



Turning a ball in a centre lathe.

are then undone to allow the rest to swivel on the centre pivot, the tool is inserted in reverse, and the compound rest wound out to the approximate radius. By moving the saddle up and down the bed the centre of the ball is easily located as regards distance from the chuck. This can be ascertained by winding the tool in and noticing if it catches the ball at an equal distance each side of the centre line, which is found by rotating the tool from back to front ensuring that the clearance of the tool when it is at the back and when it is at the front, is the same. A bar is fitted between the clamping pin and the tool, which should, of course, cut both R.H. and L.H., and have a top like a "brass" tool—rather pointed, to prevent "digging". Start with the tool in the normal position for turning and put a slight cut on, *not by the cross feed,* but by the compound rest handle, to reduce the radius of the ball. Then move the bar in clockwise and anti-clockwise directions, coming back to the same place to re-adjust the cut. By starting at this place it is possible to calliper the diameter before taking an incorrect cut. Care must be taken to see that the tool is exactly at the centre line so that at the end it can run into the centre.—*G. M. Taylor, "Practical Engineering", Vol. 2, No. 32, 31st August, 1940, p. 171.*

The Trend of Diesel Engine Design.

There are two broad heads under which the progressive development of the marine Diesel engine may be considered, one of these concerning the engine itself, whatever its power and speed of rotation, and the other its application to the ship. As regards the engine, the tendency is towards decrease in weight for power developed, partly by the use of alloy material for pistons, piston rods, connecting rods and crankshafts, and partly by the elimination of heavy castings in the structure of the engine itself. Just prior to the outbreak of wear, this development reached its highest expression in the form of a 2-stroke opposed-piston engine in which, except for the necessary forging in the crankshaft and certain castings in the cylinder structure, the entire engine was built up of strong welded plates. Although there is no case extant in which 2-stroke opposed-piston engines are coupled to the propeller shaft otherwise than as single units, there is no reason why this should not be done. The engine referred to above has always been coupled direct to the propeller shaft and is primarily intended for units of about 1,500 h.p. at some 100 r.p.m. This, in association with exhaust-gas steam-driven auxiliaries, should enable motorships of the tramp class to operate with an extremely low fuel consumption. In other cases in which high power within a small compass per engine has been aimed at, the tendency has been to follow aircraft practice, *viz.* to employ V-12 and V-16 engines with double banks of cylinders inclined at an angle to a common crankshaft. The future appears to lie in the gearing of two or four of these engines to a single propeller shaft and a consequent division of the total power over two or more units. Such a combination might also be employed in association with d.c. generators for supplying power to propulsion motors in the stern of the ship, or with alternators for supplying a.c. in a similar manner. Diesel-electric a.c. drive is undoubtedly one of the most important developments of the future. Such V-type engines have hitherto always been of the 4-stroke variety, but the appearance of a marine version of a well-known high-speed V-type 2-stroke engine with very compact scavenge blowers developed in America for motor cars, may be anticipated. Some of the latest big high-speed Japanese tankers have engines of something like 10,000 h.p. driving a single screw, the unit employed being a double-acting 2-stroke of German origin, while others of lower power have twin screws. In no case is a 4-stroke engine employed. For direct drives 2-stroke designs are likely to achieve greater poularity, but it would be unwise to assume that the double-acting type will always be employed. It is difficult to see any spectacular developments taking place in this class of engine with regard to reductions either in weight or in space. Higher weights per h.p. are an inherent feature of a design which turns a screw at slow speed and employs direct drive, as compared with engines with some form of gearing or other transmission medium between the prime mover and the shaft. The present situation, however, in regard to the weight per h.p. of direct-coupled installations of more or less conventional design, is not unsatisfactory. The 4-stroke engine is also likely to have its uses in the future, but this future is inevitably bound up in the continuous use of supercharge. Choice of correct supercharge may likewise prove to be an important factor in determining the future applications of this type of machinery.—*"Lloyd's List and Shipping Gazette", No. 39,252, 28th August, 1940, pp. 8-9.*

The Texas Oil Company's New Tanker "Ohio".

The Texas Oil Company's steam tanker "Ohio", built at Chester by the Sun Shipbuilding and Dry Dock Company, recently completed her acceptance trials. She is a vessel of 9,264 gross tons, 513ft. 10in. in overall length, with a moulded breadth of 68ft., and a moulded depth of 36ft., the d.w. capacity at a loaded draught of 28½ft. being 14,075 tons. The hull is transversely framed in the wing tanks and longitudinally framed in the centre tanks. The side shell seams down to the bilge and the side transverse frames are riveted, but the remainder of the ship's structure is of all-welded construction. There are 33 cargo oil tanks with a nominal total capacity of about 15,000 tons, in addition to a dry cargo hold forward, with a capacity of 35,350 cu. ft. The propelling machinery consists of a set of cross-compound turbines driving a single propeller through D.R. gearing. The normal output of the turbines is 9,000 s.h.p. with the H.P. turbine running at 5,978 r.p.m. and the L.P. turbine at 4,484 r.p.m., with the propeller turning at 90 r.p.m., but the installation is capable of developing 10 000 s.h.p. in order to drive the propeller at 93 r.p.m. Steam at a pressure of 450lb./in.^{2} and superheat temperature of 750° F. is supplied by two Babcock and Wilcox boilers of the two-drum type. The boilers are arranged in the boiler room with the drums fore and aft, and a 4-ft. passage between the two boilers. Each boiler has four Todd oil burners for operation with forced draught and is equipped with the Bailey meter combustion control system. The auxiliary machinery includes two 250-kW. 240-volt turbo generators running at 1,200 r.p.m. and two 120-volt motor-generator sets. The cargo oil pumping equipment comprises eight turbo-driven units with a delivery pressure of up to 150lb./in.^{2}. The four wing pumps have each a capacity of 140 tons/hr., whilst the four centre pumps have twice this capacity. They are arranged in two separate pump rooms. The ship's fuel tanks have a capacity of about 1,600 tons. The accommodation for the officers and crew is extremely roomy and comfortable, single-berth cabins being provided for every member of the ship's complement. The "Ohio" carried out her sea trials in a fully-loaded condition and attained a mean speed of 17·21 knots at a propeller speed of 90·6 r.p.m.—*"The Nautical Gazette", Vol. 130, No. 8, August, 1940, pp. 16-19 and 25.*

Some Aspects of the Design of Large High-pressure Steel Valves.

The design of a valve derives first from its function as a regulator of fluid flow, the resulting shape, viewed as a pressure vessel with super-imposed mechanical and thermal loading, defying accurate stress calculations. In the first part of this paper, the authors describe a successful method of supplementing approximate calculations by tests in order to determine the thickness of metal for safe pressure-temperature rating. Within limits, the shape of a valve may be altered to reduce pressure drop without interfering with its effectiveness as a fluid flow regulator. In the second part of the paper, the authors present test results which compare the resistance to steam flow in valves of several types.—*Paper by F. D. Cotterman and R. E. Falls, "Journal of the American Society of Naval Engineers", Vol. 52, No. 3, August, 1940, pp. 353-368.*

New Remote-control Gear for Small Craft.

A new type of automatic reverse gear and throttle control has just been developed in the U.S.A. by a New Orleans firm specialising in the construction of motor torpedo boats and similar craft. Referring to Fig. 1, a vacuum tank above the engine operates a servo piston by suction. When the control lever is moved to the forward position, as shown in Fig. 2, a vacuum is created in the forward tube and the piston of the power cylinder is moved to its extreme forward position, while air at atmospheric pressure is allowed to enter the control valve and flows through the after tube, exerting a pressure on the back of the servo piston. When the control lever is brought to the neutral position shown in Fig. 3 from the forward position, the after tube of the power cylinder is closed, a vacuum is created in the centre tube, and air at atmospheric pressure enters the forward tube thereby producing a vacuum behind the servo piston, the forward end of which is subjected to atmospheric pressure. When the piston reaches the centre of the power cylinder, the vacuum port is automatically cut off and the servo piston stops at the centre of the cylinder. During this operation a cam link operates a carburettor control which automatically brings down the speed of the engine, thus preventing racing. When the control lever is moved into the reverse position (Fig. 4), a vacuum is created in the after tube. The centre-port tube is closed and air at atmospheric pressure enters the control valve and the forward tube, exerting a pressure on the forward side of the servo piston. At the same time as this action is taking place, the control valve automatically operates the cam mechanism, which returns the carburettor throttle to its original position and allows acceleration of the engine immediately the reverse gear is engaged. In Fig. 5 the control lever has been returned to neutral from the reverse position. The centre tube is now connected to the vacuum tank, the forward-tube port is closed, air at atmospheric pressure enters the control valve and flows into the after tube, exerting a pressure on the back of the servo piston. When this piston reaches the centre of the power cylinder the centre vacuum port is closed and the piston comes to a dead stop. At the same time the connecting-cam mechanism automatically reduces the speed of the engine. This remote-control system is covered by a U.S. patent and is primarily intended for yachts and motor torpedo boats.—*"The Motor Boat", Vol. LXXIII, No. 1,815, September, 1940, p. 97.*

Pipe Hangers for High Temperature Pipe Lines.

The paper describes the general method of designing the hanger layout for a high-temperature pipe line, special attention being given to so-called "bell crank-and-spring" hangers. The author appends tables giving dimensions for all sizes of such hangers both of the heavy-duty and light-duty or marine types. The paper is illustrated by nine plates and diagrams.—*Paper by J. K. Wood, "Journal of the American Society of Naval Engineers", Vol. 52, No. 3, August, 1940, pp. 383-407.*

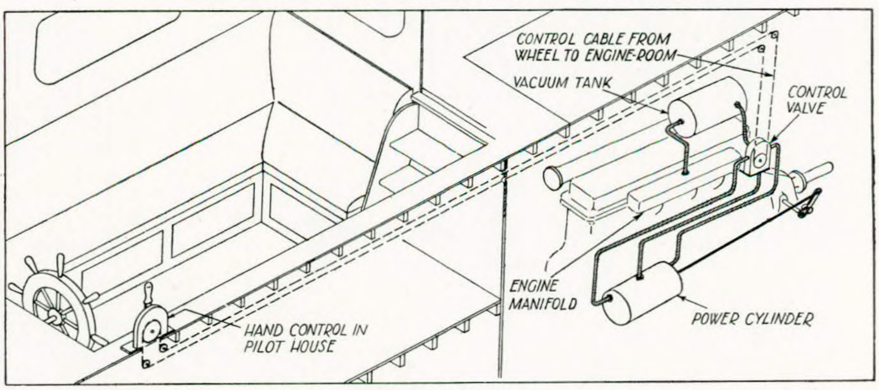


FIG. 1.—*General arrangement of the installation of the new remote control equipment.*

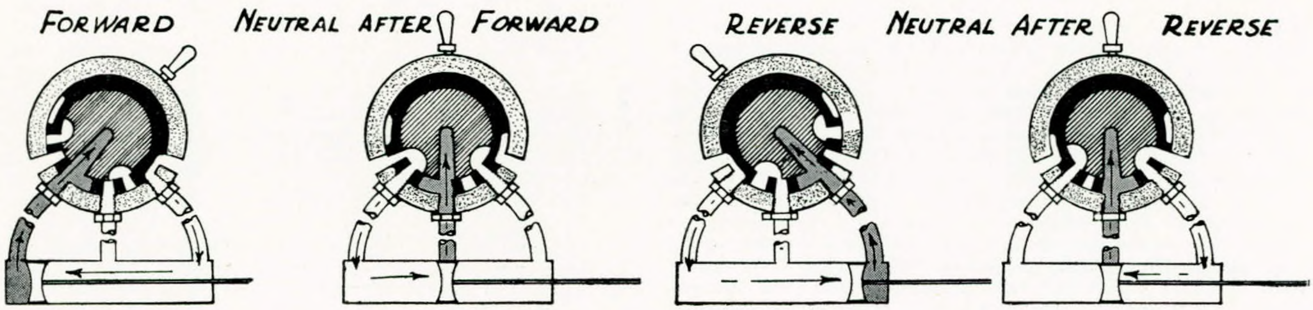


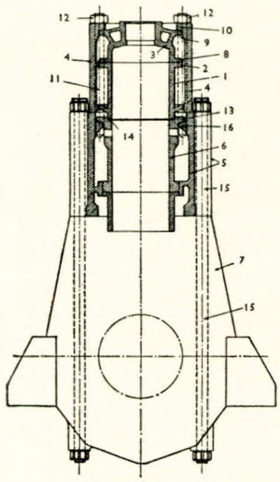
FIG. 2. FIG. 3. FIG. 5. FIG. 4.

Reheating to be Adopted in New American Ships.

The U.S. Maritime Committee are reported to be about to adopt steam reheating in the 8,000-h.p. turbine installations for a steam pressure of 1,200lb./in.^{2}, of some of their new ships. Each installation will include a high-pressure boiler with a separately-fired superheater and a separately-fired reheater, the latter being used to heat the exhaust steam from the H.P. turbine to about 800° F. A smaller boiler, with a working pressure of 450lb./in.^{2} will be used to supply for the auxiliary machinery both at sea and in port, any surplus steam being led into the I.P. turbine. The reheat will be applied only after the ship has reached the open sea when no manœuvring or changes of speed might be expected. It is claimed that this arrangement will secure the same economy with an initial steam temperature of 800° F. as is obtainable with an initial steam temperature of 1,000° F. without reheating, and that it therefore permits the use of ordinary steel for such parts of the turbines as would otherwise have to be made of expensive heat-resisting steel. Moreover, the total difference of temperature in the turbine is less and heat expansion difficulties are correspondingly lessened. The anticipated increase in economy to be gained by reheating steam is usually about 5 per cent., but somewhat more than this may sometimes be realised in practice.—*"Marine Engineering and Shipping Review", Vol. XLV, No. 8, August, 1940, pp. 142 and 144.*

Liner Assembly for Single-acting Diesel Engines.

A new British patent (of Danish origin) concerns a method of dividing and supporting the cylinder liners of single-acting Diesel engines in such a manner that the stay bolts or assembly bolts do not take any of the stresses due to heat expansion, but deal only with combustion loads. As may be seen in Fig. 1, the liner has two main parts with a short additional skirt at the bottom. The upper part (1) is suspended from the cover (3) by



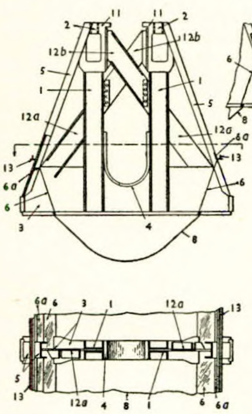


FIG. 1 (*left*). FIG. 2 (*above*).

(*See also the three following abstracts*).

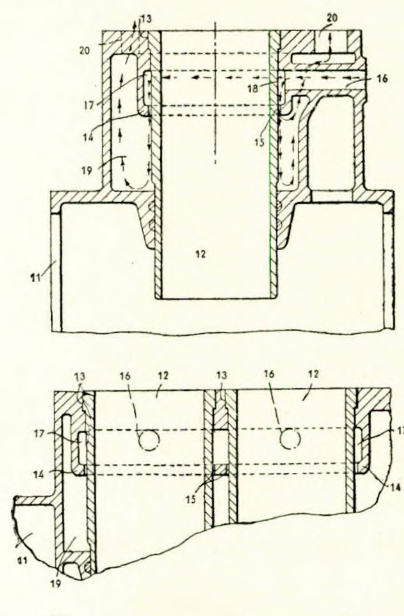
a flange (2), bolted to the cover flange (8). Another flange (9) at the top of the cover is secured to the inwardly projecting flange (10) on the cylinder frame (4), which rests on a box girder (5), forming the scavenging-air belt. This girder is carried by the engine framing (7), the two parts being assembled by stay bolts (15). The cylinder frame (4) is secured to the scavenging-air belt by bolts (11) and when the nuts (12) are removed, the entire top portion of the cylinder can be lifted off, leaving the lower part (6) of the liner in place to form a guide for the piston during the examination and, if necessary, replacement, of the rings. The lower part (6) is suspended in the scavenging-air belt which has an inwardly projecting flange (16). The latter supports the liner flange (13), and a recess (14) is provided for a spigot in the upper part, the depth of the recess being sufficient to allow for expansion without the faces coming into contact with each other.—*"The Motor Ship", Vol. XXI, No. 248, September, 1940, p. 205.*

Welded Engine Framework with Standard Plates and Sections.

A new British patent—of Danish origin—concerns engine framework constructed to the design illustrated in Fig. 2, and comprises a welded structure forming both a frame and a bedplate, with vertical girders on each side of a main bearing, together with a transverse girder welded to the vertical members, also with inclined outer girders, which transmit the forces of acceleration. The vertical girders take the loads due to combustion, and the main bearing is U-shaped. Each frame portion comprises vertical girders (1) composed of two channel bars arranged web-to-web, the main bearing (4) being welded between the frames. At the top are welded parts (11) having threaded holes (2) which take studs for transmitting the stresses from the cylinders. The channel bars are welded to the vertical web of a T-girder which is arranged at right angles to the crankshaft and extends through the bedplate, but they are also welded to the flange of the transverse girder (3), this flange fixing the frame to the foundation. The transverse girder is cut away to accommodate the main bearing (4). Inclined members (5) are carried from the upper parts (11) to the transverse girder and there are additional inclined stiffeners (12a and 12b). It should be observed that the stiffeners (12b) are arranged between the vertical girders (1) and that joints with reamed bolt holes are required in the position indicated on account of the fact that these stiffeners (12b) have to be removed when it is necessary to remove or replace the crankshaft. The various frame members are joined by inclined plates (6) which form, in conjunction with an oil tray (8) the crank casing and have bent edges (6a) for attaching the crankcase doors. An alternative arrangement is to weld channel bars (7) along the upper edge of the plates (6). The engine structure is completed by a horizontal T-section piece welded on each side of the frame members, forming an oil gutter and a support for the floorplates.—*"The Motor Ship", Vol. XXI, No. 248, September, 1940, p. 205.*

Lister Diesel Engine Cooling Systems.

An improved cylinder cooling system forms the subject of a new British patent recently granted to R. A. Lister & Co., Ltd. (and another). The cooling system is illustrated in Fig. 3, from which it may be seen that the water is introduced at the hottest part of the liner and circulates around the latter before passing through a restricted opening to the lower portion of the jacket. The flow is indicated by means of arrows. The engine is of the multi-cylinder type with the liners inserted in a casting which forms the jacket, although each cylinder has its own cooling-water inlet and the special circu-



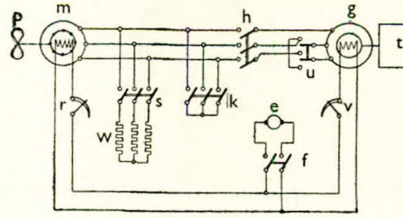


FIG. 3 *and* (*bottom*) FIG. 4.

lating device mentioned. Referring to the diagram, which comprises a cross-section and a longitudinal section through two cylinders, the casting (11) takes the liners (12) fitting in recesses (13) at the top, a short distance below being an inwardly extending flange (14) machined to allow a relatively small annular jacket space (17) on the side (18) which, with certain designs of engine, may be more highly heated than the rest of the liner. After the water has passed down through the clearance (15) it circulates in the main jacket space (19) and leaves through passages (20), afterwards joining a common stream to cool other parts of the engine, if required.—*"The Motor Ship", Vol. XXI, No. 248, September, 1940, p. 205.*

Brown Boveri Electric Propulsion Reversal Device.

An arrangement of mechanism for slowing down and reversing an electrically-propelled ship forms the subject of a new British patent granted to Brown Boveri & Co., Ltd., Baden, and is shown in Fig. 4. The installation may comprise synchronous polyphase generators driven by Diesel engines and one or more polyphase synchronous motors (for ahead running) working as synchronous machines when the ship is going astern. In this case the vessel is not only slowed down by the electrical separation of the generator and motor (and causing the motor to act as a generator), but the generator speed is reduced to a predetermined value; the generator and motor field circuits are de-energised with the falling speed of the ship; the load is then disconnected from the motor and the generator is connected to the motor with reversed-phase sequence. The excitation of the generator or motor—or both—is then controlled as necessary. The accompanying diagram of connections has been simplified. For slowing down, the source of exciter current (e) is first disconnected by means of the circuit breaker (f) and the main switch (h) between the generator (g) and the propeller motor (m) is opened. This causes the speed of the propeller (p) to drop, the speed of the ship remaining practically undiminished. The resistance (w) is then connected, by means of the switch (s), to the terminals of the motor (m) and the latter is excited by closing the switch (f), the field being adjusted as necessary by the regulator (r). The motor will then, driven by the propeller (p), operate as a generator on the resistance (w), and this additional work performed by the travelling ship will retard its speed. In the meantime the speed of the generator (g) running idle, in the excited or re-excited state, will have to be reduced, the driving regulator (t) being adjusted to the value at which it is intended to reconnect the motor (m) and the phase-changing switch (u) is changed over. When that fractional part of the speed of the ship is reached at which it is proposed to reverse, amounting to, say, one-half or one-third of the normal speed, the excitation (e) of the motor (m) and the generator (g) is disconnected by the switch (f), the resistance switch (s) is opened and the main switch (h) is closed. In the first place, only the excitation of the generator switched on at (f) is increased by the regulator (v), whilst the excitation of the motor (m) remains unaltered by returning the regulator (r) to the zero position. The motor will then run asynchronously with the aid of its damper winding at first in opposition to its rotating field, but will later reverse its direction of rotation, owing to the diminishing hydraulic resistance, the ship being thus considerably slowed down. The motor (m) now runs astern and, as soon as it has arrived in the vicinity of synchronism is excited, so that it can now be brought into synchronism. When it is running synchronously the frequency of the generator (g) can be again increased and the astern motion of the ship can be accelerated. The terminals of the synchronous motor may be directly short-circuited by means of the switch (k).—*"The Motor Ship", Vol. XXI, No. 248, September, 1940, p. 205.*

Cutting Oil Grooves.

An interesting type of power-operated oil groove cutting machine of American design has been introduced into this country. The machine can be used for internal work in sleeves and bearings as well as for external work in shafts and spindles, the limiting sizes in either case being from ¼-in. to 4½-in. diameter, with a normal maximum length of 7in., although by reversing the job, bearings and spindles can be grooved over a length of 14in. The grooves are usually cut in helical form and the driving motor, which is of ¾ h.p. at a speed of 1,200 r.p.m., operates through change gears, so that when cutting internal grooves the vertical spindle carrying the cutter can make either one or two revolutions for the complete stroke. Straight grooves can also be cut, and for external work the cutter is carried in a hollow tool post which surrounds the work. The maximum depth of groove is $\frac{7}{32}$in., and the maximum width ⅜in.—*"Shipbuilding and Shipping Record", Vol. LVI, No. 11, 12th September, 1940, p. 255.*

Controllable-pitch Propellers.

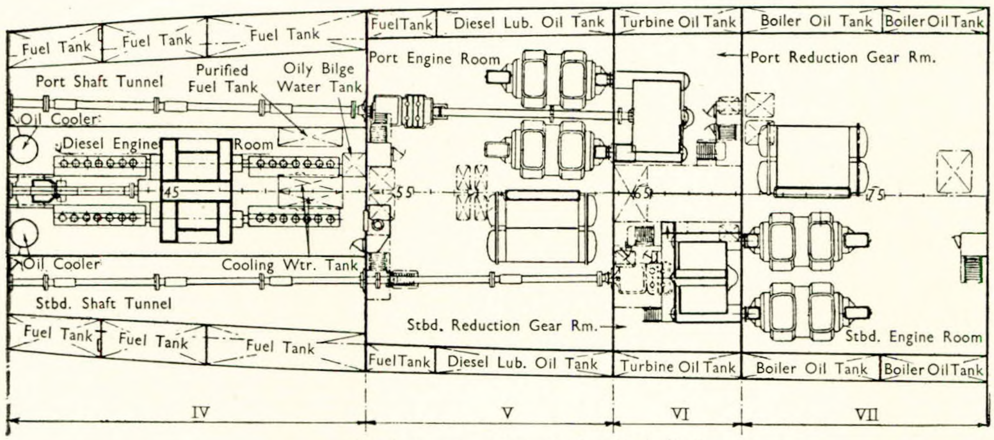
The author of this article reviews the history of the controllable-pitch propeller, tracing its beginning from successful water turbine applications. After describing historical designs and applications, he deals with current practice, which is almost entirely limited to the Scandinavian countries. He then gives a detailed description of a proposed design, with particular regard to its application in the field of submarine propulsion. The most important advantages claimed for the controllable-pitch propeller may be summarised as follows:—(1) The ship's manœuvring ability is far greater than with any system using propellers with fixed blades. (2) The vessels's speed can be varied as desired from full speed to zero. In harbours, canals, locks, and in fog, the ship may therefore be operated at low speed with the engines running at full speed, in instant readiness for an increase to the full rated horsepower. (3) The engines can always be run at their normal full speed so that optimum horsepower is available under all conditions, such as no load, or full load of the ship, head wind, stern wind, towing, icebreaking, etc. (4) By an increase of the rotative speed excess power for overload conditions is more easily obtainable from the engines. (5) At part load of the engines, as *e.g.*, at the cruising speed of a naval vessel, the propeller can easily be adjusted so that the engines work in the most economical speed range. (6) As all manœuvring is carried out direct from the bridge, mistakes are practically eliminated or, if made, may be corrected in time. Personnel can in some cases be decreased. (7) The engines will be simpler, more reliable, have a longer life and involve correspondingly lower maintenance costs. (8) Dangerous torsional vibration can easily be avoided. The text of the paper is illustrated by 23 plates and sets of diagrams.—*Paper by J. H. Strandell, "Journal of the American Society of Naval Engineers", Vol. 52, No. 3, August, 1940, pp. 408-448.*

Cast-iron Propellers.

The present shortage of non-ferrous metals for ordinary commercial purposes makes it likely that many cargo vessels will be equipped with cast-iron propellers instead of the more efficient bronze. Small craft, such as tugs and trawlers, in which low cost is important and which are liable to propeller damage, are still generally equipped with C.I. screws, but it is now recognised that the higher cost of the bronze propeller is outweighed by its greater propulsive efficiency, so that a wholesale return to cast iron will probably be only a temporary measure. In recent years the composition of the bronze used for propellers has become more or less standardised, and consists of a 60/40 copper zinc base to which various alloys, such as tin, aluminium, iron, manganese and nickel are added, the proportions of these elements depending on the physical properties desired, which, if necessary, can be made equal to those of cast steel. The tin and aluminium contents help to make the material resistant to sea-water corrosion, and at the same time have a hardening effect, while the manganese improves the ductility. The best method of preparing the alloy metal, and one which is adopted by most manufacturers, is to melt the component alloys in a crucible furnace, and remelt the resulting ingot for foundry casting use.—*"Fairplay", Vol. CLV, No. 2,991, 5th September, 1940, p. 269.*

Diesel Engines in German Warships.

The accompanying illustration shows the arrangement of the propelling machinery of the German light cruiser "Leipzig". It is reported that the three ships of the "Köln" class and the light cruiser "Nürnberg" have similar machinery. In the vessels of the "Köln" type, built in 1927-1930, the main engines are turbines of 65,000 s.h.p., with two 1,000-h.p. four-stroke 10-cylr. M.A.N. oil engines driving a central propeller through gearing. In the "Leipzig" and "Nürnberg" a modified arrangement was adopted, each wing shaft being driven by a 30,000-s.h.p. turbine and the centre shaft by a set of four 3,000-b.h.p. seven-cylinder double-acting two-stroke engines running at 650 r.p.m. and geared down to 400 r.p.m. through Vulcan hydraulic couplings. These engines have cylinders of 300 mm. diameter with a piston stroke of 440 mm. and two engine-driven scavenge blowers. The Diesel engines are used exclusively for all speeds up to 18 knots, and also with the turbines when maximum power is required. A variable-pitch propeller is employed to give reasonable efficiency both at low and high speed. When cruising with only the Diesel engines in use, the wing propellers are driven by electric motors with current from a dynamo driven off the centre shaft coupled to the Diesel engines. These electric motors each absorb about 500 h.p., whereas if the wing propellers were allowed to trail they would absorb 3,000 b.h.p. Apart from the "pocket" battleships of the "Deutschland" class, the only high-powered Diesel-engined German warship is the 1,460-ton 27-knot gunnery training ship "Bremse", completed in 1932, and equipped with eight engines of the same type and cylr. diameter as those in the "Leipzig", but with eight cylinders instead of seven. The total output is 26,000 s.h.p. at 530 r.p.m. and the general arrangement of the machinery is somewhat similar to that in the much higher-powered "Deutschland" class. The length of the "Bremse" is 338ft. and the beam 31·2ft., the total length of the two engine rooms being 158ft., while the machinery spaces of the "Deutschland" extend for some 300ft., the length of the ship being 596ft. In the "Bremse" there is a scavenge blower driven by a four-cylinder engine of the same cylr. diameter and piston stroke as those of the propelling engines, for each pair of the latter.—*"The Motor Ship",, Vol. XXI, No. 248, September, 1940, pp. 178-179.*



Engine-room plan of the "Leipzig".

Should Connecting-rod Bolts be Renewed?

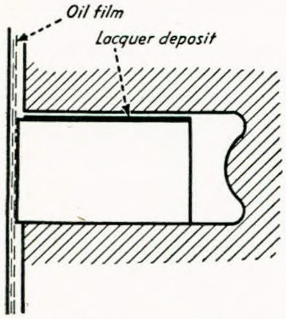
A somewhat advanced theory in engineering practice has recently been put forward by American engineers in regard to fatigue in connecting-rod bolts. It is contended that there need be no such defect as fatigue in these bolts, and in a paper by Messrs. R. L. Boyer and T. O. Kuivinen presented at the 1940 Conference of the Oil and Gas Power Division of the American Society of Mechanical Engineers (reproduced in abridged form on pp. 202-204 of the September, 1940, issue of *The Motor Ship*), there is a reference to the acceptance by research laboratories of 10 million cycles as the point of measurement of the endurance limit. It is therefore claimed that if the specimen will absorb this number of cycles without failure it will continue to function indefinitely at the given stress. The conclusion is that "the fallacy of the practice of changing bolts every few years is apparent when considering that it would be necessary to change them each week or each month, depending on the engine speed, in order not to exceed 10 million cycles". Such a theory presupposes perfection in material as well as in design and assumes that the component in question is beyond the smallest degree of suspicion at the outset. Nevertheless, well-designed bolts having a reasonable factor of safety *have* been known to break through ordinary fatigue owing to some hidden defect in material which is not disclosed until repeated—and, most likely alternating—stresses are applied. Because of these risks it is usual to take bolts out of service after a certain length of time in order either to renew or anneal them. A well-known superintendent engineer has expressed the view that annealing is not a sufficiently reliable form of treatment to be trusted for a main propelling-engine part and that he prefers to renew all the connecting-rod bolts in the case of a ship that has been in service for 10 years. Accidents in the shape of fractured connecting-rod bolts *do* occur and it is well not to take chances with ships' machinery, whatever the theories expressed by the authors of the paper referred to above may be.—*"The Motor Ship", Vol. XXI, No. 248, September, 1940, p. 177.*

A New M.A.N. Engine.

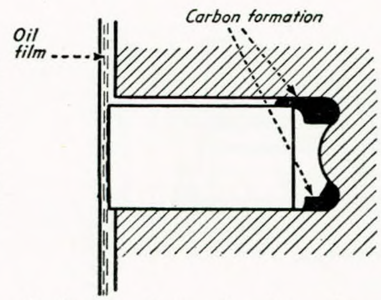
In a paper on "The High-speed Diesel Engine and the High-pressure Steam Turbine for Warship Propulsion", read before a meeting of the Schiffbautechnische Gesellschalft and published in a recent issue of *Schiffbau*, it was stated that "a new, improved, high-speed Diesel engine of the Maschinenfabrik Augsburg-Nürnberg is now running on the test bed". The paper infers that this is a high-powered unit designed for the propulsion of large warships, and an improvement on the 7,000-b.h.p., 450-r.p.m. double-acting two-stroke engines installed in the "pocket battleships" of the "Deutschland" class. It is indicated that a completely vibrationless engine has been developed by employing a vibration damper and balancing mechanism, so that with an installation of many thousands of horsepower it will be scarcely possible to hear the exhaust noise on deck. The German Government are said to be constructing two large testing and research stations for work on the development of high-powered high-speed Diesel engines and high-pressure turbines respectively, and the paper gives illustrations of both these establishments, showing them under construction and as they will appear after completion.—*"The Motor Ship", Vol. XXI, No. 248, September, 1940, p. 199.*

Piston-ring Sticking in Diesels.

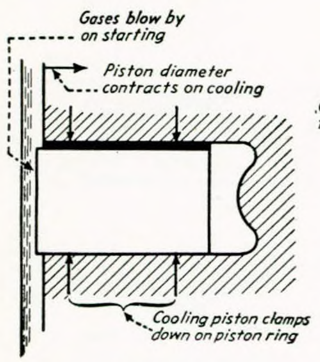
We can study ring sticking by dividing the contributing causes into two separate classes. On the left of the illustration we see a hard lacquer-like deposit formed when decomposition of the lubricating oil begins. This hard film is formed when the piston is hot. Upon shutting down, aluminium pistons radiate their heat quickly and inasmuch as clearance in the ring grooves is small, the vertical contraction in the groove, which amounts to less than 0·001in., will tend to seize the lacquer film and clasp the ring in its groove. This clamping does not necessarily take place over the entire ring surface but may be localised in limited regions only. Following this action, radial contraction of the piston continues and in the case of a piston 5¾in. dia. the contraction may amount to as much as 0·020in. Thus the ring is drawn away from the cylinder wall and the gap formed by this action makes it impossible for the ring to follow the contour of the cylinder liner, and blowby results. The hot gases of compression and combustion sweep the lubricating oil-film from the cylinder wall, producing loss of compression, abrasion, high localised temperatures, rapid wear and, in severe cases, piston seizure. The right side of the figure illustrates another type of ring sticking. In this case, hard granular carbon begins to



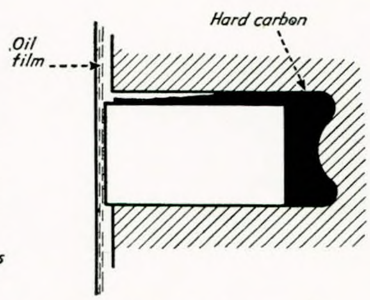
1—Lacquer deposits on piston-ring surface.



1—Carbon forms in piston-ring groove.



2—Piston cooling on lacquer deposit causes ring sticking.



2—Carbon formation blocks piston-ring action.

form at the back corner of the top ring and accumulates between the ring and the piston contour. As carbon continues to form in this area it is packed at the back of the ring by its reciprocating motion as it works in and out, following the cylinder wall. The ring soon becomes completely restricted in its movement and rides constantly against the liner. This means that there can be no flexible flow of the ring surface with the contour of the cylinder wall, and there is great danger of rupture of the oil film. Experience in the lubrication of precombustion-chamber Diesels and other designs more sensitive to carbon formation has seemed to favour the naphthenic type of lubricating oil, up to the present. However, recent developments have brought to light outstanding addition agents for correctly refined paraffinic lubricating oils, making this class highly suitable for Diesel lubrication. In addition to preventing the formation of hard, lacquer-like, carbonaceous deposits in the combustion chamber and around the upper piston rings, these addition agents in correctly refined paraffinic oils increase the film-strength characteristics and inhibit oxidation in the crankcase.—*S. S. Hansen in "Power", reprinted in "Mechanical World", Vol. CVIII, No. 2,804, 27th September, 1940, pp. 239-240.*

Auxiliary Equipment of American Standard Ships.

As the result of detailed and prolonged investigation, a number of new features are being incorporated in over 100 vessels under construction for the U.S. Maritime Commission. Most of the cargo liners in question are provided with refrigerated space for cargo of from 25,000 cu. ft. to 60,000 cu. ft., the cooling being effected by direct-expansion units. One such unit is installed for each compartment and it is claimed that this arrangement is more efficient than the brine system of cooling inasmuch as it gives greater flexibility and eliminates frosting problems, the inlet pressure to the compressor more or less corresponding to the temperature desired in the compartment. Should a compartment be empty, it is unnecessary to operate the compressor, so that an appreciable saving of current consumption becomes possible. Another novelty is the adoption of the contra-rudder, which, it is claimed, produces a 4 per cent. improvement in the efficiency of 7,000-ton 14-knot ships through the action of the rudder on the slip stream. The guide vanes are so arranged that water entering the wheel has a slight rotation in the direction opposite to that of the propeller, the rudder itself being designed in such a manner that it straightens out the water leaving the propeller, instead of permitting it to continue flowing in a spiral direction. The propellers used are of solid manganese bronze with variable-pitch blades of aerofoil section. In the new passenger vessels with a heavy lighting load it is proposed to employ fluorescent lighting instead of ordinary electric lamps. It is claimed that the resulting illuminating efficiency will be 50 per cent. greater and more nearly approximating to the sun's spectrum. The lamps used will have no filaments and will, therefore, be proof against vibration. As they will also dissipate less heat, it is estimated that in some ships the adoption of fluorescent lighting will enable a 17-ton reduction in the refrigerating effect of the air-conditioning plant to be achieved.—*"The Motor Ship", Vol. XXI, No. 248, September, 1940, p. 179.*

Steam Distribution for Low-pressure Uniflow Cylinders.

Large low-pressure cylinders must have very large passages for the exhaust steam in order to keep the velocity of the latter low enough to ensure a minimum rise of pressure during the exhaust period. The ample ports and passages which are features of uniflow cylinders fulfil these conditions admirably owing to their minimum flow resistance, and in such cylinders it is the inlet which usually calls for special attention. In a

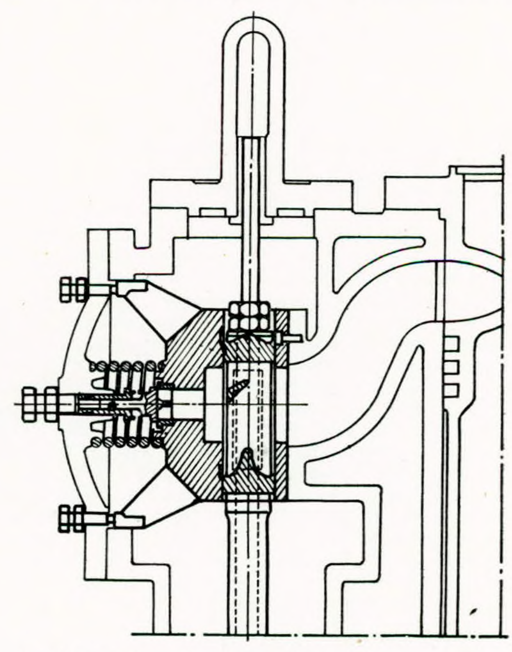
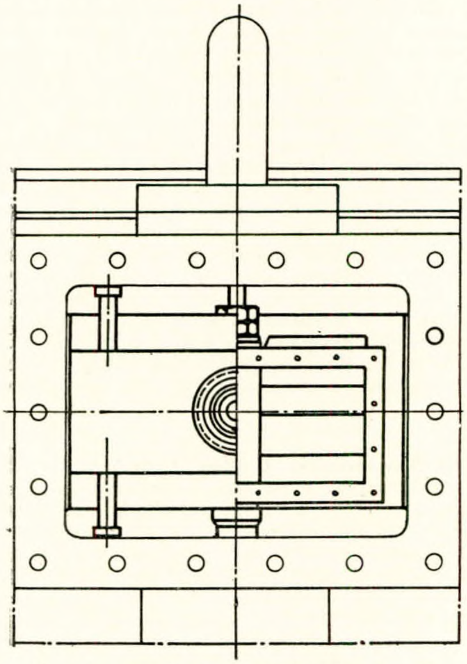
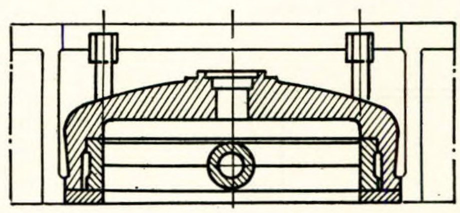


FIG. 1.—*Flat balanced slide valve with quadruple ports.*

uniflow cylinder, as the second stage of a compound engine, the normal admission will be relatively small, *i.e.*, round about ·025. In the case of a 3-crank engine with two H.P. uniflow cylinders with fully-drawn links, efficient manœuvring will be provided for with a normal steam admission of 0·25 and a maximum admission of 0·55. With 0·25 admission the actual steam velocity for the largest opening of the steam distribution gear, calculated by the actual piston speed at that instant, may be fairly high, but a large L.P. cylinder would require to have a single-inlet piston valve of so great a diameter and so long a stroke, as to suffer from serious disadvantages. Double-beat valves or Van de Kerchove slide valves would be more suitable in such a case. Light valves with very large passages and a





FIGS. 2 & 3.—*Elevation and section of slide valve shown in Fig. 1.*

small slide travel are available in the Porter-Allen design of quadruple-ported slide valve and the use of these ensures the correct operation of a large L.P. uniflow cylinder under all conditions and with perfect safety. Two points of special importance in such cylinders are their sensitiveness to a good vacuum and the provision of adequate means for draining off all water accumulating at the bottom. Figs. 1, 2 and 3 show a valve of this kind which, on opening, provides communication between the cylinder space and the valve chest. Any momentary excessive rise in the compression pressure will open the valve and return the steam to the valve chest. Instead of the heavy springs which are required by the ordinary relief valves, these valves need only light springs. Moreover, any water collected at the bottom is removed by these valves without opening the drain cocks and without bringing the relief valves into operation. It is also claimed that the construction of these valves makes it possible to maintain a flexible pressure of the balance frames of the slide valves by means of steam and spring pressure against the valve face, so that the whole balance frame lifts if any water is present in the bottom of the cylinder. In practice it has been found that the steam pressure between these slide valves and their face and the pressure between the balance frame and the face is higher than might be anticipated. As long as the compression pressure does not rise higher above the initial pressure than the pressure exerted by the spring, the balance frame remains pressed against the face. Any further increase in compression pressure results in a slight rise of the frame, which subsequently reseats on the face with a slight ticking sound. The compression bolts shown in Fig. 1 were fitted in a marine engine with L.P. uniflow cylinders to eliminate such a beating of the frames. Amongst the engines to be equipped with steam distribution valves of the type described above, is one constructed by Stork Bros. & Co., Hengelo, for the Russian tug "Signal". In this vessel, the adoption of Hackworth valve gear has enabled the length of the engine to be reduced to very small fore-and-aft dimensions. The employment of central-admission type slide valves provides equal steam admission at the top and bottom with equal laps and port openings by means of a neutral correction. The admission of steam to the L.P. cylinders can be regulated independently of that to the H.P. cylinders and the receiver pressure for normal operation can be fixed in this manner, the cut-off, when manœuvring, being 0·25. The power developed in the engine is 1,300-1,500 i.h.p. and in the course of exhaustive trials at sea it was found that the coal consumption for all purposes was 1·034lb./i.h.p.-hr., the total steam consumption of the auxiliaries being taken as 15 per cent. of that of the main engine at normal load. This result is about 15 per cent. better than that obtained with a well-designed triple-expansion engine under similar conditions. Fig. 5 shows indicator diagrams of the H.P. and L.P. cylinders, while Fig. 6 is the corresponding Rankine cycle diagram. The small pressure loss between the H.P. and L.P. cylinders demonstrates the efficiency of the steam distribution in the L.P cylinder. In these diagrams the output was 1,460 i.h.p. at 125 r.p.m. A quadruple-ported balanced slide valve of the type described above could also be applied to the L.P. cylr. of an ordinary triple-expansion engine, as shown in Fig. 7, the steam and exhaust valves being operated by the ordinary Stephenson link motion. The advantages to be obtained include the provision of very large ports, especially for steam outlet, the inlet and outlet ports being separated without producing the excessive initial condensation normally associated with such an an arrangement and thus increasing the efficiency of the cylinder concerned. —*Prof. Ir. G. Brower, "The Marine Engineer", Vol. 64, No. 758, September, 1940, pp. 197-198.*

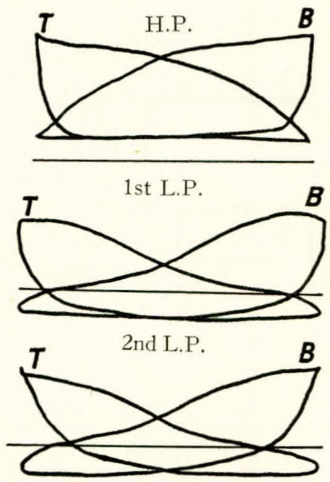
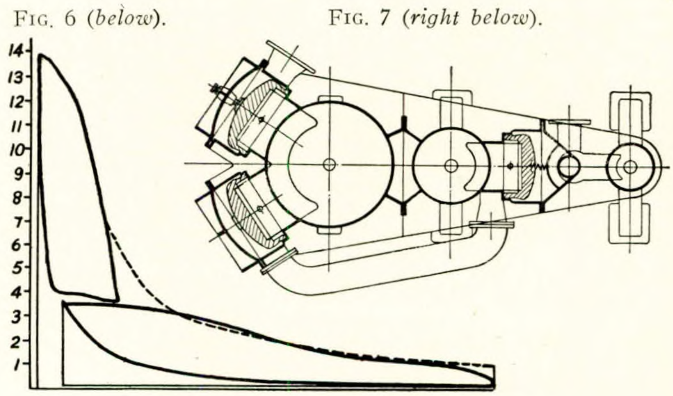


FIG. 5.

FIG. 6 (*below*). FIG. 7 (*right below*).



New U.S. Coast Guard Cutters.

The recent absorption of the U.S. Lights Service by the U.S. Coast Guard is resulting in the construction of special shallow-draught river craft for tending the lights and navigation marks on the Mississippi, and for flood relief when required. The Dubuque Boat and Boiler Works have secured a contract for building two such shallow-draught cutters, to be named

"Dodwood" and "Sycamore", at $159,000 apiece. They are to be tunnel-stern twin-screw vessels, 113ft. 9in. by 26ft., with a draught of only 4ft. at a full-load displacement of about 230 tons. A service speed of about 8·7 knots is to be obtained by two 200-h.p. Diesel engines geared to the propeller shafts and equipped with electric or air starting. The auxiliary machinery will include two 20-kW. radiator-cooled Diesel generators, two lubricating-oil coolers, an air compressor, a fire and bilge pump, a heating boiler, an electric winch, an electric capstan, and a battery installation for starting the main engines.—*"Shipbuilding and Shipping Record", Vol. LVI, No. 10, 5th September, 1940, p. 230.*

River Ships for the Argentine.

The Argentine Ministry of Public Works operates the passenger, freight and car ferry services on the River Parana and its various tributaries, the traffic between Buenos Aires and other ports being considerable. The design of the vessels used for these services involves special consideration of the strong currents and winds which prevail in this region, as well as of the shallow waters. Most of the vessels built since 1927 are equipped with Diesel engines, and in some cases electric drive has been employed. The two most recent ships (completed last year) are the "M.O.P. 11" and "M.O.P. 12", both of which are twin-screw motor vessels 139·5ft. o.a., with a displacement of 377 tons at a loaded draught of 4·2ft. Owing to this shallow draught a tunnel-stern design is employed and the special shape of the fore ship rendered necessary by the fact that the bow has at times to rest on the bank mitigates against the attainment of maximum propulsive efficiency. Two Simplex rudders are fitted, one behind each propeller, and the steering gear may be operated either manually or electrically. Welding has been used extensively in the hull construction and the engine foundations are welded direct to the hull. The latter is divided into seven watertight compartments, the engine room being amidships with public rooms forward and aft on the upper deck, which is intended for the use of passengers. The main deck is designed to carry two 6½-ton, two 4½-ton and two 3½-ton lorries in addition to four motor-cars, with a total weight of 35 tons. Under the car deck, forward of the engine room, are cabins for the captain and chief engineer, and aft of these is a first-class saloon with two small writing rooms. Aft of the engine room are the second-class saloon and the crew's quarters. The propelling engines comprise two four-cylr. two-stroke M.A.N. units, each rated at 360 b.h.p. at 300 r.p.m., and designed to give a loaded speed of 10 knots.—*"The Motor Ship", Vol. XXI, No. 248, September, 1940, pp. 188-189.*

A New Canadian Motor Tanker.

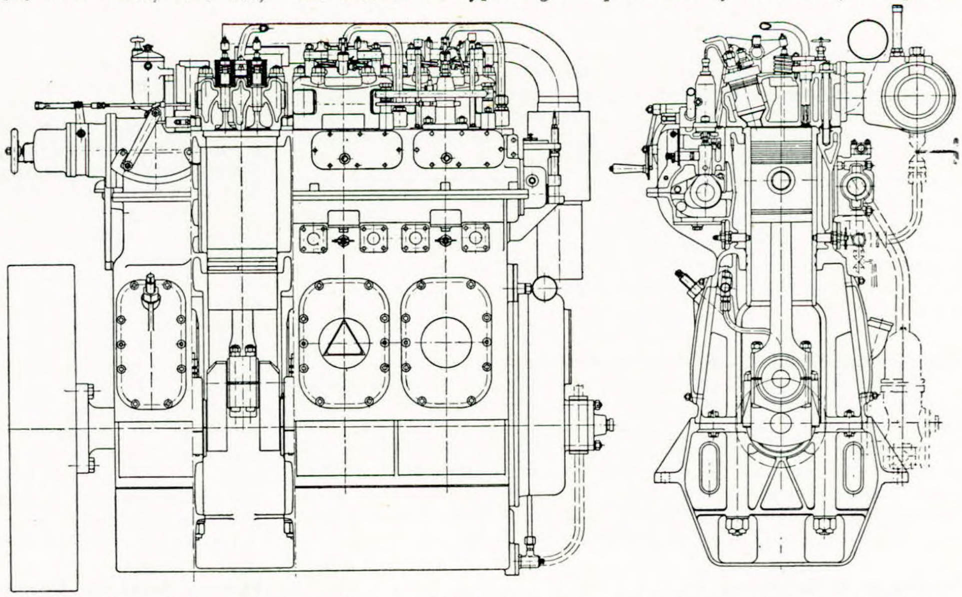
The motor tanker "Lakeshell", recently completed for the St. Lawrence and Great Lakes service of Shell Canadian Tankers, Ltd., by Marine Industries, Ltd., Sorel, is the first all-welded vessel of this type to be built in Canada. She is a twin-screw ship of 2,100 tons, 259ft. in overall length, with a moulded breadth of 43ft. 10in., and a moulded depth of 20ft. The d.w. capacity on a 14-ft. draught (F.W.) is 2,980 tons. The new tanker has a straight stem, cruiser stern and twin rudders, and is framed on the "Conduit Bilge" system. She is subdivided into 10 main cargo oil tanks, fore and after peak tanks, feed water and oil fuel tanks aft, and the engine room. There is a combined cofferdam and pump room. The propelling machinery consists of two sets of 480-b.h.p. four-cylinder two-stroke Sulzer engines running at 350 r.p.m. and designed to give the ship a speed of 8¼ knots. The auxiliary machinery includes two six-cylr. 120-b.h.p. Diesel engines driving 220-volt generators; each of these engines has an extended shaft passing through the bulkhead and driving a rotary cargo oil pump in the pump room. These pumps have a capacity of 210 tons/hr. of petrol against a pressure of 100lb./in.^{2}. There is a 12-kW. emergency Diesel-engine generating set and a 10-kW. motor generator which provides current at 110 volts for lighting purposes. Other E.R. auxiliaries include a 60-g.p.m. centrifugal lubricating-oil pump, a motor-driven two-stage air compressor, a 28-ton ballast and bilge pump of the vertical rotary type, a 25-g.p.m. motor-driven sanitary pump, a 35-g.p.m. F.W. pump, two oil fuel transfer pumps, a 50-g.p.m. stand-by lubricating-oil pump and a motor-driven bilge pump for the cargo pump room bilge. There is also a three-stage 200-g.p.m. ballast pump in the pump room. The exhaust gas from the main engines is passed through a La Mont waste-heat boiler.—*"The Motor Ship", Vol. XXI, No. 248, September, 1940, p. 187.*

Australian-built Oil Engines.

A Queensland engineering firm are now producing a range of Diesel engines—known as Southern Cross engines—for marine auxiliary and general purposes. These engines are wholly of Australian design and manufacture, except for the fuel pumps and injection equipment. They are made in six sizes covering a power range of from 4·3 to 45 b.h.p., with three cylinder sizes, the smallest being 3½in. in diameter, with a piston stroke of 4½in. The intermediate models have a cylr. diameter of 4½in. and a piston stroke of 5½in., whilst the largest unit has cylinders 5½in. in diameter, with a piston stroke of 6½in. The engines are of vertical four-stroke design, totally enclosed. Cooling is carried out either by means of tanks on the thermo-siphon system, or by radiators, the former being standard. A recent contract for Southern Cross engines was for 21 four-cylinder units coupled to 25-kW. generators, for naval use. The order, valued at £25,000, is the largest so far awarded for engines of this size and the generating sets will be the first of wholly Australian manufacture to be installed in a warship.—*"The Oil Engine", Vol. VIII, No. 89, September, 1940, pp. 128-129.*

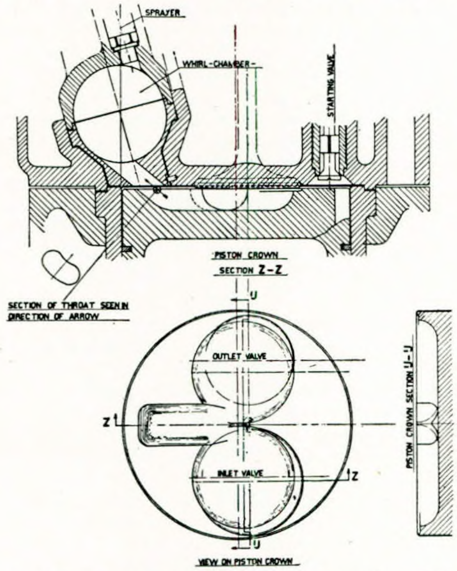
Small Diesel Engine of Stork-Ricardo Design.

The accompanying drawings show the construction of one of the smaller types of Diesel engines recently developed by Stork Bros. & Co., of Hengelo, Holland. The engine resembles the Hesselman type engines produced by that firm, except for



Sections through Stork-Ricardo high-speed Diesel engine of 50 b.h.p. per cylinder at 750 r.p.m.

the combustion chambers of the cylinders, which are of the Ricardo (Comet Mark III) type. The main combustion space of each cylinder represents about 55 per cent. of the compression space and is arranged in the piston head, the remainder of the compression space being formed by a swirl chamber incorporated



Arrangement of Ricardo Comet Mark III air cell combustion chamber in small Stork engine.

in the cylinder head. On the compression stroke the air from the cylinder is forced into the swirl chamber, where it rotates at a high velocity and is thoroughly mixed with the fuel injected into the swirl chamber at the end of the compression stroke, resulting in instantaneous ignition. The expanding gases thus formed leave the swirl chamber, acquire a rotary motion by the action of two circular recesses machined in the piston crown, and are thoroughly mixed with the air still present. This leads to perfect combustion even at the very high mean effective pressure of 107lb./in.^{2} employed in this engine. The temperatures of the exhaust gases at high loads, however, are substantially lower than those with other combustion systems. The rapid rotation in the swirl chamber is caused by the inflow of the air through a narrow passage during the combustion stroke. On account of the high velocity of the air, the atomizer is disposed in such a manner as to inject the fuel tangentially in the same direction as the air, thereby putting the centre of the combustion zone of the fuel further away from the atomizer and keeping the atomizer nozzle cooler, for should injection take place in the opposite direction to the air inflow the atomizer would very soon become clogged, especially at high load. The high temperatures prevailing in this engine make it necessary to employ a special grade of heat-resisting cast iron for the pistons. The engine is designed to run at 750 r.p.m., with an output of about 50 b.h.p. per cylinder.—*"The Marine Engineer", Vol. 64, No. 158, September, 1940, p. 204.*

Diesel-engined Ship's Lifeboats in America.

Under U.S. law new cargo ships have to carry a motor lifeboat. The first to be equipped with Diesel engines has just been completed. In it is installed a 25-h.p. Gray-G.M. two-stroke Diesel engine running at 1,600 r.p.m. and driving the propeller through 1·6 : 1 reduction gearing. The boat is 26ft. long, with a beam of 8ft. 4in. The speed is about 6 knots loaded and the fuel capacity 30 gallons.—*"The Motor Boat", Vol. LXXIII, No. 1,875, September, 1940, p. 86.*

Prevention of Corrosion.

A new material for the protection of iron and steel against corrosion is reported to have been developed by a well-known firm of manufacturers specialising in the production of anti-corrosive preparations. One of these is a proprietary form of chlorinated rubber, dissolved in an organic solvent, and applied with a brush, like paint. After evaporation, there is left on the metal or other surface, a tenacious, non-inflammable and non-poisonous film which is claimed to possess remarkable properties of resistance to corrosion, not only by the atmosphere, but also by strong or dilute acids and alkalis and other deleterious influences, and particularly by sea water. For iron and steel a special form of preparation is employed, containing about 92 per cent. finely-divided metallic zinc, which has the effect of giving additional true anodic protection, as the electrolysis which is an essential feature of metallic corrosion affects the zinc instead of the steel or other metal protected. Chlorinated rubber, although much better than ordinary rubber for such a purpose, is not recommended for temperatures above about 112° F. in wet heat and 176° F. in dry heat. For the protection of iron and steel tanks used for hot water, and similar plant and equipment, a modified form of the raw preparation is employed. This is not affected by boiling water and will stand even higher temperatures than 212° F. in the case of dry heat, so that it can, to a certain extent, take the place of galvanising. As chlorinated rubber and zinc products gradually harden and become more resistant through exposure, whether under hot or cold conditions, one of the most important fields for the application of these materials is the protection of steel ships against sea water, and of the equipment used in docks and harbours, lighthouses and other buildings exposed to the effects of sea air. Salt greatly increases the corrosive properties of air, and the same applies to the sulphuric acid in the air of towns from the combustion of coal, probably because the conditions are more favourable for the minute electric currents which play such an important part in the corrosion of metals. Another remarkable feature connected with the corrosion of ferrous metals, especially by water or wet air, is that zinc acts as an inhibitor under unusual conditions, such as when merely added to the water. It will be remembered that zinc plates have for many years been used as a means for preventing corrosion in marine boilers.—*"Lloyd's List and Shipping Gazette", No. 39,270, 18th September, 1940, p. 6.*

Under-water Corrosion.

An article in a recent issue of the Swedish paper *Svensk Sjöfartstidning* discusses the possibilities of metallisation, or spraying with zinc or other metal, as a means of preventing the corrosion of ship's hulls and under-water fittings. A new process is said to have been employed on the copper-sheathed hull of the Swedish Lifeboat Society's motor-driven lifeboat *Martina Lundgren* which had always suffered very greatly from corrosion. In 1938, when the vessel was hauled up on the slip for examination, the whole of the metal under water, both steel and copper, was sandblasted to make the surface perfectly clean, and zinc was then sprayed on. The object aimed at was twofold—first, to protect the surface against moisture and air, and therefore against ordinary corrosion, and secondly, to protect it from destructive galvanic action. The experiment proved completely successful, for when the *Martina Lundgren* was examined on the slip in 1939, neither pitting nor rust was found. The zinc surface was likewise free from all marine growth. A short time ago the lifeboat was again examined on the slip and it was found that even after two years in the sea there was still no sign of pitting. Rusting had started at a few isolated places, but this might have been due to the fact that sandblasting and spraying could not be carried out with 100 per cent. perfection on the already pitted surfaces. Furthermore, there was no sign of marine growth on the sprayed surfaces, although there were on other parts of the hull. It is therefore considered, the writer of the article concludes, that metallisation constitutes a most effective means of protection against rust and galvanic pitting under water, with the additional advantage that it also appears to discourage marine growths.—*"Lloyd's List and Shipping Gazette", No. 39,270, 18th September, 1940, p. 5.*

Furnace Front for Dual-fired Boiler.

A novel form of forced-draught furnace front which permits firing with oil and/or solid fuel is the object of a new British patent granted to two well-known firms of engineers and shipbuilders on the Clyde and Tyne, respectively. Referring to the accompanying diagrams, the furnace front structure has a central firing opening (11) and the usual ashpit opening (14). The chamber (15) accommodating the oil burner is provided with a pair of valve-controlled air-inlet ports, one at each side, the air-inlet valves being of the butterfly type operated by handles

Fig.1.

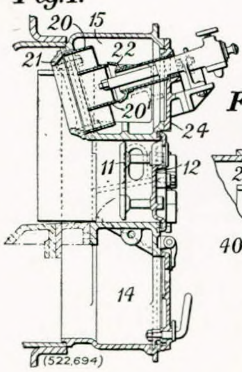
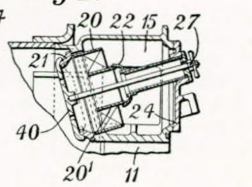


Fig.2.



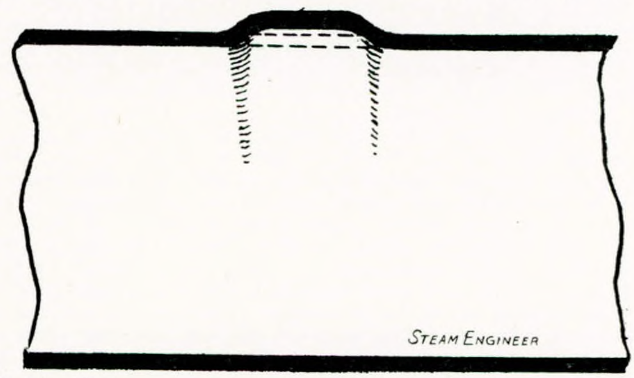
on the furnace front. In the chamber (15) is mounted a cylindrical vaned air director consisting of coaxial outer and inner tubes (20, 20') which are interconnected by vanes, and of an axially movable cowl (22) operating as a valve to control the proportion of air admitted through the inner tube (20) to mix with the atomized oil from the burner nozzle. The lateral arrangement of the air-inlet ports in the chamber (15) is such as to permit them to be of ample area, thus ensuring delivery into the chamber of air at low velocity and giving uniform distribution of air around the air director and burner and avoiding distortion of the flame. When the furnace is to be coal fired, the oil burner is removed, the cowl (22) closes the mouth of the tube (20') and the outlet (21) is blanked-off by a blank flange (40), as shown in Fig. 2. This flange is held in position by a spindle passing through the air director and clamped at its outer end by a handle-nut (27) against a cover fitted over the burner opening in the front closure plate (24). Combustion air passes downwards to the under-grate space through butterfly valves on each side of the opening (11), the valves being secured on a common control spindle which is interlocked with the door (12) in the usual way.—*"Engineering", Vol. 150, No. 3,899, 4th October, 1940, p. 280.*

Caustic Embrittlement.

Laboratory experiments have shown that in order to produce embrittlement in steel subjected to excessive strain, a concentration of over 300 grammes per litre—or 17,500 grains per gallon—of sodium hydrate is required, this being more than 300 times that which is considered good practice in modern boiler operation. It is probable that this excessive concentration is produced in the boiler as a result of slight leakage between the riveted seams, the water being gradually evaporated in the process. This leakage is not visible if the joints have been properly caulked on the outside, as is the usual practice, and it is therefore suggested that all boiler seams should be caulked on the inside. The initial straining of the plates during construction of the boiler also tends to accelerate caustic embrittlement and in order to prevent this it is laid down by certain inspection authorities that care must be taken to avoid what has been termed "abusive treatment" of the plates and rivets, while the pressures employed during power riveting should be reduced so as not to cause indentation below the rivet head.—*"Shipbuilding and Shipping Record", Vol. LVI, No. 10, 5th September, 1940, p. 231.*

Drastic Methods of Boiler Scale Removal.

The removal of hard scale from boiler plates and tubes is always a troublesome and tedious operation, and it is therefore not surprising that unorthodox and drastic methods of scale removal are sometimes resorted to. Such methods may result in serious damage to the boiler—a fact either not appreciated or disregarded by those who resort to them. A method occasionally adopted, especially with small boilers, is to blow out the water under pressure, and then play over the hot tubes and plates with cold water from a hose pipe. The effect of blowing off under pressure is to cause the scale to become baked hard on the heating surfaces, but the sudden chilling by the cold water, and the consequent contraction and straining, tend to cause the hard scale to splinter and fall away from the surfaces. To blow off the water under pressure is quite bad enough, because it induces severe straining of the boiler; but to spray cold water over the hot parts immediately afterwards is much worse, for it is almost certain to give rise to leakage troubles, and it may even set up dangerous fractures at the riveted seams. A fact which should be borne in mind is that scale does not usually harden until iti is exposed to air—in other words, it is as a rule comparatively soft whilst it is covered by water. Obviously, the sooner the scale is removed after the surfaces are bared of water the more easily will the removal be effected. The best method, therefore, when practicable, is to allow ample time for the water to cool down; then run it off slowly, and clean the surfaces as they are exposed by the falling of the water level. This method is much used with



Showing bulge on a tube of a water-tube boiler due to careles scaling.

large cylindrical boilers, the boiler cleaners being provided witl oilskins; and in many cases it enables the men to clean the boiler merely by hosing or brushing instead of having to chip off the scale. When scale has to be removed by chipping, suitably shaped scaling hammers with chipping edges are used. If these edges are too sharp and hard, the metal surfaces will be indented at numerous places, and they will then be much more prone to suffer from corrosive influences than if they had remained undamaged. Indentations along a lap edge might possibly start dangerous grooving. Hence, boiler scalers ought to be warned against the use of sharp-edged tools. Power-driven scaling tools are nowadays extensively employed. Some of these act by delivering heavy blows to the scale at the rate of several thousands per minute, so that their action under the best conditions may be somewhat drastic. If carelessly used, they may do considerable damage in the form of bulging and even rupturing tubes. The accompanying figure illustrates how a tube of a water-tube boiler was bulged for a good distance round by one of these tools owing to the tool having been applied too long at the damaged part. In order to avoid the labour and expense of removing hard scale by tools, certain substances are occasionally employed with the object of dissolving the scale or causing it to break away from the heating surfaces. Of these, hydrochloric acid and paraffin should be specially mentioned. Hydrochloric acid has a powerfully solvent action on carbonate scales. It has, however, also a powerfully corrosive action on iron and steel, and hence its use entails much risk of severely corroding the plates and tubes. Scale rarely accumulates to the same thickness at all parts of the boiler, but is usually heavy at certain parts, and light or even non-existent at others. Hence, when acid is used, those parts which are not covered by scale will be immediately attacked, and the parts which are only lightly coated will soon become exposed to the corrosive action of the acid, so that if the action is continued long enough to dissolve the thick deposits, the exposed parts must suffer. This, however, is not all. When once the metal has been exposed to the action of acid, it is more susceptible to corrosion, so that if the feed water is at all corrosive, the boiler will be more likely to suffer subsequently than it otherwise would have been. It may be possible to add to the acid some substance which will safeguard the metal against the corrosive action of the acid whilst not affecting the solvent action on the scale, but this is a matter for an expert water analyst or chemist. It is very doubtful, however, if any chemist would advise the use of hydrochloric acid for removing scale from a boiler, even in conjunction with an inhibitor. Unlike hydrochloric acid, paraffin does not remove scale by dissolving it entirely, but rather by penetrating between the scale and the boiler metal, and hence causing the scale to break loose, so that it either falls away or can be easily removed by light hammering. There are two objections to the use of paraffin: first, owing to its inflammable nature, it may ignite and cause serious injury to anyone inside the boiler; and, second, it may give rise to overheating, and consequently leakage troubles. For these reasons, especially the first, boiler insurance companies and many other authorities condemn the use of paraffin and other similar inflammable oils for scale removal. As regards the second objection, it is well known that any form of oil or grease has a pronounced effect in causing overheating, even if present in only very small amount. There are on the market numerous products which, it is claimed, will quickly remove old scale; but it is well to bear in mind that these may contain acids or greasy matter, in which case they may do serious harm to the boiler. It is wise to suspect that any substance which is able to remove scale in a very short time may cause corrosion or overheating. Many steam users have, indeed, found their boilers badly corroded soon after trying the effect of some special compound, whilst some have found it necessary to have riveted seams caulked and large numbers of tubes expanded almost immediately after the introduction of such compounds. There is obviously much risk in experimenting with unknown specifics for scale removal, and the steam user who wishes to get rid of scale without the trouble of chipping and hammering should certainly seek the advice of a feed-water analyst.—*E. Ingham, "The Steam Engineer", Vol. X, No. 109, October, 1940, pp. 6 and 7.*

Refrigerator Performance: An Investigation into Volumetric Efficiency.

The paper describes experiments carried out in the Engineering Laboratory of King's College, London, on an ammonia-vapour compression refrigerator, for the purpose of investigating the conditions affecting the volumetric efficiency of the compressor. The most important part of the investigation concerned the effect of the condition of the vapour at the suction valve, over a range from about 0·75 dry to 45° F. superheat, on both the actual and the indicated volumetric efficiencies. The actual volumetric efficiency was found to drop about 20 per cent. between the superheated and wet conditions, but the indicated efficiency showed little variation. The results lead to the conclusions that the decrease is volumetric efficiency is due to condensation of ammonia on the cylinder walls during the compression and delivery stroke, and that the temperature of the cylinder wall is the critical factor determining the vapour condition at which the drop in efficiency begins. Other variables investigated were the condenser and evaporator pressures, and the compressor speed.—*Paper by E. Giffen, Ph.D., M.Sc., and E. F. Newley, M.Sc., "Journal of the Institution of Mechanical Engineers", Vol. 143, No. 4, September, 1940, pp. 227-236.*

Yacht Tonnage.

Yachts are usually referred to by their Thames tonnage, which is determined by an arbitrary system of measurement based on length and beam only. The formula for determining Thames tonnage is $\frac{(L-B)\times B\times \frac{1}{2}B}{94}$ L being the length in feet measured from the forward side of the stem to the after side of the sternpost on deck, and B the maximum beam in feet. The approximate displacement of small craft may be calculated from the following formula:—$D=\frac{L\times B\times D\times C}{55}$, where D=displacement in tons; L=waterline length in feet; B=beam in feet; and C=the coefficient of fineness. The value of C varies from 0·3 for old-style sailing yachts up to 0·4 for the average motor yacht. In the case of fishing boats and converted lifeboats, the value of C is about 0·34, while for racing yachts it is 0·33.—*"The Motor Boat", Vol. LXXIII, No. 1,875, September, 1940, p. 101.*

Shipbuilding Yards Re-named.

Harland and Wolff have recently re-named some of their yards at Belfast. The former Main Yard is now known as Queen's Yard, a name derived from the Queen's Island on which the whole establishment stands. The South Yard takes its new title, Abercorn Yard, from the Abercorn Basin adjoining; while the East Yard has become the Musgrave Yard, from the channel of this name. Another small yard has been christened the Victoria Yard, from the Victoria Wharf, one of the riverside fitting-out basins.—*"The Engineer", Vol. CLXX, No. 4,419, 20th September, 1940, p. 194.*

Work in Norwegian Shipyards.

According to the Norwegian periodical *Norges Handels og Sjöfartstidende,* two ships for the Bergen Steamship Company are under construction at the Bergen Engineering Works. Shipbuilding is continuing at the Langesund Engineering Works, where a couple of hundred men were employed in June, but where a shortage of certain materials is now making itself felt. The Trosvik Shipyard at Brevik also resumed work, but a number of workpeople have had to be dismissed. The Porsgrund Shipyard has maintained its staff of workpeople, but they have been working short time. Work has been proceeding at the Kristiansand Engineering Works on one or two new vessels and others under repair.—*"Lloyd's List and Shipping Gazette", No. 39,276, 25th September, 1940, p. 4.*

Flame Cutting in Tanker Construction.

A paper read by Mr. Robert B. King at the last annual convention of the International Acetylene Association, described the advantages of a mechanical flame cutting machine used in an American shipyard (belonging to the Manitowoc Shipbuilding Company) during the construction of two large tankers. The flame cutting machine consisted of a wood-surfaced table 42ft. long and 8ft. wide on which layouts were traced to produce the same contour in steel on a 42-ft. by 10-ft. cutting table. Although the machine was designed to carry only one torch at the end of the beam, two—and sometimes three—torches were actually mounted during most of the time. The greater part of the material cut by this machine for the tankers consisted of plates $\frac{3}{8}$in. in thickness used for webs on the bulkheads, web frames on the ship's sides, and bottom frames. The long parallel middle bodies of the tankers' hulls required many frame members of the same shape, and in order to produce these by flame cutting a track of aluminium, $\frac{1}{4}$in. by $\frac{7}{16}$in. in section, was formed to the desired contour and screwed to the wooden surface of the table. A differential trunnion drive on the machine followed this track to guide the torches, two of the latter being used for this cutting. The plates to be cut were located on the cutting table by stops to reduce setting-up time. The bulkheads for the tankers were made of plates $\frac{3}{8}$ to $\frac{5}{8}$in. thick, welded together to form a large plate surface, this being stiffened on one side by structural shapes and webs cut as described, the other side being smooth. The bulkheads were laid out on the smooth side for cutting to the correct contour to fit into the ship. Several were cut by hand torch, producing a ragged cut compared to that of machine cutting and requiring chipping with a pneumatic hammer to smooth the edge. The portable flame cutting machine was used to cut the remaining bulkheads, the cutting being done right to finished size and shape without the need of any chipping. For straight cutting a light flat bar track with feet welded to it was used to guide the machine, pieces of scrap steel serving as weights on the feet to hold the track in place. For shape cutting the machine was guided by hand to follow the shape marked on the plate. The flame cutting machine was also used for cutting the 1-in. plates fitting around the stern tubes of one of the tankers, a twin-screw vessel. These plates were bevelled for welding by setting the torch of the machine at an angle. The applications of the hand torch included the cutting of numerous holes for pipes, and cuts to allow one structural member to fit another. Owing to the shape of the hulls it was found necessary to build many smaller units with surplus material and to trim these in place during their erection and fitting in the ship. These trunks were set on blocks above the deck in their correct positions and their bottom edges marked to fit the deck contours. A burner trimmed the edges to these lines and the trunks were then set on the deck and got ready for welding. The hand torches provided a very flexible and economical means of shaping these units to fit the hull. The lighter material used for the ships' deck-houses provided similar applications of flame cutting. The author pointed out that many of the welded rudders used for ships at the present time have frame members of flame-cut plate ½in. to 1in. in thickness, these diaphragm plates being usually of a streamline shape with lightening holes and cut-outs to fit the rudder stock. In such cases it is convenient to make use of paper layouts to guide the flame cutting machine because of the few pieces of each shape necessary. Several rudders having cast frames were rebuilt with flame-cut members instead of the former cast members, the latters being removed from the stock by flame cutting in order to prepare the stock for use in the new rudder. Some of the sections cut in preparation were 12 to 15in. deep and 2ft. long at the junction with the stock. In his concluding remarks the author called attention to the wide uses of flame cutting in ship repair work, particularly in rivet cutting. He expressed the view that flame cutting has proved itself to be an important feature of ship construction and repair work and that a definite trend towards greater application of mechanical flame cutting in ship and machinery construction appears to be indicated at the present time.—*"Shipping World", Vol. CIII, No. 2,467, 25th September, 1940, pp. 249-250.*

Lubrication of Valves.

Lubricated valves have been developed through the introduction of heavier valve mechanisms to control greater volumes of gases and fluids. To those who are accustomed to operating the average small gate or stop valve in a 2 to 6in. line, it is difficult to realise that valve mechanisms may be so large as to stand well above the height of the average man, and, in turn, their operation is often beyond his strength. In this way mechanical means became necessary, using toggles or gearing for power transmission. Even electrical remote controls have been perfected for some types of service. A variety of designs has resulted from the concerted efforts of the valve manufacturers to provide for lubrication. In this connection, grease lubrication by pressure gun or the application of grease cartridges into special retainers has been widely adopted. For large valves toggle mechanisms have been found especially adaptable to power economy. Obviously, the loads which may be developed may sometimes be extreme, but pressure lubrication will effectively protect the pins and bearings. Some builders plan for this by use of individual pressure gun fittings, others employ centralised lubrication designed for manual handling. Some makers employ a hand-operated gear-driven valve mechanism for heavy duty work. Here the gears work in a bath of medium viscosity gear lubricant, the bearings being independently lubricated by a pressure gun. Electric power can also be utilised for the operation of the geared valve. Ball bearings have also been adopted to facilitate the motion of valve mechanisms. The function of the lubricant in valve operation is threefold, in that it must facilitate movement of the mechanism, prevent sticking of the gate or valve lid, and retard corrosion and etching of the valve seat surface. In addition, a lubricating film serves to prevent deposits from accumulating on the valve seat. Gate lubrication was primarily undertaken for the purpose of facilitating the moving of the gate when under pressure and to reduce the stress on the valve spindle. This development led to the design of the plug type of gate valve, a mechanism designed with a special lubricant pocket adjacent to or forming a part of the valve stem. This arrangement called for lubrication in the form of a relatively stiff grease generally moulded in stick form to conform with the size of the pocket. In valves of this type the lubricant is forced into the clearances between the tapered plug and valve body via suitable ducts when the lubricant screw is turned down. The design provides for carrying an adequate supply of lubricant to the base of the plug where it exerts an upward pressure to free the plug in the event of sticking. This lubrication can be accomplished by turning down slightly on the lubricant screw at regular intervals. Meanwhile a complete film of lubricant over the contact surfaces of the tapered plug and valve seat facilitates operation and prevents the valve from leaking. In other words lubricant pressure offsets the pressure of the liquid or gas being handled. Another type of valve designed for lubrication of the valve seat involves a typical gate mechanism with provision for grease lubrication by pressure applied through small permanently attached grease guns of special design. In this type of valve the presence of a suitable lubricant is claimed entirely to offset any slight inequalities in gate or seat surfaces with the result that leakage is effectively prevented and indentations kept from becoming larger. In the lubricated gate valve grease can be forced from the pressure gun directly to the working face of the gate. No intricate ducts are necessary. Lubricating the plug or gate of a valve which is designed to handle a variety of chemicals of acid or solvent nature is very beneficial in that sticking is materially reduced, especially when the valve has been closed for any length of time. Under such conditions deposits sometimes develop a cementing action. This is prevented, however, by an adequate film of lubricant, especially where the latter is so manufactured as to be able to resist breakdown in the presence of solvents or acids. When such a valve is to be opened or closed only for emergency, application of pressure to the lubricating film just before opening will raise the plug or gate just enough to separate it from the seat and cause it to move freely when the spindle is turned. Valves of the toggle control type, which are usually of massive construction and built for heavy duty, present a problem for external lubrication. Pressure grease lubrication is called for in the majority of such mechanisms. Wherever ball bearings are employed care must be observed to guard against over-charging of the bearing retainers, otherwise the seals may be impaired to result in leakage of grease. Collective lubrication of sleeve-type bearings by pressure sufficient to ensure complete renewal of the grease is of material assistance in protecting the bearing elements. Normally, where moisture is excessive, it is well to use a non-soluble grease which is resistant to moisture. Provided it is chemically stable and of non-oxidising characteristics such a lubricant will also withstand acid conditions. It is practicable to use a cylinder stock grease of medium consistency where resistance to oxidation is of primary importance. Regarding the method of application, the portable pressure gun can be used to good advantage. This device enables accurate control of the amount of grease to be applied with but little possibility of waste. Meanwhile the grease is protected against contamination and cleanliness is maintained. Where heavy duty valves involve a hard or motor-operated reduction gear mechanism, added consideration must be given to gear lubrication in accordance with the nature of the work. Where the latter provides for adequate housing, a medium viscosity gear lubricant should function satisfactorily. As a rule if the viscosity range is about 1,000 seconds Saybolt at 210° F., a protective coating can be maintained on the teeth with but little drippage unless temperatures become abnormal, when a heavier grade should be used. Normally, any such lubricant is applied by hand-brushing. In the selection of suitable lubricants to meet the usual working conditions, probably the most important factor requiring consideration is the matter of pressure. Where pressures are high, the tooth surfaces, due to their relatively small areas of contact will carry heavy loads. The more carefully and accurately the gears have been cut, the more intense will be the pressure, as line contact will practically exist under such conditions.

Further, this line of contact or pressure will be constantly changing as the gear teeth mesh with each other. As long as rolling motion predominates, the effect on the structure of the teeth will not be serious. Once wear has begun to take place sliding motion will supplant rolling motion to a proportional extent and grinding of the surfaces will result. This explains the more or less rapidity with which gear teeth will become worn down whenever lubrication has been neglected, especially where exposure to abrasive materials may have prevailed.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 35,141, 19th September, 1940, pp. 1-2.*

Superheated Steam Cylinder Lubrication.

Superheated steam has many advantages for marine service, both technically and economically. Superheated steam does not condense until its temperature has been reduced to that of saturated steam at the same pressure. Also it has greater volume per unit of weight than saturated steam at the same pressure, the volume increasing with the temperature. The lubrication of steam cylinders operating with superheat, however, raises special problems. Engine cylinders working with saturated steam eventually acquire what is known as a "water polish". This polish acts as a protecting film and has a very low coefficient of friction. Where superheated steam is used, however, water is not always present. Absolute dryness prevails only where a very high superheat is employed, and even then the degree of superheat at the end of the expansion stroke or throughout the entire exhaust stroke is questionable. It is believed that in the neighbourhood of 200° F., initial superheat at the throttle is required for any superheat to remain in the steam at the exhaust when working at about one-quarter cut-off. This means that the majority of engines using superheat are operated on saturated steam for part of their expansion stroke and throughout the entire exhaust stroke. Consequently, instead of a purely superheated steam condition, there is a dual problem presented in the selection of the most suitable steam cylinder oil, *i.e.,* initial superheat with subsequent saturation or moisture conditions. The one oil must, however, be capable of meeting both types of service. If there is not more than about 30 to 50 degrees of superheat present, internal lubrication is sometimes effected by injecting a small amount of fresh water with the steam. This water serves the same purpose as the moisture in saturated steam. For superheat of a higher degree, however, it is necessary to use a specially prepared lubricant for the cylinders. Such an oil must not break down at temperatures as high as 700° F. In order to obtain efficient internal lubrication, the oil must maintain a lubricating film under the influence of high temperature and steam condensation, and must be properly atomized and distributed by the steam to the valve seats and cylinder walls. It is generally impractical to use superheated steam in auxiliaries due to the difficulty in effecting proper internal lubrication in the cylinders. The steam pipe supplying all the auxiliaries is, therefore, usually planned to take saturated steam from the boilers before it enters the superheater. If condensation were not present in a steam cylinder there would be no necessity for requiring a lubricant which would emulsify, and a straight mineral oil would be perfectly satisfactory. In multiple-expansion engines, however, especially where a low degree of superheat is used in the high-pressure cylinder, the exhaust from the intermediate cylinders will be relatively wet and the proper oil film will not be maintained. For an oil to be suitable for superheated steam conditions it should have a viscosity of about 165-195 seconds Saybolt at 210° F., and contain a small percentage of animal compound. This ingredient will enable the oil to emulsify slightly and thereby lubricate the cylinders efficiently during that period when they are filled with saturated steam. As the compounding is slight no ill effects should result from the exposure of the oil to superheat conditions. An approved type of lubricator should be used for applying steam cylinder oils where highly superheated steam is employed. The mechanical lubricator which works off the main engine is generally most economical and dependable. Where a hydrostatic type of lubricator is employed, the cylinder oil should be thoroughly mixed with saturated steam previous to its admission to the main steam pipe so as to prevent carbonisation. Such steam can be taken from a convenient point on the saturated side of the superheater provided a difference in head of about 2ft. is available to mix the steam and oil. This mixture is then carried in globular form into the main steam pipe and thence to the high pressure cylinder. The excessive oil feeds which many engineers have considered necessary for superheated steam cylinders are due to the use of a straight mineral cylinder oil and misunderstanding of the values of high viscosity, and high flash and fire points. Any oil of this nature, while suitable for the lubrication of the cylinder, as long as the steam remains dry and superheated, is not useful for lubrication during that part of the stroke when the steam is saturated, as the moisture washes the oil off the cylinder walls and the cylinder becomes dry. This results in wear, increased friction and noise. As a result, the engineer is liable to increase the amount of oil fed, so that satisfactory lubrication may be secured, but in so doing, such a large amount of oil is fed to the cylinder that it is not carried away, and accumulations of carbon deposit are the result. In the lubrication of superheated steam cylinders, most of the troubles encountered have been caused by carbonisation of the oil, and deposits on the valves at the end of the valve travel, and at the end of the counterbore in the cylinders caused by the oil remaining in contact with the hot surfaces and the superheated steam long enough for its lighter constituents to be vaporised and the oil partially decomposed. It is of importance to know something about the flash and fire points of lubricants used on engines operating on superheated steam, and to make a careful study of such conditions with the view of selecting lubricants which will resist the effects of high temperature as much as possible. As a guide to the lubricating quality of any oil, flash and fire point readings are of value only as indicators of the relative initial volatility. The flash point should not be regarded as a definite temperature at which boiling takes place, or at which a petroleum product may pass even partly over to the vapour stage. The extent to which vaporisation of an oil may occur at temperatures below its apparent flash point will largely depend upon the proportion of low flash point or high volatility hydrocarbons which may constitute its make-up, and the extent to which the surface of the oil may come into contact with fresh-heated air. This may be important where improperly refined oils are used, for it will lead to abnormal consumption and a false impression as to the actual cause. Higher flash and fire point oils will in general be of a higher viscosity if of similar composition from a hydrocarbon viewpoint.—*C. H. S. Tupholme, "Boiler House Review", Vol. 54, No. 4, October, 1940. p. 132.*

Investigation of Steam Turbine Nozzle and Blading Efficiency.

After a short introduction the paper describes the essential characteristics of the passages forming the fixed and moving elements of multi-stage high-efficiency turbines, whether impulse or reaction. The problems of the nozzle investigations by static and dynamic methods are discussed, and a new nozzle tester is described. Reference is made to the Reynolds number, its physical significance is explained, and experimental results are used to demonstrate its effectiveness as a correlative factor. The significance of the static (nozzle) efficiency and the dynamic (turbine) efficiency is discussed, the essentially different way in which they are affected by the discharge angle is pointed out. A mathematical expression is given for the relation between static and dynamic efficiency for 50 per cent. reaction blading as a function of the discharge angle. This, in conjunction with the Reynolds number, is used to demonstrate the unity and consistency of static and dynamic test results which at first sight would seem to be conflicting or unrelated.—*Paper by F. Dollin, B.Sc.(Eng.), at a meeting of the N.E. Branch of the Steam Group of the Institution of Mechanical Engineers, on the 7th October, 1940.*