INSTITUTE OF MARINE ENGINEERS

INCORPORATED

SESSION 1909-1910

President : JAMES DIXON, ESQ.

PAPER OF TRANSACTIONS NO. CLIV.

Some Details of a Cargo Steamer

BY MR. W. VEYSEY LANG (MEMBER).

Read Monday, February 15, 1909.

CHAIRMAN: MR. JOHN LANG, R.N.R. (MEMBER OF COUNCIL).

CHAIRMAN : The paper to be read to-night by our friend, Mr. Lang, is one which ought to prove useful and instructive to members of the Institute, especially those members who have been appointed to superintend the building of new ships. They continually find it necessary to ask for a little extra from the shipbuilder, but are always met by the reply that "it is quite outside the specification." Mr. Lang's paper will enable us to anticipate those details, and I therefore have pleasure in calling upon him to read it to us.

I do not intend to-night to touch upon the sacred ground of the naval architect nor the pros and cons of length versus beam or depth nor of type, but only in regard to the details as they are required to be stated or set forth in the specification of a new steamer.

It is impossible to cover the ground of varying sizes and classes of ships, and I therefore only propose to take one type, and for that one I select the very ordinary modern tramp steamer of (approximately) 6,500 to 7,000 tons D.W., and an

East Coaster of, say, 350 to 360 ft. by 48 to 50 ft. by 28 to 30 ft. dimensions.

The steamer, as she is desired to be, is necessarily decided by the owners as to length, breadth and depth, type of vessel and deadweight, the loaded draught and speed being also important items, governed in the main by the trades to be, or expected to be, engaged in.

The classification is fixed, viz., whether to be built to Lloyd's or other society rules, and, after these main points come the terms of contract and details of the specification, in all of which the respective parties are interested and more or less (generally more) discussion, and more or less give and take (mostly take) on both sides, is the prelude to the signing of contract for the building of a cargo steamer.

The shipbuilder's "usual practice" and the rules of classification are the basis upon which the modern cargo steamer is designed and quoted for, and these are to all intents and purposes a "standard" article with most builders as representing quantity and quality—so much iron and steel—so much wood, so much equipment and outfit, and I.H.P. and speed form the foundation of price at per deadweight ton or horse-power, but the estimating of details is separately gone into and added to the basis figures. These items, which are mainly left to the owners' representative or representatives to specify and arrange, nevertheless tend greatly, in the life of the ship, to economy or efficiency, or both—or the reverse.

Details, therefore, greatly influence the final results and require careful consideration in regard to

First cost,
Working economy,
Maintenance and
Provision against repairs.

There is no economy in filling up a ship with "patents" and extravagant notions—for on top of first cost and interest on capital you have increased maintenance to keep up, both in repairs and stores; but, on the other hand, the "bare" specification ship comes into her deserts all in due time, and things which might have been guarded against or been of better size or quality in the first instance often turn out to be the most expensive in the long run. "Cheap and nasty" are synonymous terms as far as my experience goes whether in shipbuilding, house building, or the buying of a suit of clothes. There is usually a reliable article between the extremes of deficiency and extravagance, and a choice also in details that, if not absolutely necessary, are most desirable ; and such others as can be very well dispensed with.

The " Spec " ship—as a rule—leaves much to be desired in regard to details more than to arrangement ; for obviously the builder is building to sell and, whilst his price must be in the nature of a marketable attraction, he nevertheless wants to see as much profit as possible as a result of his enterprise, and the *details* generally are cut down, and steamers built to the " bare " specification are very often deficient in many important details.

What I have chiefly and generally observed when inspecting ready-built steamers for sale are, amongst other things, the following important items :—

(*a*) Everything is to the barest classification, rule size, and no allowance for wear and tear. All decks of steel.

(*b*) The holds are obstructed by beams, and these and the decks supported by a *forest* of stanchions and pillaring.

(*c*) Accommodation is usually very limited ; berths small, and officers and men respectively crowded together. The boats, davits and life-saving appliances, etc., without margin for any extra crew.

(*d*) Masts and rigging to the smallest rule diameter, and not suitable for the " cargo posts " they really are. Derricks and cargo gear too light.

(*e*) Scarcity of mooring bollards, lightness of castings, fairleads, etc. Small windlass. If a dynamo, too small and lights limited. Bilge keels (if any) too small to be effective.

(*f*) Winches too few in number and too small in size. No mooring winch aft. Generally no winch on bridge for working bunkers. Steam pipes small—too small usually to permit of extra or larger winches being fitted—and sometimes of iron. Exhausts always of iron. Coverings very ineffective.

(*g*) If three main boilers, no donkey boiler. If a donkey boiler, is usually too small to efficiently work all winches and auxiliaries at the same time.

(*h*) No navigation (upper) bridge, nor deck house.

(*i*) Ventilation and side lights (scuttles) too small and too few.

(*j*) Tank filling and suction pipes too small to fill or empty tanks under 16 to 20 hours. Small ballast pumps.

(*k*) Thin plating and angles of bunker and internal casings. Ventilators of very light gauge. Main funnel lightly plated. Air casing and sheet metal work generally very thin.

Air and sounding pipes of "gas" quality.

(*l*) Equipment generally very limited and of common quality. Outfit usually comprises a long list of the very small and inexpensive items. No extra spare gear.

In all the foregoing items (*a–k*) the chief point for consideration is that they are "permanent" disqualifications, for it is beyond practical consideration to renew (or alter) masts, winches, donkey boiler, etc.; whilst such attaching details as steam pipes, exhaust, suction and delivery piping, electric wiring (if any) being only to the bare requirements for the service fitted, can never be called upon to serve an extra winch or another group of lights, or, in the case of tank suction pipes, permit of a larger pump being fitted than they will pass water for.

The fact remains, however, that there *is* a demand for the cheapest steamer obtainable, and in pointing out their usual shortcomings, I only do so from the standpoint of a good average class ship, and not as any reflection whatever upon the shipbuilder, but only as points to be noted for or against the items of my further observations.

But, further, I would also remark that the tendency during the last few years is, with some leading builders, to put forward, and quote, upon a really good all-round specification, with additional scantlings above classification rules and a good substantial equipment, clear holds and good cargo gear—all of which goes to show that a "good" class steamer is also in demand and increasingly so.

General.—My remarks so far have been rather general than specific, and you will think it is quite time I came to the details.

I cannot do better than follow the usual order of a builder's "standard" specification, which from time immemorial has been no order at all, but just clause after clause as they happen to have come into the mind of the compiler and without any regard to alphabetical sequence.

In some specifications—especially if typed—there is often no index, or if indexed it is very incomplete. It is most important, and a great saving of time, both in and out of the yard, when a specification is well indexed even to the smaller details of the respective departments.

General Description.—This is generally set forth briefly as to type, rig, class, material of hull, deadweight of cargo, etc., and is merely a preface to the setting forth of the various items in fuller detail.

Dimensions.—These are usually given in

L, overall. L—B.P.
B, extreme. B, moulded.
D, moulded to main or upper deck.
Shear F and A.
Co-efficient of fineness.

The earliest record we have of shipbuilding is that of a cattle ship, built to special order, plans and dimensions, by the old-established firm of Messrs. Noah, Sons & Co., Ltd., at their "Asia" yard, and was a shelter decker built to the three-deck rule. From authentic records, her dimensions would appear to have been about 450 L by 75 B, by 50 D, to the shelter deck. She had three decks laid, lower, main and upper, with shelter deck above. She was classed B.C. 4,000 with freeboard, and as she was especially built to carry a large cargo, we may assume she was a "full" ship—both inside and out. Depth of water was limited, and she probably had a draught of 20 ft., which with a co-eff. of ·880 would give a displacement of 17,000 tons or thereabouts.

The details of specification are not available, but as far as we know them they were not up to Board of Trade regulations in regard to light and air spaces, although the life-saving arrangements were evidently all that was desired. The predecessors of Messrs. Wailes, Dove & Co. coated her inside and out with their bituminous composition.

I have speculated upon the sanitary arrangements, but without enlightenment. Two donkeys were certainly aboard, but whether for ballast or for general service is a matter of doubt. No horse-power is stated. She took a phenomenally long time to build, made one of the longest passages on record, experienced most exceptional weather and finally stranded and became a total wreck.

L. B. and D. are determined by the varying conditions of service; loading and discharging berths or quays; draught of water in harbours or over bars; width of entrances, locks and docks and overhang of cranes, shoots, etc. If for light general, bale or timber cargoes, or if for coals, ores or other deadweight cargoes. The H.P. and speed are governed by or arranged to suit to other conditions.

In regard to *breadth* it might be worth while to consider the question of dry dock accommodation, especially for a ship intended for certain or stated ports, as any extra 6 in. of beam might make it impossible to use certain dry docks, which, as one of the necessities of maintenance, is a point for consideration.

Taking the common beams of 46 to 52 ft. extreme, I find on consulting Lloyd's Appendix to their 1908 Register that in the U.K. the public and private dry docks and pontoons capable of taking 350 ft. in length and upwards, average for widths of entrance as follows—

				No.
Will take	46	ft.	=	115
,,	48	,,	=	109
,,	50	,,	=	106
,,	52	,,	=	90

Whilst docks capable of taking the larger cargo vessels of 450 feet and upwards, I find—

				No.
Will take	54	ft.	=	63
,,	56	,,	=	60
,,	58	,,	=	59
,,	60	,,	=	44
,,	62	,,	=	40
,,	64	,,	=	36

These figures exclude Government Dockyard accommodation in the United Kingdom (N.B., these are not available for merchant vessels except in cases of distress), also gridirons and patent slips. I have in each case allowed for at least 1 ft. clearance between beam of ship and width of entrance stated, which is really too narrow a margin, and if 2 ft. 6 in. is allowed, the available docks will be reduced considerably.

In the case of the greater beams of 58 to 64 ft., I would point out that although there are thirty-six available dry docks, these larger docks are mostly in a few ports (Liverpool accounting for eleven alone, of which seven are 60 ft. width of entrance), and in the other cases they are mostly the property of railway companies (Southampton accounting for three dry docks capable of taking 450 by 58 to 64 beam).

The dock accommodation for broad beam ships, therefore, is limited more and more as the width increases, and the larger and more in quest the dock, the higher the tariff. Such docks abroad are very scarce and the charges heavy.

DRY DOCKS.—It is particularly to be noted in going through Lloyd's Appendix, what a large number of docks have their width of entrance out of all proportion to length. Thus, some docks of 400 ft. can only take in 44 ft. in beam, and there are twenty-three dry docks in the United Kingdom capable of taking 360 ft. of length, but too narrow of entrance to pass a proportionate beam of 48 ft. Several of these belong to dock companies or River Commissioners and should long ago have been modernized.

CLASSIFICATION should stipulate to be to latest Home Office requirements and regulations as to Factory Acts, etc. Openings in 'tween decks, etc., to the rules of the Welsh Trimmers' Union.

SCANTLINGS.—These are usually named in brief as to be to Lloyd's (or other classification) rules—but some items can be increased upon to advantage, both in strength and to allow for corrosive waste. Classification rules are *the minimum*, and when parts specially subject to wear and tear and oxidation are reduced to a percentage limit, their renewal is imperative sooner or later.

Steel is the usual material for the modern hull, but weather decks should be of iron to better withstand their excessive tendency to corrosion. It is not necessary to carry the iron to within covered-in spaces or under wood sheathing, and a concession to weight and cost can here be allowed.

'Tween decks and tank tops are sometimes specified to be of iron, and are desirable as such, but the extra thickness is also proportionate weight and cost.

Where I would advocate putting extra scantlings would be—

(*a*) Tank margin strakes.

(*b*) Floors, angles and intercostals under engines and boilers.

(*c*) Do., do., under donkey boiler.

(*d*) Division plate floors between all tank spaces.

(*e*) Bottom or coaming plate of each W.T. bulkhead.

(*f*) All bracket plates connecting bulkheads and stiffeners to tank tops.

All the above to be of steel of iron thickness.

Height 'tween decks is entirely a matter of arrangement, but to keep within the rule for minimum scantlings 7 ft. $11\frac{1}{2}$ in. is the maximum. At the same time, for cattle and transport requirements a greater height is desirable, as also for general cargoes, timber, etc., say up to 9 ft. 6 in., top of beam to top of beam.

Height of Erections—above deck—enclosing accommodation, etc., should have a nett head-room of at least 6 ft. 6 in., and preferably 7 ft., for the saloon department. The higher the deck erections the greater the top weight and "windage," but in these days good accommodation is required, and air space conduces to health, especially in hot climates. I went over one of Messrs. Holt's new steamers some time ago, and was astonished at the generous spaces devoted to officers' and engineers' berths. To a one-man berth there must have been quite 600 cubic ft. of space—partly due to extra height of deck to under beam. The forecastle area was also greatly in excess of that usually allowed in ordinary cargo steamers.

Heights of Engine and Boiler Casings are as well if carried to height of side houses, etc., and help to secure the maximum deductions from gross tonnage.

WINDAGE.—This is a term not often found in textbooks, and seldom used; yet in the modern steamer must be a considerable quantity and worthy of some attention. Any wind force from abaft is welcome, while a beam is of little account, but when dead ahead is a more or less serious opposition to progress.

The height of hull above water is an unalterable mass, and the form of a bow does not offer a serious resistance—it is the square front of bridge and superstructures that offer a square face to the wind ahead. That these superstructures are necessary, and high navigating bridge and chart houses indispensable to safe and speedy progress in these days of crowded ocean routes, goes without saying, but it seems to me that such upper work might be made in bow form, with considerable reduction to "windage." A bridge front, saloon, upper bridge and chart house, etc., could as well be at an angle of (say) 45 degrees as square on, and resistance would be greatly reduced.

I find from the plan of an ordinary 7,000 ton cargo steamer that the front of saloon house, the upper and flying bridge weather screens, and the chart house have a frontage of about 500 sq. ft.

Taking the velocity of wind and pressure per square foot, this gives—

Velocity. Miles per hr.	Press per sq. ft.	As Described.	500 sq. ft. of resistance. lbs.	Tons.
10	·492	Mod. breeze	246	·11
15	1·107	Fresh ,,	550	·24
20	1·970	Strong ,,	985	·44
30	4·499	Mod. gale	2,249	1·0
35	6·027	Fresh ,,	3,013	1·34
45	9·960	Strong ,,	4,980	2·22
50	12·3	Whole ,,	6,150	2·74
60	17·71	Storm ,,	8,855	3·50
80	31·49	Hurricane	15,745	7·02
100	49·2	Hurricane	24,600	10·98

Add to this the forward speed of ship, say 10 knots, and you have a very good reason for the long passages a ship makes in the teeth of head winds and gales + seas. A good strong tugboat will pull about 9 tons and would probably tow a 6,000 to 7,000 loaded steamer 4 knots under favourable conditions, and a corresponding opposition would be much greater at a higher speed. I think a bow form of superstructure would be a great advantage to speed on all classes of ships, and, from the navigating bridge would give a clear sea view well abaft the beam on either side when standing at the centre position or forward angle. In the case of large liners the opposition due to superstructure must be enormous at fast speeds, and they seem to take this somewhat into consideration by elongation of the funnel areas, although a circular form of even 10 to 12 ft. diameter cannot approach to the direct frontal area of the bridge structure.

Joggled Plating.—I suppose I shall be courting trouble—and controversy—when I say that I cannot understand an owner accepting joggled shell plating in lieu of plain plating ! especially if he (or they) carry their own risks. Joggled plating is urged as dispensing with liners and saving weight. Well, so it does, but it reduces the displacement proportionately, and also the grain space. Roughly speaking, a 54 in. width of (outer) shell plate will take, say, a 48 in. by $3\frac{1}{2}$ in. by $\frac{5}{8}$ liner on each frame = 29·16 lb. ; the *set in* of a corresponding surface of plate, with 24 in. frame spaces, is approximately 24 in. by 48 in. by $\frac{5}{8}$ in. thickness of water = 28·13 lb.

Speaking from memory, I think the saving of liners in a steamer of about 7,000 tons was stated at about 25 tons, and the loss of displacement as over 30 tons, and, of course, the internal capacity for grain space is proportionately reduced. When it is taken into consideration the considerable extra cost of renewing or repairing joggled plating, it ought to be a sufficient consideration to put against any reduction in the first cost of building.

The joggling of bulkheads (to save weight) would have that effect, and no other disqualifications worth consideration, but for decks and tank top plating the joggling of the plating, whilst it duly saves weight without reduction in displacement or appreciable reduction in grain space, appears to me to be undesirable on the score of carrying water both on decks and tank tops in the saucer-like depressions of their respective surfaces, and I think I shall not be contradicted when I say that the less water that hangs about the decks and tank tops the better.

Some builders meet such objections entirely by joggling the frames. This method reduces the weight of liners without any corresponding reduction in displacement or grain space; plating is plain throughout and repairing costs normal. If a frame is damaged or cut, it can, of course, be repaired or renewed and liners fitted as ordinarily. In any case—where joggling of the shell plating is quoted or arranged for—I would strongly advocate that the bow plating—to abaft the collision bulkhead—should be plain plated; then, when the inevitable collision *does come*, the cost of repair will not be abnormal—especially if it has to be done abroad. Anything like special sections (such as joggled plating and Z frames) are worth serious consideration for future possibilities of repair—and the same applies to abnormal sizes of shell plating or unusual sections of beams or frames, as in the event of a considerable damage being experienced such material is not to be found anywhere in stock, and rolling mills will not put in special rolls for a small order.

Double Bottom.—This is now built almost universally on the " cellular " principle. The usual practice is to carry water ballast fore and aft—with the frequent exception of " under boilers," and often in way of hold wells. No doubt an open bilge or tank under boilers conduces to less deterioration of the floors, angles and plating in way of the heat, than when subject to the "sweat" of a closed tank, but much depends upon the coating and ventilation of such spaces. The arrangement of bilge wells—as frequently fitted—across the ends of hold spaces seems to me to be undesirable in view of the very small normal drainage in such spaces.

It is generally claimed (or spoken of) that the modern double-bottomed vessel is a safer ship and less liable to total loss by stranding, etc., than a single-plated or open bilge bottom; but unless that double bottom is entire from the collision bulkhead to the after bulkhead any open bilge or well *is* a single bottom space and as likely as any other to be holed—in which case the whole adjacent space is flooded, and if this is the engine space then the ship is rendered quite helpless to assist herself. A ship with an entire inner bottom may rip open her bottom shell plating and still float in safety, but with sections not so protected the danger of "holeing" is serious, and very probably many such a ship has been lost that might—with a continuous double bottom—have been saved.

STEMS.—These are almost invariably now specified as "straight," and the clipper bow and short bowsprit, or the "hook" nose, are rarely seen in the modern tramp steamer. 15 ft. of "anxiety" I have heard to aptly describe the sailing ship bow when built on a steamer. Some builders give a little forward rake to the stem—about 2 ft. at the head—the idea being that in a collision the upper part would suffer most and the lower the least.

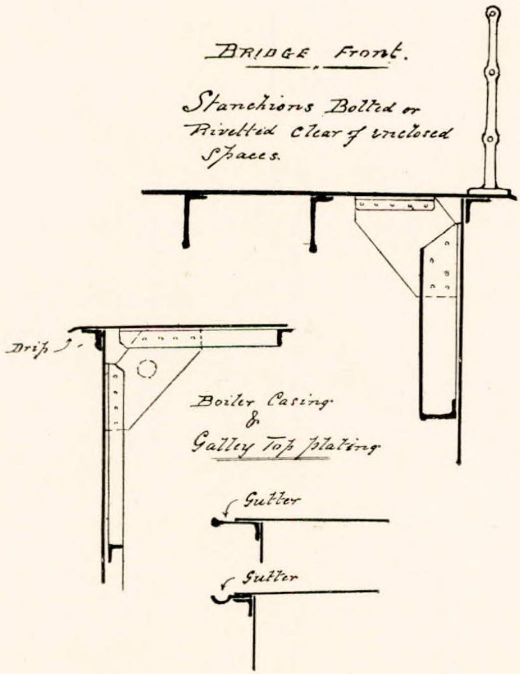
Stem Bars should always, I think, be scarped at the light line, and in large vessels I do not see why two such scarphs should not be fitted to minimize the repair when the inevitable collision or damage to stem comes along. Very frequently a scarph saves the one half of a stem having to be dealt with; it is, however, important that no "tack" rivets are fitted—as sometimes there are—as in that case the plates on each side have to come off to get them out. The scarph is quite sufficiently bound by the through stem riveting, the same as in the case of keel bar scarphs.

STERN POST is now very frequently made of cast steel, but of the advantage of that metal over the older form of wrought iron, there can be no other claim than that of cheaper cost. Of the disadvantages of cast steel versus wrought iron, there are but two important ones, viz.: a greater first cost for wrought iron (although this is not great), and the irreparability of cast steel, as against wrought iron when the former is broken or fractured. Wrought-iron frames, until quite recently, held the field on account of reliability of structure, flaws in welding being rare, and when found ofttimes being reparable in place, or at any rate being temporarily dealt with, either at home or abroad. Cast steel—on the other hand—has been, until quite recently, more or less undependable and subject to the sudden appearance or development of latent or vibratory flaws, in which event there is no alternative than entire renewal; and this, in the case of cast steel, is a matter of time.

I have only to add, in this latter respect, that the casting of steel has in late years very greatly advanced in regard to soundness of castings and their reliability; but were they *in every respect* equal to wrought iron, I would still throw the die in favour of wrought iron, on account of reparability. This brings me to a point I would like to emphasize, viz.: that cast-steel frames are generally made in two pieces, with scarpled joints, and I do not see why wrought-iron frames should not also be made in sections, and especially so in regard to the rudder or "after post." This latter carries the gudgeons or bearings of the rudder, and if same could be easily removable, whether of cast steel or of wrought iron, for reboring purposes, would be very much better for that very much used, much abused and hardly used piece of machinery—The Rudder.

The difficulty and expense of reboring rudder gudgeons in place is such that these are frequently found to be much out of line, and the bushings oval. If a rudder post could be easily unbolted and taken to and bored out in the lathe, a better working rudder and considerable easement on the steam (or hand) gear would be the result. The rudder post, or after post is, after all, nothing more or less than a "hanging post," and provided the sole piece is sufficient to carry the rudder heel thrust, and the rudder stock strong enough to carry its own strain between upper and footstep bearing, the rudder or after post is dispensable, as in warships and other rudder-postless vessels.

BILGE KEELS to the modern flat-bottomed keel-less ships are, I venture to say, indispensable. That plenty of ships are built without them (especially if "spec" ships) is no proof of their uselessness, but of cheapness. Such ships roll badly and are very liable to shift their cargoes. They are also "dirty" ships in bad weather and give everybody on board a very bad time. When dealing with such ships and having fitted bilge keels, say from mast to mast, the captains have invariably declared—after the next voyage—that "it was not like being in the same ship." Bilge keels are fre-



quently put on too small, and their effect is hardly worth the expense. For "two-thirds the length amidships" is a good rule, and just extends (in a full ship) from the beginning of the rounding at each end, viz., for the length of the straight of the bilge. Such keels should be (approximately) the depth, on each side, that the centre or bar keel would be if she had one, viz., about $10\frac{1}{2}$ in. to 11 in. in a 7,000 tonner. There is no fear of a steamer, so fitted, rolling with too quick a motion, and a steady ship in bad weather must get along better than one that is putting her bulwark rails under, and pitching the coal in the stokehold from side to side.

Bilge keels are fitted to the bilge plating, either with an angle or a tee bar. The size in either case would be about 6 in. by 4 in. by ½ in., and the riveting "reeled." I always specify that "the angle (or tee) to stop in way of plate laps or butts, and the bulb plate to be in short lengths (say equal to plate lengths) with double straps at joints." When so fitted any one damaged bilge shell plate can be taken off or renewed with a minimum of disturbance. Fore and after ends of bilge keels should be tapered away for fully 4 to 5 feet and rounded in to the shell plating—not by shearing off the bulb (as I have seen done), but by shearing off the back of the plate and furnacing and setting back the front portion.

It is advisable to keep bilge keels well in to avoid damage from the "batter" of dock and quay walls, and as it is equally desirable to keep them well up, the best position to suit both requirements would seem to be that pointing to the angle formed by the intersection of the perpendicular line at side and the line of rise of floor.

Ballast Tanks in Double Bottoms.—Probably no feature of a modern cargo steamer is so capable of improvement by the shipbuilder as these. In the greater number of steamers the tanks (or some of them) (*a*) are too large, (*b*) badly arranged as to effect upon trim when in or out respectively, (*c*) seldom subdivided, (*d*) slow to fill and empty, and (*e*) difficult to drain.

The usual thing is just four divisions fore and aft, with sometimes a small tank under engines and boilers. This means in a No. 2 tank of a

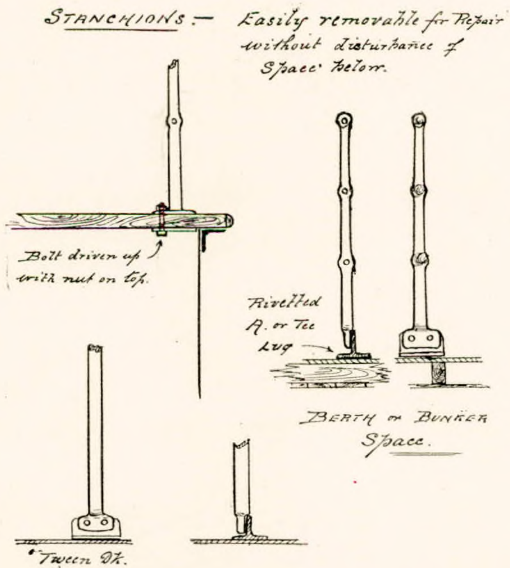
	3,500	tonner	180 to 200	tons of W.B.
in a	4,500	,,	200 to 250	,,
,,	5,000	,,	250 to 350	,,
,,	6,000	,,	300 to 400	,,
,,	7,000	,,	350 to 450	,,
,,	8,000	,,	400 to 500	,,
,,	8,500	,,	450 to 600	,,

depending, of course, upon lengths and beams of respective ships, but these approximate figures are taken from actual plans. The No. 3 hold double bottom and the Nos. 1 and 4 hold tanks usually follow in size in that order.

It is very desirable that no single tank should carry more than (say) 150 to 200 tons. Even 150 tons water weights when slacked back, are causes for anxiety when a heavy deck load is present, or when a ship is "flying" light and upper bunkers contain coal.

By the subdivision of tanks—fore and aft way—a great gain to stability and means of trim from side to side is attained.

I consider that "the double bottom should be subdivided from mast to mast," or, in other words, the keelson plate is watertight and suctions, etc., are in duplicate on the engine and stokehold bulkheads respectively.



This arrangement costs very little extra, as no tank pipes are led through floor spaces, but only an extra tank valve with centre and wing suction at each end of machinery space.

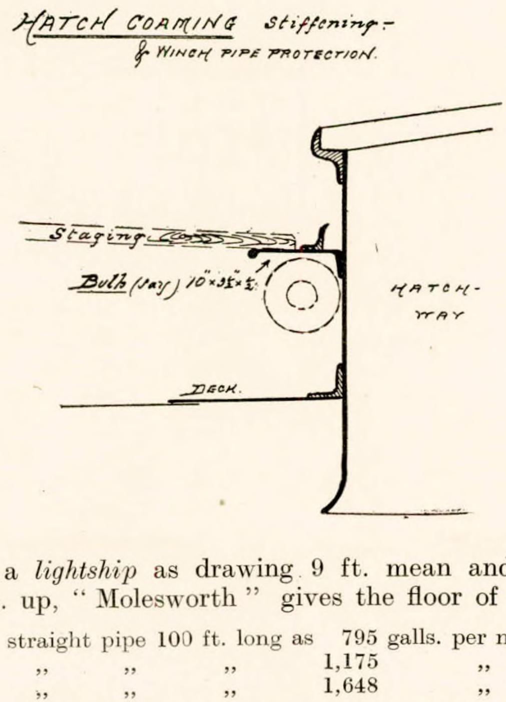
For greater subdivision of the double bottom, in large vessels, I should be inclined to *sub-subdivide* fore and aft, rather than extra tank divisions athwartships, on account of simplifying the suction and filling arrangement and entry and examination of the double bottom afloat and loaded. As it is now usual (and much the best) to bring the Nos. 2 and 3 hold tanks one space into the engine-room, such entry is at all times possible, when the tanks are empty, or it can be kept under (if leaking) by the ballast pump. The after tank or tanks can always be so examined by manholes fitted within the tunnel, and the only tank—in general—that cannot be examined under loaded conditions is the No. 1, and this difficulty I have got over by fitting two manholes (one on each side the centre keelson) with W.T. bolted plate covers, at the *bottom of the collision bulkhead* and accessible from the bottom of the fore peak. Needless to say, it is important that the studs and nuts are on the *fore* side and not *inside* the No. 1 tank.

For accessibility and examination of tanks the manholes in floor spaces are very often small and their edges very rough. The manholes in tank top are frequently as far apart as twenty spaces = 40 ft. There are often no means of getting from one side to the other of the centre keelson plate, and manholes are sometimes found under pipe lines, stools or girders where entry is impossible. For easy access to the double bottom manhole doors should not be (approximately) more than 10 to 12 spaces apart fore and aftway—size, say, 18 in. by 14 in., and in duplicate P. and S. The minimum openings in floors should be as nearly as possible 24 in. by 18 in., and if larger so much the better.

Tank Filling and Suction Pipes.—These are—too frequently—very small and often inadequate, especially to the after peaks. It is not reasonable in a modern up-to-date cargo steamer that it should take *more* than (say) eight hours—a working day—to either fill or empty the tanks. . . . This time need not include draining, which depends upon the trim of ship, but to get the gross weight out, say to pass a harbour bar, a docksill, or to enter a dry dock.

Any sea-going engineer here will bear me out that 4 to 6 hours is frequently necessary to fill or drain one single tank, and I have known 8 to 10 hours required for a large after peak of 130 tons, due to nothing else than a badly arranged 2 in. pipe through the tunnel. The smaller the pipe is, the more quickly and more permanently it becomes corroded up, for the larger pipes seem to cast off their oxidation from time to time—probably due to the action of various river waters—or, at any rate, are capable of being cleared by hammering and sponging.

Lloyd's rules only specify for the *minimum* size of centre or wing suctions up to 3½ in. diameter, but without any regard as to *size* of double bottom space or quantity of water to be dealt with. For my own guidance when drawing out a specification, I take a *minimum* of 3 in. diameter for any bilge or tank pipe (whether centre or wing) throughout a ship of the size I am stating up to 50 tons of W.B., and for centre suctions ½ in. extra diameter per extra 50 tons—or substantial part of 50 tons, and for wings 3 in. up to 100 tons and ½ in. extra diameter per 100 tons (or substantial part of 100 tons) extra. This gives for (say) a No. 2 single tank of 250 tons, a centre suction of 5 in. diameter = area 19·635 □ and 2 wings of 3½ in. diameter = areas 19·25 □ ; total 38·88 area ; equal to a main tank pipe of 7 in. diameter.



Taking a *lightship* as drawing 9 ft. mean and the tank valve 2 ft. up, "Molesworth" gives the floor of water in a

6 in. straight pipe	100 ft. long as			795 galls.	per min.
7	,,	,,	,,	1,175	,,
8	,,	,,	,,	1,648	,,

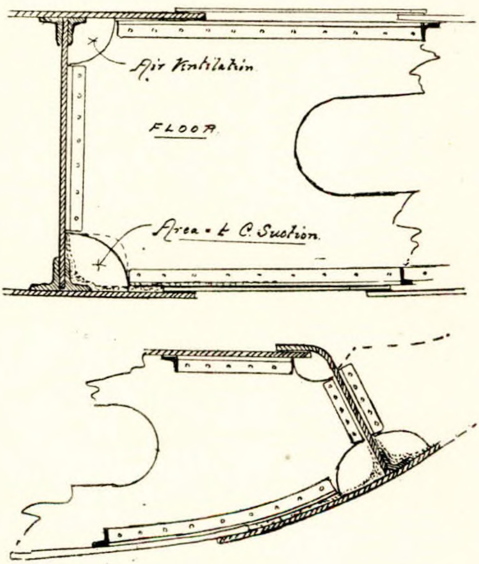
These equal 212,315 and 440 tons per hour respectively, and the size of tank pipe governs the number of tanks that may be filled at one and the same time, whilst the size of ballast pump or pumps governs the output.

From these quantities I should deduct (say) one half for bends, angles, valve boxes, etc., leaving for 6 in., 7 in. and 8 in.—106, 157, 220 tons respectively.

A duplex pump for low service will discharge approximately as follows :—

Suct.		Disch.		Cyl.		Pump.		Stroke.		Tons p.h.
$4\frac{1}{2}$	..	4	..	6	×	6	×	6	=	50
5	..	$4\frac{1}{2}$	..	7	×	7	×	8	=	75
$6\frac{1}{2}$	..	6	..	8	×	8	×	8	=	110
7	..	6	..	8	×	9	×	8	=	130
8	..	8	..	9	×	10	×	10	=	170
8	..	8	..	9	×	11	×	10	=	200

AIR & WATER CHANNELS in FLOORS of
DOUBLE BOTTOMS



A 7 in. tank pipe and ballast pump suction therefore would fill or discharge (approximately) 1,000 to 1,200 tons W.B. in 8 to 9 hours, which, for the purpose of my remarks is sufficiently near to practice.

As illustrating my point further I asked a firm a little while ago if they had any data *re* tank suctions, etc., and this was their reply :—

"We have very little reliable data as to the pumping of ballast tanks, etc., as this is a matter upon which we have very few opportunities of getting any figures. We had a pumping test about a year ago on a large steamer, the following being the ballast tank capacities :—

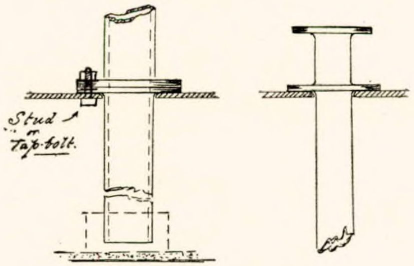
No. 2 tank	353
No. 3 tank	261
No. 4 tank	218
No. 5 tank	52
No. 6 tank	131
Fore-Peak tank	458
After-Peak tank	199
	1,672

"The main ballast suction in this case was 8 *in. bore.* The whole of this ballast was to be discharged in *six hours* (exclusive of draining), and for this purpose we fitted—

1 Rotary ballast pump 11 ft. 9 in. by 10 ft.

1 Duplex ballast pump 10 in. by 12 in. by 10 in.

These pumps are rated at 100 and 200 tons respectively."



SUCTION PIPES thro. TANK TOPS.

I am convinced that a large amount of donkeyman's overtime and extra cost in coal is incurred by small tank suctions and ballast pumps—leading frequently as it does to continuous working to get out the water ballast in time for completion of coal and other rapidly loaded cargoes. For above 1,000 tons water ballast two ballast pumps should be fitted, capable of pumping from forward and aft respectively. If two sea inlets are fitted, then any tank forward or aft can be filled or emptied at the same time if an alteration in trim is required quickly. Also by a separate connexion an after tank can be pumped direct to a forward tank and vice versa—

all of which such arrangements come to be very useful and oftentimes conduce to despatch in the life of a modern ship.

TANK SUCTION.—Drop pipes are usually fitted internally, and through-bolted with the connecting pipe above or on the other side. This arrangement necessitates two men to make a joint (one inside the tank) and the pumping out and entrance made to a suction space to effect clearance or repair. A better way, and a cheaper to fit in the first instance, is to cut the hole the full diameter of the *outside* of the pipe and let the joint be outside, viz., on the underside of the flange, and the next pipe to joint on face of same. This permits withdrawal of a suction pipe with a full tank.

TANK DRAINAGE.—I am persuaded that much of the deficiency in cargo deadweight (which varies mysteriously) is frequently due to the inadequate arrangements for effective drainage of ballast tanks. In most vessels the floors abut against the centre keelson plate, and the only means of drainage below the manhole opening is—generally—a 2 in. hole at the lower corner of the plate, and a $\frac{3}{4}$ in. or $\frac{7}{8}$ in. hole through the angle near the centre keelson. This lower drain hole is a rough hole, and is easily choked by waste wood or pieces of cement.

I have known cases—when under survey or repair—that double bottom tank spaces have been found full of water up to the manholes—sometimes in twelve to twenty spaces, and probably accounting for 25 to 30 tons of cargo. Yet the sounding rod would not detect this, as it is generally in the after end.

A ship with a very flat floor, when on even keel (or especially if a little by the head) cannot possibly be pumped out, with small drain holes, to less than $1\frac{1}{2}$ in. to 2 in. of water, and this would represent many tons of actual weight throughout the double bottom of a large vessel. Rise of floor should be at least 9 in. to ensure sufficient removal of the water ballast, and floors should be made to give ample air and water passage at the respective corners.

RUDDERS.—One need not refer to types of these ; the single plate built rudder holds the field and needs no comment. As to the merits or demerits of cast-steel versus wrought-iron rudder frames—they each have their advocates—but I can only conceive a preference being given to the former on account of lesser first cost. In my experience I have seen several cast-steel frames renewed in wrought-iron, but never vice versa. The insidious cracks which so frequently develop in cast-steel frames are non-reparable, but a broken wrought-iron frame can be dealt with at the forge—at home or abroad. A broken cast-steel frame means a new one, and that is a serious matter in point of time.

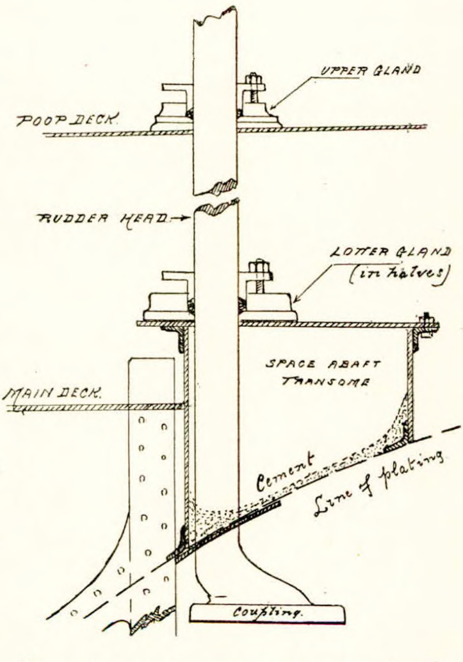
RUDDER HEADS are all the better for $\frac{1}{2}$ in. extra diameter over rule to guard against excessive wear in way of the gland, and also permits of the rudder area being increased if found necessary, or desirable, at a later date, which is not possible with a rule diameter head—as I found out not very long ago, when, after having had a 6 in. strip riveted on the back of the rudder of a bad steering ship, an energetic and courteous classification surveyor showed me the urgency of taking it off again.

RUDDER TRUNKS are a costly piece of flanging, very confining to the shipment or unshipment of a rudder and liable to leakage. A better and cheaper way is to fit a water-tight intercostal plate about 24 in. abaft the transome frame in the centre cant frame space, and plate over the top. A water-tight packed gland (which should be in halves) then completes the job: the hole in this covering plate should be oval to permit the rudder—when dropped down—to be withdrawn at an angle. The upper deck (poop) gland beneath the quadrant is required as usual.

RUDDER PINTLES AND BUSHINGS.—These are a source of continual wear and expense, as usually fitted. Iron pintles and iron bushes (or both steel, as most probably they generally are) are the most common type of fitting and corrode and wear rapidly. Lignum vitæ bushes are often fitted in conjunction with brass-sleeved pintles, but soon wear out; Brass bushes and brass-sleeved pintles run well if thick and with plenty of surface, but in the presence of sandy water soon grind away. The inverted bush is a good principle, and permits of rebushing the upper gudgeons without lifting the rudder, but if the bottom pintle is done the same it means a special form of after sole piece and provision for carrying the weight of the rudder other than a footstep.

The last ship I had to rebush and fit new pintles throughout I took the advice of the repairers (who had recently done a job that way—at, I believe, the superintendent's order) and fitted all new solid cone-bottomed bushes of wrought iron, and cone-ended pintles to suit. Each pintle was a bearing pintle—five in all—and so fitted, the rudder cannot work sideways. This vessel has not yet returned from an Australian voyage, and I cannot report upon same!

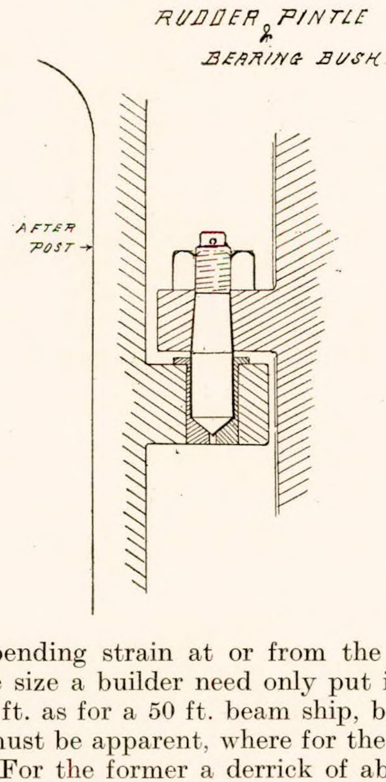
In the old days of the hand tiller, and later of the after hand-steering gear, it was no doubt necessary for the rudder to be pivoted and to work as easily as possible, but in these days of steam gear it seems unreasonable to carry the weight of an iron rudder—say, 6 to 7 tons—on a bottom pintle of



(say) $3\frac{1}{2}$ in. diameter; the consequence is the wear down of the rudder in a few months. My own practice is to fit a wrought-iron solid washer ($\frac{5}{8}$ in. to $\frac{3}{4}$ in. thick) between the gudgeon and brace of alternative pintles, and carry the weight of the rudder on these thrust collars.

Masts for carrying sails, or as mere signalling poles, are altogether apart from and cannot be compared with, the "posts" required for carrying, loading and discharging gear. Lloyd's rules only give sizes and scantlings in relation to length, viz., from cap to keelson Taking the Manchester

Ship Canal bridges as 70 ft. of maximum height above light load line + a light load line of 12 ft. minus (say) 4 ft. depth of double bottom, and we arrive at a rule length of 78 ft., which gives a diameter at deck of 26 in., heel 20 in. and head $17\frac{1}{2}$ in. diameter, and a thickness (at deck) of $\frac{8}{20}$ in. only, and in a rule-built vessel we get masts insufficient in strength for the hoisting in and out of weights at the end of derricks. Obviously, the broader the vessel's beam the longer must be the derricks to put a load over side, and the greater the



leverage and bending strain at or from the masthead. By taking the rule size a builder need only put in the same diameter for a 40 ft. as for a 50 ft. beam ship, but the weakness for the latter must be apparent, where for the former it might be sufficient. For the former a derrick of about 35 ft. to 36 ft. would plumb the ship side at Nos. 2 and 3 hatches, but for the latter a length nearer 44 ft. to 45 ft. would be necessary. A modern vessel is expected to easily handle 5 to 6 tons, and even up to 10 tons is frequently named in charters.

The staying of masts, too, or the *rigging* is not such as one would stay a derrick post ashore. The usual three shrouds on each side of $3\frac{1}{2}$ in. rigging wire, together with a fore and main stay (both in the way of the swing of derrick head) leaves much to be desired. I have frequently watched the masts when discharging iron ore and log timber, and the strain and vibration at the masthead is, in many cases, quite alarming.

Masts are sometimes found to be stepped upon a single beam and with only a $3\frac{1}{2}$ in. round stanchion beneath for support. I had two such vessels to deal with not long ago, the beam being set down $1\frac{1}{2}$ in. I have no idea as to the "down" strain due to the setting up of rigging, but it must be several tons (say, 25 to 30 tons). In a sailing ship of square rig, the weight of mast and gear would be (approximately) 25 tons, and the pressure on step due to setting up of standing rigging about 60 tons—a total of (say) 85 tons.

In some recent specifications I have made the size for masts at the deck (for vessels of 5,000 to 8,000 tons) having beams of 48 to 52 ft., to be equal to $\frac{1}{2}$ in. diameter per foot of beam + 4 in., and proportionate to rule at heel and head, etc., and scantlings as for iron, although built of steel. This gives for a 48 ft. beam a 28 in. mast, which looks, and is, none too heavy. This gives $\frac{1}{2}$ in. plating of the deck and is little enough where double derricks are fitted both on forward and after sides. It will be noted, by referring to Lloyd's Table 9, that a 28 in. mast secures its being built with longitudinal angles—a great gain in resistance to bending or buckling. Personally, except for the conservation of appearance, I do not see why masts should not be even larger in diameter and made to be up-cast ventilators for the holds—with proper provision to protect against rain getting in when rolling to an angle.

A great departure from the *mast* (as hitherto understood) is the heavy derrick posts and lattice girder tie adopted recently in some steamers, notably in the Holt Line steamers of Liverpool, which all goes—and none too soon—to break away from the old sailing ship style.

DERRICK POSTS are generally too short to give the necessary lead for a derrick topping lift or span, and too small to lift a substantial weight. They want to be quite 28 to 30 ft. high and 24 in. diameter at the deck, to carry a 10 to 11 in. derrick and lift ordinary cargo.

Rigging for Cargo Steamers.—For the support of a 28 in. mast I have adopted, in recent vessels, the staying as follows—with the masts perpendicular to the keel—2 = $3\frac{1}{2}$ in. wire shrouds or standing rigging on each side of each mast, spread 4 ft. to 4 ft. 6 in. at the deck and shackled singly at the masthead band. These are "rattled" down respectively with iron bars or American elm rails, wire-bound to the two shrouds; a pair of wing shrouds or stays (also on each side) spaced as wide apart as the outward swing of the derricks permit—about 24 ft. apart at the deck—of $4\frac{1}{2}$ in. wire. This gives a strong and nearly foursquare staying to each mast. These wing shrouds are separately shackled to a second masthead band—independent of the standing rigging bands, and so doubling the security against accident. The usual fore and main stay are fitted to carry stay-sails if required, but these can be safely let go and the derricks allowed to work across the ship if required. All stays set up with extra strong rigging screws. The wire rigging only served 12 ft. up and 6 ft. down, so permitting of examination of the wires—which, if carefully and properly treated, will not take any harm. With such staying and proportionate fittings there need be little fear of accident to masts.

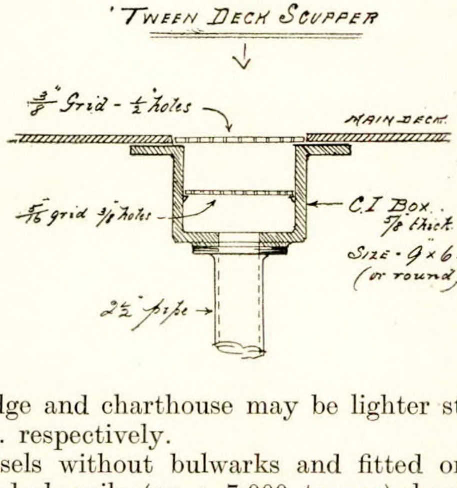
It is not sufficient to rig a mast for a maximum dead load of stated weight, for whilst a heavy piece of timber may not weigh over 4 tons, yet the strain in "breaking out" such cargo is quite beyond calculation, and will frequently carry away a $2\frac{1}{2}$ in. wire runner—the breaking strain of which would be fully 12 to 15 tons, and, to that extent at any rate, the mast derrick and gear has (if even for a moment) been undoubtedly subject.

Bar Rails.—These are details which are worth some consideration, as the method of fitting, their height, strength and rigidity, greatly affect after service and repairs.

The Board of Trade rule for the minimum height of rails on passenger steamers is 3 ft. 3 in. above top of deck, and the lower or between rails to be so spaced that there is no danger of falling through, viz., about 9 in. In the case of cargo vessels I know of no such rule, and height will be found down to 2 ft. 8 in. Personally, I consider that 3 ft. is a good standard of height and ample.

Two lower or intermediate rails on forecastle, poop and bridge, and one on upper and flying bridges and charthouse (if fitted with weather cloths)—viz., two and three rails respectively—seems to be the usual thing and is sufficient. Diameters of bar rails differ with various builders—but a $1\frac{1}{8}$ in. solid top rail on poop bridge and forecastle, with lower rails of $\frac{7}{8}$ in. and on upper bridge a top rail of 1 in. and lower of $\frac{3}{4}$ in. is a good standard, without being either too heavy or too light.

The stanchions and their spacing are important to the general strength of bulwark rails, and especially so on the bridge amidships, where boards are frequently lined on the inside and bunker coal carried on deck, in summer time. For the strength of bars I have given, stanchions are approximately $1\frac{1}{2}$ in. at top and 2 in. at the lower part on poop bridge and forecastle, and $1\frac{3}{8}$ in. and $1\frac{7}{8}$ in. on upper bridge, whilst a



flying bridge and charthouse may be lighter still, say, $1\frac{1}{4}$ in. and $1\frac{3}{4}$ in. respectively.

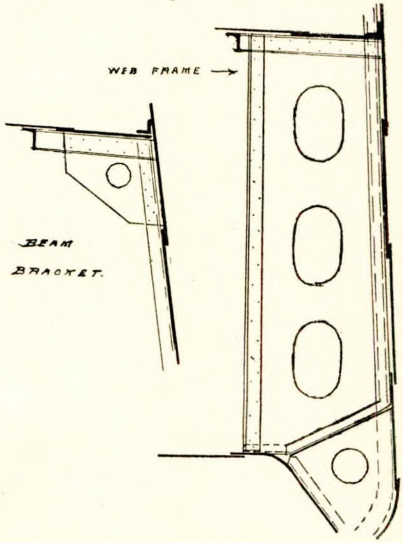
For vessels without bulwarks and fitted only with rails, the main deck rails (on a 7,000 tonner) should not be less than $1\frac{1}{4}$ in. top and 1 in. lower, and stanchions $1\frac{5}{8}$ in. at top and $2\frac{1}{8}$ in. at bottom. Spacing of stanchions should not be less than 3 ft. 6 in., nor wider apart than 4 ft. It is important that the feet of stanchions should be strong and well adapted for the deck they are to stand upon, and whether four or three or two rivets or bolts. Their varying forms of square, triangular or oblong depends upon space and position. Upon wood decks or wherever bolts are used, I always specify that the bolts are to be driven up from underdeck, and the nuts on top of foot. This enables a leaky stanchion foot to be rejointed or repairs to rails and stanchions carried out when spaces below are filled with cargo, or are lined—as in the case of berths, saloon, etc.

Rails are usually wedged up in, or caulked in way of line stanchions, and lightly riveted over at the end stanchions. Any through drilling and pinning is to be deprecated on account of any future repairs or renewals. The butts of rods are very generally arranged to come in way of a stanchion ball, but unless carefully divided off the shallower rod is very liable to draw out when bent. For butts between stanchions a usual plan is a pipe ferrule drilled and through-pinned, but as a rule they are fitted too short and too slack. I think that four diameters is little enough for length of a rail ferrule. A neat arrangement is (where diameters suit) to screw the ends gas thread and run on a running joint steam pipe socket. This requires no caulking or pinning. Iron piping is freely used in light draught vessels—but to be equal in strength to solid bar requires to be approximately equal in bore to the diameter of a solid bar.

SCUPPERS.—On weather decks. The cutting of the gunwale angle bar is a poor job and conducive to leakage, and if leaking is very difficult to caulk properly. The flanging of a scupper in the deck angle bar, and the retention of its continuity is a better job than the above, but the water cannot drain right away to less than the thickness of the bottom flange. Much the best weather deck scupper is the underdeck or Collinson type, permitting the draining away of all water. Also, in the case of shelter deck or other spaces exempted from the tonnage measurement, such scuppers are easily and effectively closed—when carrying dry or other cargoes—by a cast-iron button or lid, and crossbar dog and through bolt.

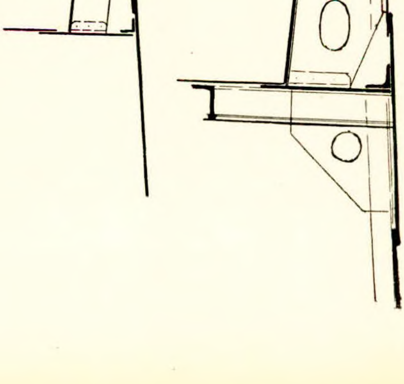
'TWEEN DECK SCUPPERS.—These are generally most ineffective and easily choked—being lead pipes of small area with a brass rose placed on the deck with a few $\frac{1}{8}$ in. holes in same. For a shelter decker with 'tween decks specially arranged for horses, I had special cast-iron hat boxes made which were approved and favourably commented upon by the transport inspector. It had the merit of giving large surface—of draining absolutely all water off the deck, and permitting of raking over to clear away straw, etc. The lower or internal grid is to catch the refuse which passes the

LIGHTENING of STRUCTURE.



upper or coarser grid. Both are easily lifted, cleaned and replaced. Other shapes and sizes would, of course, commend themselves on similar lines.

LIGHTENING of STRUCTURE.



HAWSE PIPES.—These, as usually fitted, are a compromise between a lead for the chain and to facilitate the "stowing" or "housing" of stockless anchors, and are a bad lead—at the top—for the cable to the windlass, resulting in the cover plate and upper end of the pipe being quickly cut through with consequent leakage into the forecastle spaces. A "steep" pipe is necessary so that the anchor shank hauls in, but a good roller—with chain groove—would suggest a remedy for the excessive "nip" at the windlass lead and greatly ease the strain on the engine. I have never seen any such roller sheave, but a rough sketch will illustrate my meaning.

Double hawse pipes, as sometimes seen on old vessels, are most convenient for mooring to buoys, as the anchor can be secured in its own pipe, and the unshackled cable put down the smaller pipe. I have seen a hawse pipe fitted right aft, with a stockless stream anchor "housed" in same, with a special drum in the after winch, and a screw stopper for heaving on or holding the wire hawser. It commends itself as a very useful fitment for vessels trading in narrow waters (where grounding is often almost unavoidable) as being quickly available for laying out the stream anchor. Also for a "drag" aft. Both the former and the latter are especially suitable for vessels mooring to berths between buoys.

LIGHTENING OF STRUCTURE.—It seems to me that instead of devoting considerable ingenuity to the reduction of scantling in a hull, the ship-draughtsman might to a considerable extent follow the structural steel and bridge builders' designs in regard to lightening floors, webbs, stringers and brackets, and thickness in lieu of width. For after all the main object and the end of a ship is to make profit for her owner or owners, and hold obstructions are a loss of convenience to loading and discharging; and where two methods can be submitted, the one with the least obstruction is the best. I would rather have a webb frame 36 in. wide by 1 in. thick, than one 72 in. wide by $\frac{1}{2}$ in. thick (supposing same was equally acceptable for classification), and, apart from actual width, I would rather have a $\frac{3}{4}$ in. thick bracket, lightened by punching to the weight of $\frac{1}{2}$ in. bracket, on the score of corrosive waste—for I am very much persuaded that light scantlings corrode and waste away more than thicker ones, due, I think, to the extra vibration in thin material over that of thick. Beam brackets might be lightened, without reducing strength, by punching (say) 3 in. to 4 in. holes in same; webbs by punching in manholes (as in floors); and bulwark bulb stanchions by 2 in. to $2\frac{1}{2}$ in. holes. All of which holes or orifices would conduce to better ventilation and the trimming of cargoes —especially for grain—and might, I think, reduce in some degree the weight of hull, such holes and lightenings conducing to ease of erecting staging in holds, for lashing or shackle eyes, and generally for convenience in working the ship and cargo.

CLEAR DECKS.—I should like to make an observation regarding the desirability and easy possibility of clear decks "from or between erections, and from hatch sides to bulwark rails or stanchion." Clear decks are indispensable for the carrying of deck loads of timber, and for cattle or transports. One not infrequently finds hold ventilators and "stand-up" air pipe—not to speak of wire rope winches and mooring bollards—placed right in the fairway of clear decks, and dead in the passageway of access from forward to aft or vice versa. Such obstructions are indefensible from any point of view, and can only be excused on the ground of lack of thought on the junior draughtsman's part, or inattention on the surveyors' or superintendent's part.

VENTILATION.—I think one could write a paper to itself on this interesting subject. To a steel structure such as a ship, plying as it does upon water and subject to the damp of sea air and the sweat due to varying conditions of temperature, ventilation is most important and vital to a ship's structure. I will not refer here to Board of Trade rules and requirements on account of crew accommodation and the ventilation due to gaseous and other cargoes, but only as it concerns the ship herself. All unventilated spaces engender sweat and foul air, both of which are very detrimental to iron and steel, and the latter more particularly. Go down into unventilated lower peaks, lower bunkers, tank spaces, under boilers, and the unventilated bilge spaces at sides of holds, and there you will see the abnormal deterioration, due to vitiated air and clammy unwholesome atmosphere. Paint seems to have little protective power in such spaces; nor does cement wash seem to be any more effective where the conditions are all in favour of decay, for iron and steel, like life itself, cannot withstand the ravages of unwholesome surroundings.

Water ballast tanks, and similar spaces subject to frequent flooding, do not come under my category in this respect, for fresh or sea water is in itself aerated, and carries and brings with itself freshness and life which does not seem to greatly affect steel and iron ; as witness the life and little deterioration in the cellular double bottom tanks of a ship.

SAILS.—These have so far become a rarity on the modern ocean tramp steamer, and, indeed, also on the faster lines, that the view seems general that they are of no use on self-propelled vessels. Yet, I think it is a pity they have so easily become more or less obsolete, for sails (when set), steady a ship a good deal, and any sea-going engineer will testify to the easement upon the engines when the " fore and afters " are set, with a good beam or following wind. When in ballast trim or " flying light," it is often a difficult matter to keep a *full* ship to a strong head wind, and the setting of a main sail has helped many a steamer to keep her course or successfully work away from a lee shore. On the whole, I think a suit of good sails should be retained as the equipment of a steamer.

STANDARDIZATION.—We are indebted to Lloyd's and the other classification societies' rules, for a comparative standard for a ship's hull of the ordinary mercantile class, as also for many of its details, but there is room for more of these, either as rules or as recommendations. For one cannot ignore the fact that such rules as are now embodied in classification scantlings, have become an established market commodity or factor ; and an owner buys a new vessel, classed to such a standard, believing he (or they) is getting an all-round good thing. As illustrating my point, I would mention that prior to about 1902 there was no rule scantling for steering rods and chains, and in three vessels of over 7,000 D.W., built just prior to the rules now in force, the chains were $1\frac{1}{8}$ in. and the rods $1\frac{1}{8}$ in. These have all had to be renewed to as large a diameter as the quadrant grooves and chain leads would permit. The present rules require $1\frac{3}{8}$ in. chains and $1\frac{5}{8}$ in. rods for similar ships, showing conclusively that a " standard " is not only desirable but necessary for the working details of a modern cargo ship ; and the more such details are brought to an efficient and common denominator, the less will be the divergent quotations of respective builders upon the same general specification.

I venture to say, that if Lloyd's, and other classification societies, issued a list of "recommended" extra scantlings, diameters, etc., as distinct from actual minimum requirements, that many owners would include "the recommendations" of such societies in their inquiries, and the outcome would undoubtedly be a better ship. Lloyd's and the others now exercise so mighty an influence, and, I might say, a beneficent one, upon the structure of ocean-going craft, that the owner or purchaser of a single craft, or the foreigner (either or both very probably without a special technical adviser) are safe, in regard to the main structure, in purchasing to such a standard from any reputable builder; yet are they, at present, without due protection in regard to such important details as masts for cargo work, derricks and fittings for handling cargoes, minimum water ballast for unloaded conditions, and for the pipes in connexion with same, and other items of convenience to the working of the ship.

CHAIRMAN: You will agree with me that Mr. Lang has given us a very interesting paper. I find that papers have been read previously at the Institute, one by Mr. Adamson in 1900, on "Sea-borne Traffic," and another by Mr. Aisbitt in 1897, dealing with "Shipbuilding, Ancient and Modern," to these Mr. Lang's will add a very good supplement. The subject is now open for discussion.

Mr. F. M. TIMPSON: Mr. Lang has stated many points of interest; that as to the obstruction caused by the upper structures deserves to be emphasized, in many cases the area of resistance is increased, yet the same speed is expected. In high-speed vessels efforts are made to avoid windage, but in many ships a great amount of power is lost through the resistance of upper structures. The ordinary hawse-pipe arrangement is equal to a heavy weight dragged up an inclined plane, and I do not see why a system of rollers should not be adopted. The stanchions and other obstructions one sees in 'tween decks of the ordinary cargo-boat, and which make the handling of cargo more difficult, might be better disposed in many cases. Would not the "girder" system of construction obviate this difficulty?

Mr. JAS. HOWIE (Member): I also would like to thank the author for the paper he has given. It is certainly very substantial and very much detailed, yet not so bulky as some specifications, which require a special staff to analyse and another to carry them out. A good many of the points are, indeed, carried out by first-class builders at the present time, and some of those economical ideas that he has given us to-night must be largely the result of experience. There has been a great deal of improvement of late years, as far as the " cutting down " question is concerned. Probably that has been due to specifications drawn up by those who require vessels to start in first-class condition. I do not think the author is at all extravagant in his figures as to what is required, especially in regard to ballast and bilge pump work, and work of that description, nor is he extravagant as to the sizes of tank pipes, because large pipes are common at the present time, and are rather an increase upon those cited ; if the author is trying to make this common ground, and bring the majority of builders up to this standard, he is aiming at good work. In regard to accommodation, I was surprised when on a vessel belonging to the Anglo-American Oil Co., at Purfleet, to see the good accommodation provided for the crew, and also on one of the steamers of our Past-President, Mr. Corry. Still, the accommodation on a good many vessels could be improved, but there is no doubt a general agreement on this subject with most shipowners. Yet the superintendent may not be quite strong enough in insisting upon improvements. He may be in sympathy and yet hesitate somewhat in putting expense to the owner by advocating certain rules in regard to this matter. The windage question has a great effect upon the vessel's speed, although some say the wind effect is not appreciable. I do not think it would be a great trouble to put an angular bridge on the upper deck, as possibly it would be cheaper ; it would not upset the arrangement of the vessel generally, and the windage resistance would be reduced, as the angle of incidence would thereby be very much less.

Mr. J. H. FERGUSON. I would like to ask the author what are his views upon the design of ballast tanks ; some vessels are fitted with them above the water-line. One sees various small details which it may be well to mention in connexion with a paper of this kind. For instance, there is the arrangement of sounding pipes. I have seen them put in so that in the course of a few years, if the carpenter has been assiduous in his duties, the sounding rod goes right through the tank and a leak results, which is not found until the cargo is damaged. In one case, the sounding rod went right through the bottom of the ship, and the cause of the leak was not found until the ship arrived in port. Again, I have seen the tank suction pipe fitted and put into the next tank through the one hole. It was fitted in No. 1 hole, then through No. 2 hole, and through one of the floor plates into the water-tight bulkhead. Of course, that meant the man had to go down into the tank to make the joint against the watertight bulkhead also, and the result was he had very great difficulty in getting out again.

Mr. John McLaren: We are indebted to Mr. Lang for bringing forward such a very able paper. When he started I was led to understand that he was approaching the subject from the engineer's side. He has not told us about the engines, however, but has rather dealt with what comes under the scope of the naval architect. I endorse his views as to strengthening all round the corners of hatches, usually the weak parts in a tramp ship; and also aft of the engines, and just behind No. 2 hatch, I have seen that part cracked right through. I can sympathize with any one dealing with the subject of bilge suctions on some tramp steamers. In one instance I had to deal with a case where the same line of piping was used for pumping out of the tanks and also out of the after bilges. There was an arrangement by which a cock could be shifted on to the bilges or the tanks as desired. That I condemned, but it was passed, and the ship is sailing yet wth the same arrangement. Things of that kind are done simply for the sake of cheapness. Then for pumping out the fresh-water tanks they had a little valve, $1\frac{1}{2}$ in., fitted to the bottom of the suction pipe. On the first voyage this choked up, and they could neither get fresh water out or into it, with the ship at sea. Mr. Lang referred to making joints; in this case they had the flanges bolted on to the bulkhead, one flange on each side, and that arrangement gave trouble right through the voyage. The engine seating is very often a weak part, and when ships are "built by the mile and cut off by the yard," it is such weak points we want to discuss. I would like to hear more about the engines. Many defects are due simply to cheap shoddy materials, and I put it down that the shipowner gets what he pays for. Very often, when a new ship is being quoted for, the cheapest man gets it, but the buyer has to pay for his bargain in many ways afterwards.

Mr. J. H. Redman : The author referred to the disadvantage of drainage wells in the bilges as spoiling the continuity. Would it not be an advantage to fit double bulkheads to avoid the danger of two holds being flooded. They could be used for ballast tanks and also fresh-water tanks. He also referred to the use of tack rivets as not being advisable for the stem scarph. I believe these are usually insisted upon by the classification surveyors or superintendents, and even when fitting new stems, tacks have been insisted upon. With regard to the holes in the floors, 24 in. by 18 in. would not allow of much comfort in getting through. The author also refers to cast-iron stern frame, should this not be of steel—the rudder frame ?

Mr. Lang : Cast steel, certainly.

Mr. Redman. In the sketch handed round, showing the position of the pipes on deck, I think this construction would form a fine rest for staging, but it would be inconvenient for getting across the decks, the pipes being rather high up for getting over.

Mr. Veysey Lang : I thank you for your kind reception of my paper, but you will quite understand my difficulty ; there is so much in the subject. When I started, I began with the ordinary builders' specification, the shortest I could get—and I thought I would just sketch it out on those lines—putting down my views in conjunction with each class—but I very soon found that inexpedient. Many points I have not been able to touch upon at all, and when I had drafted the paper I found I had material enough to go on writing, on the same lines, two or three times as much. I will try to follow roughly what has been mentioned.

With regard to hawse pipes, as Mr. Timpson says, it is strange that they have not been improved upon. I do not see why a pipe should not be in two pieces, as shown in my sketch. There are certain things one would like to do if the ship were one's own, but one does not like to do them on behalf of other people. As regards stanchions in the holds, ships now, I think, are more usually specified to be built without stanchions than formerly. Of course, if a ship is wanted for the grain trade or the Black Sea trade, the lighter hull the better, and the lightest ship is the one with the greatest number of round pillars, because that means the cheapest form of hull to Lloyd's scantlings. But now the fore and aft girder is becoming a common way of supporting the superstructure. The depth of the girder varies according to the size of the ship and the spacing of the beams. Pillars are frequently placed at each corner of the hatch. A good many ships are built with a continuous girder fore and aft, although there are one or two pillars in the holds of most ships. No doubt clear holds are very useful. In some types of ships there is absolutely clear hold fore and aft. These holds were practically as long as the ship; that is to say, the length of the hatch is only determined by the requirements of deck space for the winches. The hatchway in one ship I saw was 58 ft. long—in fact, the ship was open—in other words, it was a barge; a splendid ship for timber. With regard to the double bottom tank, of course, the double bottom naturally lends itself to be the easiest space to put water ballast in. In a large ship, or where more water ballast is required, say for the Atlantic trade, the deep tank is very much in vogue; but it cannot be favourably used for cargo, and in some cases it is even objected to for grain. As regards making a double bulkhead, of course, the chief point against the double bulkhead is the expense. With regard to standardization, I do not know that I have ever seen much tendency towards that end, although it is a thing in every way desirable in connexion with details. It is easy to standardize a lot of things on board a vessel. Of course, one important subject is that of deck machinery, and the deck winch is about the worst treated piece of machinery there is. As regards accommodation, all who have been at sea are unanimous on the point that they ought to have good berths. Now I must say that in these days there is a good class of men at sea, and the better the class the better accommodation is wanted, accommodation that a respectable man could take a delight in. The trouble with double berths for an officer, or engineer especially, is, that he might have a bad companion. I have had a bad companion in my time, and it was not nice to be in his company. A man ought, I think, to have a berth to himself; it can be done quite well in a new ship, and as regards the crew, I do not think that owners themselves can be blamed for insufficient crew accommodation. My opinion is that the builders do not arrange the details always to the best advantage; in most cases it simply means that the Board of Trade rules for accommodation (which are really the minimum) are made the standard practice. "To Board of Trade accommodation" is, of course, the bare thing; but owners, I always find, are anxious to make their people as reasonably comfortable as possible, and I think the fault lies a great deal with custom and practice. Personally, I think if the accommodation on ships had been better in the past, a better race of sea-going men would have grown up; but the accommodation generally has been such, that respectable men, in the majority of cases, would rather stay ashore than go to sea. With regard to windage, I have never seen any particulars on this subject or any results of tests, but I really think it has a big effect. Only last week I was crossing from Liverpool to Birkenhead and looked at a big liner, and the whole front of that ship was one huge mainsail. It must have an enormous effect. Why do ships with a head wind drop from 8½ knots to 6½ knots? It is not merely due to the sea, it is due also to the wind! A remark was made with reference to sounding pipes, and there was something else said respecting the strengthening of corners of hatches and two or three other things which I think should come in under the head of maintenance—a very interesting subject, and one which I may dwell upon at a later date. As regards the sounding pipe rod going down through the shell plating, it has happened more than once. The shipbuilder ought to embed a piece of plate about 6 in. square and ⅝ in. think in the cement under the sounding pipe, as otherwise the constant tapping of the rod soon wears its way through. With regard to tack rivets in stem scarphs, I have never known a surveyor insist upon it, and I do not think there is any rule in that respect; I do not see the good of tack rivets in a stem scarph. There is a proper rule for lengths of scarphs, and what is the use of putting in half a dozen tack rivets ¾ in. to ⅞ in. diameter? I know some builders put them in, and in repairing stem damage you have to take plates off to get the rivets out. Lloyd's do not ask for them to be put in the keel bars, why in the stem bars? As to the height of the winch pipes as shown on the sketch, generally I find when pipes are carried too low to the decks a heavy sea washes them up, and even the protection plates do not seem altogether to stop that. As regards not having touched upon the engine department, I can only refer to the length of my paper, and any reference to the machinery must be for another time.

The discussion was adjourned to March 29, and the meeting closed with the usual vote of thanks.

ADJOURNED DISCUSSION.

March 29, 1909.

CHAIRMAN: MR. F. M. TIMPSON (MEMBER).

CHAIRMAN: Before calling upon the members to discuss the paper, perhaps Mr Lang might go over a few points, and I have much pleasure in asking him to do so.

MR. LANG: I am very sensible of the honour you have done me in appointing to-night for the further discussion of my paper on "Some Details of a Cargo Steamer." My remarks hitherto and to-night are only in regard to the hull of a steamer. Many of the members of this Institute are engaged with the hulls as well as with the machinery of the modern cargo vessel. When starting to write up my subject, I soon found that even a comparatively long paper would by no means exhaust or even fully dilate the hull section, and any consideration of the machinery department must be the subject of a future paper or from an abler pen. First of all, with regard to shell plating: much attention is given to a "clean" propeller, some attention is given to a clean run aft and a good entrance forward, but very little to a clean skin. In the days of old the hulls under water were models of symmetry and smoothness, and sandpaper and blacklead were not unknown in the days of the China clipper; but in these degenerate days of steam propulsion, the engines are expected to drive anything through the water. From carvel we have come to clincher and from butts to lap jointing, but still the engines are expected to do what the wind at equal pressure would not be expected to do. With a 7,000 ton steamer recently in dry dock I counted up the plate laps from keel to load line, and the square or "dead" after ends totalled to about 12 to 14 sq. ft. of surface. Add to this the stern and after post, and you have an area of 20 to 30 sq. ft. of dead end dragging tons of water behind. I certainly think that a good bevel taken off the after end of shell plates would lessen the drag or skin friction and be of little extra expense when planing the ends.

I will round up my subject by suggesting the importance of a full set of plans being obtained and specified for with every new ship. In the old days of twenty to thirty years ago, the owner of a new ship received with his purchase an elaborate illustration of a steamer in full sail with wind abaft, flags flying astern, and a lighthouse in the distance. Later these became coloured tracings with a deadweight scale attached, but now in these days of cheap production of copies by the ferro-prussiate process there is no reasonable excuse why the owner should not have, as he ought to have, a full set of working drawings for the use of the superintending and chartering department. I suggest as a minimum the following :—

1. To be framed and screwed up on board in a position accessible to captain and officers :—

$\frac{1}{8}$th in. General arrangement.

$\frac{1}{16}$th in. Capacity plan.

$\frac{1}{2}$ in. Midship section for dry docking purposes (showing bilge keels).

$\frac{1}{8}$th in. Hold and tank piping plan. Sheet of particulars.

2. To be framed and screwed up on board in the engine department :—

$\frac{1}{8}$th in. Hold and tank piping plan, engine-room piping plan and suctions, main boiler plan, tail shaft and propeller. Sheet of particulars.

3. For the owner's office (or chartering department) :—

$\frac{1}{8}$th in. General arrangement.

$\frac{1}{16}$th in. Capacity plan, deadweight scale, sheet of particulars of equipment, etc., particulars of trim and tipping moments at varying draughts, estimated capacity for timber (in loads and mille.) both under and above deck, and other information of general requirement when chartering.

4. For the superintendent's department :—

A full set of working tracings (blue prints) for both hull and engine departments, supplying all the information and data necessary to be referred to at any time for reference in case of damage, particulars when making and issuing detailed specifications for repairs, or when ordering stores, etc.

For the hull department I would have these to be fully dimensioned and detailed working (shop) drawings, viz. :—

$\frac{1}{8}$th in. General arrangement.

$\frac{1}{16}$th in. Capacity plan.

$\frac{1}{2}$ in. Midship section, with Lloyd's calculations and numbers.

$\frac{1}{4}$ in. Longitudinal section.

$\frac{1}{4}$ in. Expanded shell, plating plan.

$\frac{1}{4}$ in. Hold plan, showing position of stanchions and tank manholes, etc., working tracing of stern, frame and rudder as sent to or supplied by the forge, plan of steel masts and derrick posts.

$\frac{1}{4}$ in. Plating plan of each deck.

$\frac{1}{4}$ in. Plan of each division bulkhead.

$\frac{1}{8}$th in. Rigging plan, stating size of ropes, shrouds and spars.

$\frac{1}{8}$th in. Hold and tank piping plan, showing sounding and air pipes. And full particulars (in detail) of equipment, giving sizes ordered, weights, etc.

Other items will suggest themselves according to individual requirements. I have not named the drawing I suggest for the engine department, as this would better belong to a paper upon that department ; but I do say that the owners representative or representatives ought to have at their instant disposal all such information as the drawings above mentioned would give to him, or them, at a glance.

I have, in the foregoing, to some extent answered some questions that were asked at the limited discussion of the previous evening, but I shall be glad, as far as lies in my power, to answer any question that arises from the paper read.

Mr. E. Shackleton : I do not profess to have a very intimate acquaintance with respect to a cargo boat, but I notice that Mr. Lang says with regard to the dynamo that it is often too small for the ship's lighting. I suppose that is a common complaint, but we have hitherto laid out a simple plant whereby in connexion with an oil engine it would not be a great trouble to have a larger size dynamo. I see here some pertinent remarks about joggled plating. I understand that on one of the latest boats, where the plating is on this system, the amount of " whipping " of the ship in a gale was very marked, and the remarks of the captain were anything but favourable to joggled plating. Another thing very interesting to me is Mr. Veysey Lang's remark about the use of sails. I have often thought it was an enormous waste of good power, when good winds were available, that even the most modern type of tramp steamer did not have some system for utilizing the winds. I suppose it would not be going too far out of the way to suggest that there must at least be 300 to 400 H.P. going to waste in this way. Notwithstanding the fact that the working of sail on a tramp steamer is perhaps not quite feasible under modern conditions, as the crew, very largely, are not sailing-ship men, yet I think it must be, as Mr. Lang has pointed out, an advantage to utilize winds. Another point which he dwelt upon was in regard to having the outer skin clean. I think that in some of the tramp steamers that are built the friction in water is never considered. The old traditions of the smartness and cleanness of the China clipper seem to be entirely forgotten. I think that point of extra friction might well be gone into, as it is obvious that if there is a rough surface it must modify the progress of the boat, which means more engine power to be used.

Mr. G. A. Bradshaw: There is one little item I should like to ask about with regard to the keel bar scarphs and stem bars. Do I understand that tack rivets should never be used?

Mr. Lang: I do not think they are necessary.

Mr. Bradshaw: I believe Walton's book specifies tack rivets, and I thought they were rather necessary.

Mr. Lang: I do not see any advantage in the use of them. The scarph is about 4 ft. 6 in. long, and tack rivets are never more than $\frac{3}{4}$ in. or $\frac{7}{8}$ in. They are only for the builders' convenience in erecting. I have never heard of Lloyd's having a rule in this respect, but they have never enforced it in cases I have been concerned with.

Mr. J. S. Gander: With regard to the question of plating, I was told some time ago that on a certain ship the plating was butted up the reverse way, opposing the motion of the ship, and eventually the plates had to be trimmed off with a hammer and chisel. I could not understand it being so designed by the shipbuilders, and I thought there might be some other explanation. What effect have bilge keels on the straining of the ship? I might say I was away last voyage in a flat-bottomed ship without bilge keels, and unfortunately we all knew it, the effect was very perceptible. I was interested to note the remark about derrick posts. I notice in some ships, particularly American ships, masts are not in favour; they have six or seven very substantial derrick posts, which appear to work the cargo very easily and cleanly. With regard to carelessness on the draughtsman's part, I may say I was on one ship where the steering rod crossed the deck just as one came up from the cabin; the steering rod was about 4 in. above the deck, and everybody found it, especially in the dusk. I should say it could just as easily have been put at the other side of the ship, which was not used nearly so much. It was a small point, but it seems to me that little things like this make a lot of difference. With regard to ventilation, what is the actual cause of the decay owing to lack of ventilation? Is it due to acid action which would be prevented if the ventilation were more efficient? The use of sails has been mentioned, and in this respect I may say that I have experienced the steadying effect of even a tarpaulin; with a fair wind it had a considerable steadying effect upon the vessel.

Mr. Lang: Mr. Shackleton spoke in connexion with joggled plating whipping the ship in a heavy sea. There is no doubt this occurs with a very light scantling steel ship such as were built when steel first came in, and when such a large allowance was made for steel. At that time many weak ships were built, this was soon rectified. I have been in ships where, leaning against the bunk, you could feel the ship panting, and no doubt many ships of that time were comparatively weak ships. Of course lightness is considered of great importance on account of the ships being thus able to carry more cargo; but I think the classification societies have brought up the modern ships to rectify the former weaknesses. Naturally they could not get the ideal ship without experimenting, and they had to wait a little while before arriving at the minimum. As regards bending strains on the hulls, I must say I have always thrown a large amount of scepticism upon the remarks of many captains I have met. I believe in the old days of the wooden ship, when the ship "gave" a lot it was the custom to load the ends of the ship and cause it to hogg—that is to say, bring the freeboard up. I have heard that it went as high as 6 in., and I quite believe it. I have known it necessary to line the keel blocks 9 in. up in the middle. But in connexion with steel and iron there is very little at all, although there is a certain amount of spring in a heavy sea. I remember some years ago, in connexion with the plating of a very light vessel for the North of Russia, the draught of which was not to exceed 2 ft. 6 in. She was a passenger steamer about 130 ft. long, with very light plating, about $\frac{3}{16}$ to $\frac{1}{8}$th in. thick. Mr. Goodwin of Liverpool was consulting engineer, and sights were taken at the launching of that ship, when it was found that she only sprang something like $\frac{3}{8}$ in., so that there would be practically no bending strain at all on a heavily plated vessel. I believe Lloyd's some three or four years ago made exhaustive trials of the bending moment of vessels at the time of launching. They loaded vessels at the middle or ends, and there was slight whipping or bending to be found ; I believe in a 400 ft. ship it only ran to about 1 in. Therefore to talk of buckling 2 in. to 3 in. when loading is ridiculous, although some captains say they have got to $2\frac{1}{2}$ in. Mr. Gander mentioned about butts facing forward. I should think it would have been impossible for such a thing to occur. As regards any straining on the bilge keel, there could be no actual straining on the ship. If there was any severe strain at all it would mean that the bilge keel would come off, and the bilge keel does not come off very often. It sometimes works slack, but that would be caused by the riveting giving out. Of course on grounding or touching anything it would naturally buckle up, but the object of having angle or T-bars is that if anything breaks it is the angle or T-bar without pulling the riveting out of the plating. In connexion with putting on bilge keels, I think tack rivets are good. I have had a good many put on like that, and it makes a splendid job. As regards derrick posts, of course some ships are built with a large number of derrick posts. The benefit is that they can be placed close to the ship's side. The signalling mast must be in the centre, but in the case of derrick posts they can be placed about 12 ft. from the ship's side or in a line with the hatches, so there is a much greater advantage than with masts, and of course the corresponding derrick may be shorter. As to the junior draughtsman and his faults, I will undertake to say that if you or I or any one else sets out or draws the hull of a ship, there will be some things which in practice you will find ought to have been arranged another way. These are the things to rectify before building. As regards ventilation and the cause of decay, I am not a chemist and cannot give you the reason for that, but it must be only too apparent that if there is no air admitted there will certainly be a foul atmosphere. It is never safe to go down a well unless a light is put down first to ascertain the condition of the air. Many a man has gone into a lower peak and barely escaped with his life ; I know of cases where men have gone down into tanks and have become unconscious almost immediately. The want of ventilation is detrimental to life, and therefore a cause of decay and corrosion.

Mr. Jas. Bell, R.N.R. : I understand from Mr. Lang that he approves of the bilge keel being secured by tap bolts. Is that the ordinary way of securing bilge keels ?

Mr. Lang : No, I do not think it is ever done by the shipbuilder, but I know it to be done by the repairer. It makes an excellent job, and of course is quite in accordance with Lloyd's regulations. In the shipyard when the riveting is thoroughly well done it is certainly to be preferred, but in the case of fitting bilge keels at a later date, see what the ordinary riveting would mean. You have to cut out the cement in the bilge spaces, take all the coal out of the bunkers, and very often take out pipes in the engine-room. It is a very difficult job to get the rivets in, and even then you have to use some tap bolts. They make an excellent job, are perfectly tight, and I have never known any of them to come out, although some have been running for over six years.

Mr. Jas. Adamson : There are one or two points in Mr. Lang's paper that I think we might with advantage discuss more fully. I have not had very much experience with tramp steamers, but I think the tendency now is to make much better accommodation than was the case twenty years ago. In modern steamers I have been on board of, the accommodation has been greatly improved, but what has puzzled me is that the sleeping-rooms, or even the mess-room, is often put next door to the lavatory and w.c. ; I cannot understand the *rationale* of that. I think, however, on the whole, the accommodation is much better and the berths are larger. I agree that each officer of the ship at least should have a room to himself. With reference to the small dynamo to the bare margin noted in the paper, steamers of the type have come under my observation, not built to an economical specification, where the dynamo is made to the bare requirements, and one has to adopt the expedient of reducing the candle power, or obtaining another dynamo. Attention has lately been directed to the turret vessel, due to the unhappy loss of the Clan liner. I have been informed that these vessels require careful attention in respect to stowage, trim and adjustment of deadweight, otherwise there may be trouble in a seaway. I have seen signs of buckling and apparent weakness in cases which have come under my observation, possibly due to the disposition of the cargo and weight. A peculiarity sometimes found in steamers loaded with salt in bulk is worthy of note, where the lower part of the cargo melts and a tunnel is formed, to the extent of affecting the comfort of the ship in sailing. I can quite understand the difficulty of getting a full set of drawings. Naturally, the builder looks upon the design of ship and engines as his own brain work, and he does not know whether or not his drawings may not be submitted to a competitor to estimate for the next prospective order. I have known of cases where drawings supplied have been supplied in good faith by an engine builder and have been handed over to a competitor to quote from, and for his guidance. Some thirty or forty years ago I was engaged in the drawing office in connexion with some steamers being built for abroad; the Continental representatives were very persistent in their desire for drawings showing all details. I formed the opinion then that the builder is somewhat justified in only giving copies of drawings absolutely specified. I have always found builders very courteous and willing to send copies of drawings when asked for them. I quite agree that some drawings are absolutely necessary to have on board, such as the piping plan. I agree with Mr. Lang as to the joggled plating—it is not pretty; this, however, is a matter of sentiment only. I recently saw a curious anchor failure on a steamer which arrived at a northern port. The anchor had been dropped at the mouth of the river on account of fog; the officer experienced the sensation of the ship drifting; on this being verified, the engines were got under way, and just in time the danger of drifting on to a shoal was averted. The anchor was found to be broken, a large cavity being in the head, and with only about 1·25 ins. of steel to form a crust. The mishap was due to one of those causes which cannot be detected by ordinary tests, as the anchor in question had stood Lloyd's and Board of Trade tests and inspection. I may mention another case where a certain tested steel plate gave out while being flanged. A sample was again tested and stood the mechanical tests all right, also the analysis, but the etching showed the structure to be not homogeneous, and therefore uncertain in working. We see from such cases that material may pass muster at all the mechanical tests and yet fail; we therefore want some new method of discovering the suitability of material for different purposes. We know that steel some twenty-five years ago was very unreliable, but of late we have had more faith in it; still failures occur occasionally, after all the ordinary tests have been applied, without detection of causes contributing to those. Such should always be investigated, however, with a view to discover the defect. Steering rods are sometimes found led through the coal bunker or cargo space, an arrangement which leads to trouble sooner or later, with expense incurred in shifting the rods above deck. It seems thoughtless to put mitre wheels to work among coal or cargo. There is another matter worthy of mention in connexion with manholes in ballast tanks. One may go into a tank with a good boiler suit on, and come out with it torn to rags, caused by the ragged edges of the holes; one's skin suffers in addition. It is bad practice to leave a ragged hole for one to crawl through. The coal bunkers also require careful attention in designing; often space is allotted for bunkers into which coal cannot be put, in some cases with economy, and in others even with safety. How many holes and trimming hatchways have to be cut after a steamer gets to work, and yet when one considers all the efforts being made on land in workshops to reduce labour and fit labour-saving appliances, it seems surprising that these facilities are not thought out for coaling. The bunker spaces also often suffer from heat and have to be kept empty in some cases and in others expense is incurred in ventilating and insulating them. In Mr. Ward's admirable address to the Institution of Shipbuilders and Engineers in Scotland, he pointed out the great amount of labour-saving appliances nowadays in connexion with the loading of ships, as well as in connexion with other work; the coaling and trimming of coal in bunkers, and the work often falling upon the ship should also be emphasized for saving, by careful forethought in the original design. Some time ago a large bilge keel was fished out of the entrance at the Royal Albert Dock; the owner remained unknown till some months afterwards, when the ship was discovered. The bilge keel had evidently been ripped off as the steamer was leaving dock, unobserved by those on board. Mr. Lang's reference to want of ventilation and consequent deterioration has often been illustrated in the shell plating at bath-rooms, lavatories and suchlike behind linings. Most builders are alive to that now, however, and the plating is left exposed and painted, besides which the wood once used to cover up the skin of the ship is saved, and as a rule the ship's skin is left entirely bare, so that a free current of air can get at it. I have seen the bilge and the ballast tank suctions in several ships connected to a common pipe, and we know the dangers and disadvantages of having such an arrangement: it is undoubtedly bad practice. I quite endorse Mr. Lang's view about the equipment; you get everything you want if you specify it, only the bare margin otherwise; but it is simply a question of first cost, and the first cost acts and reacts through the life of the ship: cheap to begin with, dear to keep up, and costly to run, with consequent worry to keep down expense.

Mr. L. A. Argus: With regard to the paragraph on rudder pintles and bushings, where the author mentions about removal for re-bushing purposes, would it not be better if the gudgeons were fitted with steel bushes, as I believe is sometimes done? It would certainly obviate a great deal of the expense of bushing. If these bushes are removable, how are they secured to the rudder post; if riveted, would it hold in a heavy sea, considering the narrow fore and aft diameter of the rudder post? The author referred to the clipper stem as being "15 feet of anxiety." Does he not think that this formation has its advantages also? If the steamer is in a heavy head sea, in my experience the clipper stem has the effect of splitting it. Under such conditions the straight stem makes it very wet forward compared with the clipper stem.

Mr. J. S. Gander: I should like to ask the author which he considers the worst type of vessel, the turret steamer or the trunk steamer. I was on a trunk steamer where the harbour deck was joined right aft to forward, but when a sea came along the harbour deck and struck this at an angle of 45° a very heavy blow was felt, and it always had the effect of breaking the supports that held the rail. The harbour deck was three-quarters the length of the ship.

Mr. LANG: There is a similarity between the turret and the trunk steamer; the turret ship is made by one builder, and the trunk ship by another.

Mr. GANDER: If a heavy sea struck the ship it had a tendency to keep her down, and I should imagine there would be far more danger of her capsizing. With reference to whiping—I suppose it means the longitudinal bending—I was speaking to an engineer who was on the *Viper*, and he said the effect was visible to the eye. Of course the plating was only something like $\frac{3}{16}$ths in., but I thought that was an extraordinary case. With regard to oil tanks, it often happens that an oil tanker has to go to some port to collect oil, and the ship is loaded with, perhaps, coal and other material on the outward voyage. The hatches are very small, and we found it took a long time to discharge the general cargo, while it took about a fortnight to get the coal out of the ship. It seems to me there ought to be some improvement in the design in that respect if the oil ship has to take other cargo on occasion.

Mr. VEYSEY LANG: With reference to my former remarks upon the subject of windage, I was interested to read in the newspaper a fortnight or so ago of an *almost* record passage of the *Mauretania* across to New York, which was spoilt on the last day or day and half's run, when, owing to a head wind, her speed dropped something like 80 to 90 knots in 24 hours. Now a steamer approaching America, with a head wind, is off a lee shore, and we may reasonably suppose that the sea itself was not a detriment to progress, but only the wind pressure. Assuming a strong breeze of 20 to 25 miles and a forward speed of 25 miles, we have a total of 45 to 50 miles wind pressure or a strong or whole gale equal to, say, 10 lb. pressure per sq. ft. Assuming the *Mauretania* to have a frontal surface of bridge erections and weather screens of 1,400 to 1,500 sq. ft., this would be equal to a resistance of 6 to 7 tons. I should very much like to see an experiment on such a ship, of a strong canvas or boarded screen from the foremast to the front corners of the bridge, forming a false bow, and am of the opinion that it would show some interesting results on such high-speed vessels. Mr. Adamson remarked upon the accommodation on tramp steamers, and no doubt this has been greatly improved. I remember in the first ship I was in as third engineer there were two of us in the one berth, and one had to get outside while the other dressed, and I daresay many of you have been similarly placed. For a berth now, the Board of Trade require about 100 cub. ft. per man, and as that in itself might mean bad accommodation in respect of floor space, it is also required that there shall be 12 sq. ft. of floor space per man. Of course one cannot expect good accommodation in a coasting boat where there is very little room for both crew and cargo, but for big ships I think it is good, even from the owner's point of view, as the men are healthy and better placed to do their work. The officers and engineers ought to have berths to themselves, and I would even go so far as to say that the seamen ought not to be all berthed in one forecastle. In the forecastle one bad character makes that forecastle simply untenable for the others. On shore, men in the cheapest lodging-houses can get cubicles to themselves, although I do not see how that system could be arranged on board ship. As regards turret and trunk steamers, I have always heard them spoken of as capital sea ships, and I think for the cargoes they are built for, coal, iron ore and cargoes of a more or less self-trimming nature, they answer very well. I would not suggest that there is anything wrong with them on that point. There are hundreds of them afloat and they suit some trades excellently. As regards the turret ship which turned turtle, I would not like to say it was due to the trimming. I understand she grounded, and as the tide left her she turned over—a thing that might have happened to any ship. Any cargo loaded badly may make a ship unstable, and it is not always the fault of the captain that the ship is loaded badly; it is very often the fault of the merchants. For instance, with a timber cargo, they often send down the small stuff first; she is filled up with shorts and light timber, and then the big heavy logs have to go on deck. It was not an uncommon thing to see them coming from the Baltic almost on their beam ends, through overloading on the deck, but the new laws tend to stop that sort of thing. Mr. Adamson raised an interesting point regarding salt cargoes. The only thing I have against the salt cargo is that it makes a mess and sets up corrosion very badly. If you once get salt thoroughly into a ship the ship will go on rusting, and it is well known that for years after carrying salt or hides there will be trouble in this way. As regards plans, I do not quite agree with Mr. Adamson. Ten or fifteen years ago if you asked for a large set of plans you had to pay for them, because every plan was a tracing and took some time to produce, but now the blue prints cost very little; and as regards secrecy, the only thing I find the designer does not care about is to give the lines of the ship. As to the midship section, if you are a draughtsman you could make it yourself. You have Lloyd's rules, and at any time it simply requires a draughtsman to take the particulars, so that the builder's brains are not confined in any one ship. Where you have a special ship built, like an experimental ship or a battleship, or a ship like Parsons' *Turbinia*, or one on the new Isherwood system, as long as it remains a secret the builder might be justified in withholding plans, but why one should not have a plan of a tail shaft or a propeller, I do not know. Supposing a builder had a legal right to withhold plans, it would hardly be fair to be obliged to go to that builder whenever one wanted a new part. Spares would then become a builder's perquisite. With reference to anchors, I must say there are a good many breakages with cast-steel anchors. The case mentioned by Mr. Adamson is due entirely, apparently, to a defective casting. But several cases have come under my notice where, on heaving the anchor up, the shank has been all right, but there has been no head, and it seems as though the pin had broken or fallen out. Sometimes I have found that the rivet at the end of the head is loose or very small, and the pin might easily fall back. I quite agree that the steering rods should not be exposed, and with a cargo vessel it is all the more desirable that it should be put in a safe place, but to put it in the bunkers is unpardonable; in any case the bevel wheels should be carefully boxed in and proper oiling facilities provided. With regard to the ragged ends of manholes in cellular double bottoms, I think Lloyd's should take the matter up, because their surveyors have to do most of the crawling. Another point mentioned was in connexion with bunkers and their trimming. I quite agree that a lot of thought should be given to the bunker department, as so much can be done to benefit the trimming. There is one thing I have noted and steer clear of now, and that is, that where there are two or three decks, never to put the bunker hatches one over the other. I think it is a mistake; the coal blocks all the hatches and ceases to run. It is better arranged so that the running of the coal to a second bunker hatch is inclined at an angle of 45°, and the next one either forward or aft according to the position of the first; it makes a great deal of difference if the coal is continually running, and, further, it enables the man to get out at any time. The explanation of the bilge keel being found in the dock seems to be that the edge of the bilge keel came up against the sill. I do not think they would feel it on the ship. In that case almost certainly the bilge keel would be square-ended or butt-ended. Using the ballast tank suction pipe for the bilge pipe is against Lloyd's rules, and I do not think one would find this in a modern ship. With regard to woodwork, the less woodwork the better, because wherever the shell is covered up, corrosion is sure to be going on. As to the remarks about steel bushes, the use of steel bushes is quite the usual thing; in fact, it is unusual not to have them. The fact remains that even with bushes the pintles of the rudder will, if not rebushed in good time, wear flat. Of course the form of stem has a good deal to do with a ship having a wet or a dry deck. A good flanged bow will send the water flying on one side or the other without bringing any on board. The clipper stem, however, is out of date, and when the vessel is lying in dock the room which it takes up is lost and ought to be paid for extra. I do not know much about the oil-tank steamers, but usually they are vessels built entirely for the oil trade and not for a general cargo. If an owner has an oil ship, and for lack of freight turns her into a cargo ship, not being built for the trade the trouble described by Mr. Gander is just a natural consequence. A tank steamer is differently constructed—it has not a cellular bottom, for instance—and I daresay the ordinary builder would conclude that it would not be used for ordinary cargo, but kept to the trade it was built for.

A hearty vote of thanks was accorded to Mr. Lang on the proposal of Mr. J. G. Rendall, seconded by Mr. Wm. Earnshaw, and the proceedings closed.

The following were elected at the meeting of Council held June 3, 1909 :—

As Members.

Name.	Proposer.	Seconder.
Arthur Blackburn, Liverpool	J. H. Silley .	R. Balfour
Frank Canham, London, W.	W. Earnshaw	R. S. R. Barrow
J. E. Charnock, Stockport .	W. Earnshaw	A. E. Battle
A. J. Crighton, Antwerp .	J. Adamson .	J. E. Elmslie
E. A. Field, London, E.C. .	W. Earnshaw	R. S. R. Barrow
L. S. Polychroniadis, Constantinople	A. E. Battle	R. S. R. Barrow
B. Salisbury, Battersea .	W. Earnshaw	R. S. R. Barrow
Walter Scott, Norwich .	J. Adamson .	J. E. Elmslie
Edward Taylor, West Ham	W. Earnshaw	A. E. Battle

As Graduates.

R. K. Craig, Greenock .	R. Elliott, B.Sc.	Jas. Adamson
Robt. Riddell, London, E.	W. Earnshaw	J. H. Redman
P. G. Saccas, Greenwich .	Jas. Adamson	J. E. Elmslie

As Companion.

S. Weigall, London . .	J. T. Shelton	J. G. Walliker

Transferred from Associate to Member.

T. M. McLean, London .	Jas. Adamson	E. W. Ross

Transferred from Graduate to Member.

J. G. Robertson, London .	A. H. Mather	J. McLaren

INSTITUTE OF MARINE ENGINEERS

INCORPORATED

SESSION 1909-1910

President: JAMES DIXON, ESQ.

VOL. XXI.

PAPER OF TRANSACTIONS NO. CLV.

EFFICIENT CIRCULATION OF WATER IN STEAM BOILERS

READ BY

MR. ARTHUR ROSS (COMPANION), F.I.C., F.C.S.

Monday, March 1, 1909.

CHAIRMAN: MR. JOHN McLAREN, (MEMBER OF COUNCIL).

DISCUSSION ON

April 19, 1909.

CHAIRMAN: MR. F. M. TIMPSON (MEMBER).

INSTITUTE OF MARINE ENGINEERS

INCORPORATED

SESSION 1909-1910

President: James Dixon, Esq.

Hon. Treasurer: A. H. Mather. *Hon. Secretary:* Jas. Adamson

Members of Council:—

Geo. Adams.
K. C. Bales.
A. E. Battle.
P. T. Campbell.
John Clark.
J. E. Elmslie.
D. Hulme.
J. Lang, R.N.R.
John McLaren.
J. F. Redman.
J. H. Silley.
W. I. Taylor.

J. T. Milton—*Chairman.*

Hon. Minute Secretary: J. G. Hawthorn.

Hon. Financial Secretary: E. W. Ross.

Conveners of Committees:—

Geo. Adams, Press cuttings.
Jas. Adamson, Awards
A. E. Battle, Papers.
J. E. Elmslie, Issue of Transactions.
D. Hulme, Reading Room.
J. T. Milton, City Premises.
A. H. Mather, J. McLaren, } Recreation.
J. H. Silley, Property.
J. F. Redman, Library.
W. I. Taylor, Annual Dinner.

J. G. Hawthorn and John Lang—*Joint Conveners, Junior Section.*
J. Clark and K. C. Bales—*Joint Conveners, Experimental Department.*
Mr. George Shearer—*Representative on Advisory Committee, Board of Trade*

Vice-Presidents:—

W. G. B. Alder (Antwerp).
D. K. Blair (New Zealand).
A. Boyle (London).
G. W. Buckwell (Barrow).
P. T. Caird (Greenock).
F. Cooper, R.N.R. (Birmingham).
W. D. Cruickshank (Sydney).
H. Dayer (Dublin).
P. Denny (Dumbarton).
Prof. A. C. Elliott, B.Sc. (Cardiff).
J. D. Fraser (Karachi).
Sir A. S. Haslam (Derby).
J. Maxton (Belfast).
W. Lawrie (London).
Robt. Leslie, R.N.R. (London).
J. Lockie (Leith).
J. Y. Lowe (Sea Service).
J. Macdonald (China).
A. R. Mackintosh (Calcutta).
A. J. Maginnis (Liverpool).
R. Mollison (Sea Service).
J. W. Richardson (Hull).
W. C. Roberts, R.N.R. (London)
Jas. Stewart (Newcastle).
A. Taylor (Alexandria).
Engr.-Comr. H. R. Teed, R.N.
F. P. Wallau (Southampton).
W Weir (Glasgow).
Chas. Williams (Bristol).
W. G. Winterburn (Vancouver, B.C.).