DISCUSSION.

Mr. Macartney said that the author, in his paper, opened out a very wide field, the various types of ships being so numerous. A ship may be considered a tool, and like all tools or machines of trade, must be the one which experience has shown to be the best for a particular trade, cargo pure and simple, passengers only, or passengers and cargo combined, a weight carrier, that is, handling heavy, dense cargoes, or general or light cargoes. This paper deals with some of the latter class of ships, where the main idea is a clear hold free from all obstructions, giving the greatest length between bulkheads, and large hatches; in fact, some of the latest cargo ships, notably colliers, may be said to be all hatch, there being only sufficient deck space left on which to place the winches and efficiently work the ship. Take a ship engaged in the Australian coasting trade, cargo and passenger, with anything from four to twelve ports of call, taking in and discharging cargo at each, passengers handle and sort themselves; but to efficiently place and separate the cargo, so that there may be no over-carrying or damage to the miscellaneous assortment to be dealt with, a ship, instead of having a single deck and clear holds must have about as many decks as there are shelves in a warehouse, and to suit some trades, as many divisions as there are pigeon-holes in a modern desk.

The owner, having decided upon the class of tool or type of vessel most suitable for his trade, if wise, will place the matter in the hands of the naval architect, who, from his training and experience should be able to turn out the article required, using the least amount of material permissable, properly disposed. Complaints have been made that classification societies, having framed hard and fast rules, have blocked original design. Looking at some of the vessels put afloat during recent years, rather discounts this. It may be that competition between the societies has led to modifications. At any rate, within the last few years, there has been more originality shown than ever before.

Ships on the Cantilever System.—This vessel, as described, comes near the owners' ideal for carrying bulky or weighty cargo. They are great deadweight carriers, on small freeboard. In this respect they are treated as three-deck ships. What would otherwise be waste space is occupied now by water ballast, thus reducing the nett registered tonnage, on which dues are paid. A self-trimmer when carrying grain in bulk, coal, or ores. By the addition of side-tanks, the amount of water ballast carried is considerably increased, and placed in the right position to make an easy ship in a sea-way. Externally, they do not differ from the ordinary type of vessel, and may be built with long bridge and poop, fitted for passengers, or adapted for cattle-carrying. The framing is generally a bulb angle, more easily got at for cleaning or painting than the ordinary plain angle with angle reverse to make up the necessary strength. Unlike the turret, trunk, or Priestman's type of self-trimmer, the full width of deck is carried, a great consideration when carrying deck cargoes.

This is not the only type of vessel with side ballast tanks, the McGlashan ballast system having been introduced some years previously. In a vessel built on this system, deep framing is introduced over a considerable length of the vessel. The transverses are on the web-frame system. Longitudinal stiffness is given to the sides by web stringers worked intercostally between the transverses. Over the framing, another skin is placed, these, with the double bottom, forming a double skin from gunwale to gunwale. The bottom is utilised in the ordinary way for the carriage of water ballast. The double skin on the sides adds greatly to the longitudinal strength, gives additional safety in the event of collision, provides for additional water ballast between the two skins, the tanks extending from the bottom tank margin up to the upper deck. This ballast, like that carried in the wing tanks of the cantilever ship, can be made self-discharging down to load line, while part of the weights being carried well up will make her a more kindly ship when in ballast trim in a seaway. This mode of constructions also dispenses with beams, gives better facilities for stowage, there being no projections in the form of stringers or deep frames, and although the actual space may be slightly reduced, yet the nett tonnage is also kept low.

Alfred Holt's steamers, the speaker believed, were designed by Mr. H. B. Wortley, and were first looked on as freaks, built without sheer, and with extra high forecastles, bridge houses, and poops. Sheer does not add to the strength of a vessel, the extra depth at the ends adding only to the reserve buoyancy. This reserve buoyancy has been maintained by the long, high forecastle and poop. To please the eye, the sheer line has been given to the bulwark. But it is not in the absence of sheer that these vessels differ so much, but in the transverse framing and box girders in lieu of hold pillars. Built with deep framing, widely spaced, the longitudinal strength being maintained by means of a stringer on each strake of plate, the stringer extending only a very little beyond the face of the transverse framing. Although this reduced the number of hold pillars, it did not do away with them entirely. This combination of deep framing widely spaced (some 36 inches apart), and longitudinal stiffeners, may have influenced Mr. Isherwood in his latest design, as described by the author; although Mr. Isherwood, in a paper read by himself, he gives the spacing of transverse framing as from 12 to 16 feet, with an additional floor between, worked intercostally. In a vessel built for oil-carrying, he states that the main tanks were 30 feet long, with two transverses fitted in each, 35in. deep at the sides, 20in. deep under the deck, 39in. at the bottom: the same spacing was continued in engine and boiler rooms. In the way of the double bottom, the alternate transverses were fitted continuously round the double bottom to the middle line. The remaining transverses were stopped at the deep girder in the double bottom next the margin plate, and are then fitted intercostally between the longitudinals to the centre line. The longitudinals on the ship's side were bulb angles graduating in size according to position. The bottom longitudnals graduate in depth, and are flat plates attached to the shell by an angle, and stiffened at the edge by an angle. The decks are treated in much the same way. The paper referred to was read before the Institution of Naval Architects, April 9th, 1908. In it, Mr. Isherwood goes very fully into detail, and shows what can be done with material when put in the proper place in the proper way. The vessel he gives particulars of was 355 feet between perpendiculars, beam extreme, 49 feet 5 inches, depth, 29 feet. The scantlings were approved of by three Classification Societies:—Lloyd's, Bureau Veritas, and British Corporation. The saving in weight of material is given as 275 tons over a vessel of similar dimensions, built in the ordinary way. This saving in weight alone would, in many cases, mean a dividend.

Turret Ships.—No doubt, as indicated, the turret is the outcome of the "Geo. H. Watmore," termed a turtle-back steamer. She made one voyage across the Atlantic, and one only, although it was given out at the time that she was going to revolutionise the type of ship used more particularly for grain carrying. Built after the manner of barges, used in the American Lakes, the cross-section gives small rise of floor, flat sides, but with a rounded deck, the only deck erections being trunkways, leading from the internal part to a gangway placed high above the turtle-back and leading fore and aft, with a small navigating platform and slight protection round funnel and boiler casings, the idea being that seas would sweep clean over, that is, she could sail partially submerged without sustaining damage. No hatch coamings were fitted, the hatch openings being covered by bolted-jointed plates. As stated, she made one voyage across the Atlantic, no more. The turret steamer is so well-known in Sydney Harbor, that it calls for little description; but one of the latest of this type, 360 feet in length, with a beam of 51 feet, and a moulded depth of 26 feet 6 inches has been launched. Machinery placed aft, and with one hold extending from the collision bulkhead, aft to the boiler-room bulkhead. Fitted with triangular side-ballast tanks at the turn of the bilge, and forming part of the bottom tank. The only obstructions in the holds are a series of struts, widely spaced, extending from the bilge stringer taking the transverse beams in the hatchway. This vessel is a self-trimmer for coal or ore, and admirably suited for long lengths of timber. The addition to the water ballast gives a good immersion when in light trim, but, being placed low down will, he considered, make her very stiff. Following on the turret, we have the trunk type of steamer. It does not appear to have come into such general use as the turret, still its special facilities for the stowage of bulk cargoes gives more area for working the ship. When carrying grain in bulk, the trunkway serves as an efficient feeder. The trunk extends right fore and aft the ship, and in breadth is about equal to one-third to one-half the beam. These ships have been framed in various ways: deep framing on the web system widely spaced with longitudinal stiffeners on the plates to give the needed strength, and hold pillars reduced to a minimum. Much time could be spent in going over the various types of vessel's manner of framing, and construction generally, but, as already stated, each type must be adapted to the trade in which she is engaged. Before leaving the subject, there is another matter, that is, in plating. Of recent years, the joggled form of plating has been largely adopted, thus dispensing with liners and long rivets, reducing the weight considerably, and adding to the deadweight capacity of the ship. One drawback to the joggled plate, is the facilities for damage repair in outside ports. A renewal of what may be called an outside strake or joggled plate would mean considerable expense in hand working, where no hydraulic press is available. (Outside of the builder's yards we would not look for rolls to give the necessary joggle.) Of course this could be overcome by substituting plain plates, putting in the liner and long rivets. What appeals to him more than the joggled plate, and effects a similar saving in weight of liners and rivets is the joggled frame bar. Lately this joggling of frame bar has been extended to reverse bars on floors in the way of tank tops, also to deck beams in the way of iron decks. The same fault can be found with it as with the joggled plate when it comes to a matter of damage repair, but it can be treated in the same way by fitting ordinary frames, making up the joggle with liners and longer rivets.

Mr. W. H. German said he did not intend to deal with ship construction itself, but when the Colonial Sugar Company decided to build a large steamer to carry 6500 deadweight, consisting principally of coal to Fiji, and sugar from Fiji to Sydney; also to be able to carry about 1000 tons molasses, we did not consider the various types. The "Echunga," having come into Sydney, he paid a visit to her, and it struck him from the point of ship construction alone that this diagonal tank practically at the top of the transverse section of the girder formed a remarkable strong flange for the top girder, and the double cellular bottom an equally strong flange for the bottom. He thought from a constructional point of view it was essentially good. As regarded carrying coal, it was so obvious that that diagonal side meant a great saving in expense of framing that it would be most economical, and, of course, the same followed from the sugar carrying point of view. Incidentally he might mention that sugar stowed in the ship weighed considerably heavier than coal. That would not naturally seem the case, but was a fact. From the position of these tanks alone for the purpose of carrying molasses, they appeared to offer special advantages, because the great difficulty of dealing with the molasses in discharging was from the ship, on account of it flowing so sluggishly. Provided they could carry the molasses well up and place the pumps low down, that practically decided them to have a ship of this design.

Then came the question as to the best position for placing the pumps. The position decided on was in the stoke hold, that meant that from a molasses point of view alone it would be better to have the machinery aft, because supposing the machinery was in the middle of the steamer and the tanks right fore and aft, if the ship was down by the stern the molasses would not gravitate to the pumps it followed that the tanks aft would not gravitate properly.

Although it might not be picturesque, or what we have been brought up to form an artistic point of view, they decided to place the machinery astern, the engines, then the boilers, and the pumps near the stokehold. The molasses tanks ran from the stokehold to the bow of the ship with a small compartment left for water. When the ship was to be discharged, if she was practically empty, she was by the stern, therefore the molasses flowed easily to the pumps. He could not say that the steamer was a beauty, but it was not built for artistic but ulitarian purposes. A point the author mentioned that, providing the tanks were for water ballast only, they were not counted in the tonnage. He found that Lloyd's would not grant it; they said that it was registered tonnage. The "Fiona" in point of registered tonnage would not compare with boats intended for water ballast only.

The important point of carrying 1000 tons of molasses in a ship opened up a number of difficult problems, because first of all there was the question of getting the molasses into the ship. Owing to its sluggish flow—and a ship of that size means an expense of £60 per day—it was very obvious that they had to get it into the ship in the smallest amount of time possible. He thought it is rather too big a problem to try and describe the system adopted to do that, but he might say that the principal mill that would supply molasses to this vessel was three-eights of a mile distant from the wharf. Molasses was a very difficult material to handle; it depended upon its temperature, and quite a number of other little items, as to the size of the pipe and the pressure necessary to force it along; then there was the further question of getting it out of the ship, they could not allow more than two days to discharge it, that roughly meant that no matter what was the state of the tide, or whether the ship had a list, it was necessary to elevate the molasses 100 feet high to the tanks of the distillery, the distance being about 300 feet, at the rate of one ton per minute. He would not enter into that because it was his intention, when on the next arrival of the vessel to invite the members to inspect her from stem to stern, more especially as to one or two interesting mechanical appliances on board. One thing there was the Dr. Harker Fire Extinguisher. He believed many of the members knew that one of the Sugar Company's officers, Dr. Harker, had had the honor of having patented, and having brought to a successful issue these appliances. It utilized the waste gases that passed up the funnel which were practically deoxidized, and was ultilized for extinguishing fires in ship's holds.

MR. JAMES SHIRRA said the author has brought before us some interesting phases of ship construction, worthy of notice, as engineering design of a structure to sustain very complicated stresses. A bridge or a boiler is subject to what are easily calculable stresses, in the main members thereof, anyway, so they can be designed with some confidence to resist them; but a ship may be racked and twisted and sagged and sprung indefinitely, so that the man who would calculate the sectional strength and the strains it has to sustain, as the Marine Board's requirement for a certificated Marine Engineer Surveyor puts it, has a simply superhuman task before him. Ships are built on experimental data; their design is not evolved from the brain of some academical science lecturer—but grows almost spontaneously like that of a living being; where a greater strain on, or a greater use made of, any one organ or part, leads to its greater development, automatically almost; witness the oarsman's biceps. Hence the not unreasonable timidity shipowners exhibit in going in for radically new designs where experience fails them as a guide.

One of the most obvious innovations of recent years in mercantile steamships was the "Turret" steamer, introduced by Doxford about 1893. The turret steamer, however, only differs from the ordinary form in its superstructure, below water it is not different from the ordinary steamer; the absence of sheer makes the assemblage of the parts much simpler, and the heavy plating of the "harbour decks," or flat shoulders, stiffens the structure laterally, so that there is no question as to the strength of the design, whatever may be thought of its elegance. Ship designers having thus once broken with all the artistic traditions of the sea, ruthlessly giving up the graceful curves and sweet fairness that characterise anything really ship-shape, innovations no longer hampered by ætheticism, came in like a flood, and we got those ocean-going barges the author brings before us, as a result. Fortunately the Registration Societies keep their eyes on what is being done, and it is only in "No

Class'' vessels that a really clear hold, a hold unimpeded by bulkheads as well as stanchions, is found. Some such have been built for Norweigan, and other foreign owners —but they do not indicate progress in ship construction, but retrogression. If a ship was only a receptable for goods, a silo for grain, or a packing-case, these box-shaped monstrosities might be all right; but a ship is almost a personality, she lives and moves and has her being, poised on the unstable and ever hostile sea, and has many conditions to satisfy besides that of capacity. Besides being a store for cargo, she should be a habitable home for her crew—submarines are all very well for defence and attack, but won't do for commerce.

Great ingenuity is displayed in making the sides of these immense boxes stiff and strong enough to be able to dispense with beams, pillars, and deep frames. The best transverse stiffener in a ship is a water-tight bulkhead, and a hold two or three hundred feet long without such a bulkhead is a source of weakness and danger. But the Commonwealth Navigation Bill, which he presumes will be brought on in earnest soon, provides that all steamships registered in Australia or engaged in the coasting trade shall, if required by the regulations, be divided by water-tight partitions in the prescribed manner, and have water-tight false bottoms.

The author referred to stability, and pointed out that vessels may have too much stability; this is a hard-saying to the ordinary man, but every seaman knows the truth of it. The investigation of stability gets a more important matter the more we depart from the ship-shape forms we are accustomed to; every seaman has a sort of instinctive knowledge of how a ship's weight should be best disposed for comfort and safety in a ship of the orthodox sort; but in a ship with no top-sides or free-board to speak of, only a trunk or turret erection as surplus buoyancy, and ballast tanks high up in the 'tween decks, an ignorant or thoroughless master or engineer might easily cause his ship to turn turtle, hence the necessity for educating the officers up to a full knowledge of their responsibilities. It has been stated that a turret ship has as great stability at ordinary inclinations, up to 15 degrees or so, as an ordinary vessel, and that although at greater angles up to 30 degrees, say, the righting arm may be less, yet that is sufficient, and attains its maximum at 60 degrees, only vanishing at 88 degrees, while an ordinary ship's righting arm would attain its maximum at 30 degrees, gets less at greater angles and has the same value as the turret at 42 degrees, and thereafter rapidly diminishing, and disappearing at 60 degrees. These figures are taken from the description of the s.s. "Turret," in Enginering in 1893, but are not of much value unless we know full particulars of the loading of the two boats compared.

If a clear hold free from projecting frames and stringers is a great desideratum. Mr. Flasban's side ballast tanks could be used, where the ship's side are double as well as her bottom, giving a better disposition of weight, additional security in collision, and providing a smooth skin next the cargo as well as next the sea. The fact that the outside measurement of breadth would be four or five feet more than the breadth of hold need not hinder this.

Of equal importance to new methods of construction are improvements in constructive detail, which might be mentioned. Thus, the bulb-angle ought to prove a God-send in the construction of frames, avoiding the rusting and wasting that goes on between the reverse bar and the frame, and in the thin members thereof, in the old style. There is great room for improvement, yet in many details, thus the manholes and lightening-holes in floors and web frames are too often cut out with the punching machine, leaving jagged edges all round through which surveyors and scalers and painters have to crawl; this should be made a penal offence, and all holes cut with smooth edges. The fastenings of man-hole doors in tank tops also call for improvement; the nuts get rusted on the studs, and it is a laborious job getting all the doors off, so they are left on and the interiors neglected.

Sound and strong construction is certainly wanted, but also facility for inspection and maintenance, and these must be rigorously attended to, or the expensive structure may decay under your feet. The minute cellular sub-division of some of the new designs in construction seem to militate against this being thoroughly done.

Careful and free use of Portland cement seems about the best way to secure preservation of iron. Cemented surfaces, other than in the bottom, have been looked on with suspicion in the past, because the cement was usually put on merely to hide defects. If put on to preserve good material, it should do as well afloat as ashore.

The most radical departure in naval construction is the building of ferro-concrete boats. The "Engineer," of May 7, says: "Large boats of reinforced concrete have been built in Italy, and five vessels, of 120 or more tons, have been constructed for the Italian navy. The first of these, a 120 tons barge, was built in 1906. This vessel, which was built with a double bottom, and of the cellular type, was recently submitted to severe tests at the naval arsenal in Spezia, where a much larger boat of iron equipped with a ram was directed against it, without producing any considerable damage. In consequence of the satisfactory results obtained in the experiments with this boat, four more of these barges were ordered on account of the Italian navy. The problem of re-inforced concrete ships has been meeting with a good deal of attention and experiments and trials on a much larger scale will now be conducted in this kind of construction."

In conclusion, he desired to propose a hearty vote of thanks to the author for his interesting paper.

MR. HECTOR KIDD said he had much pleasure in seconding the motion for a vote of thanks to the author. He thought in his reply he might give some idea of the relative weights of the different kinds of construction as far as the cantilever ship was concerned. He did not think we knew very much about its behaviour yet as not many had been built. Some that have been built have shown a weakness. The difficutly was in keeping the tanks tight, that might be rectified as a better knowledge of the ship was obtained.

MR. W. REEKES, in reply to Mr. Kidd's request that he would give some idea of the weight of the cantilever type of ship, said he was not in a position to give any information, but his impression was that the weight would not be materially reduced, if any, rather to the contrary, as compared with ordinary ships. In the design (plate xxx.) he understood, on excellent authority, that there was a material reduction in the weight of the material.

He would look forward with a great deal of pleasure to the paper which Mr. German had promised to read.