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PETROLEUM TANK STEAMERS:

THEIR DESIGN AND CONSTRUCTION.

BY

MR. GEO. H. LITTLE

(HONORARY MEMBER).

Read at Gresham College, E.C., on Tuesday, July 12th, 1892.

PREFACE.

58, Romford Road,

Stratford,

July 12th 1892.

A meeting of the Institute of Marine Engineers was held in the Gresham College, Basinghall Street, E.C., this evening, by kind permission of the Secretary and Council, when Mr. Geo. H. Little (Honorary Member) read a Paper on "Petroleum Tank Steamers: Their Design and Construction."

The chair was occupied by Mr. W. H. Northcott (Vice-President).

Owing to the importance which has surrounded the subject of late, the discussion was very animated; it was looked forward to with considerable interest, on account of the references made in the Press to the apparent dangers of the trade, especially in respect to the Suez Canal.

It was considered desirable that the subject should be further discussed, and that another paper might be contributed at a subsequent date in the course of the session.

The Blocks for illustrating the several figures in the body of the Paper were presented to the Institute by the Editor of the *Steamship*; our thanks are accorded to him for his courtesy and kindness.

JAS. ADAMSON,

Honorary Secretary.

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At the present time the subject of this paper is exciting very considerable attention from the shipping community. Ever since petroleum was carried in bulk in steamers, the trade has been attended with a certain amount of danger, and the succession of disasters which have occurred demonstrate that the conditions for the safe transport of petroleum in bulk are either imperfectly understood, or else violated in some important particulars. At the beginning of this year it was decided to send petroleum in bulk through the Suez Canal to the East. The proposal has called forth a perfect storm of opposition from the shipowners and others interested in the case oil trade; this opposition arises in a very large degree from commercial motives, and partly from a very widely held opinion that bulk-of-oil-steamers, or "tankers," as they are usually termed, are not only dangerous in themselves, but also constitute a grave source of danger to shipping and property in their vicinity. With regard to the commercial aspects of the case, I do not propose to say anything, but a consideration of the mechanical problems involved in the bulk transport of petroleum at the hands of such a body as I have now the honour of addressing, cannot but carry weight with the authorities and with the public, not from anything which I may say, but from a discussion by the members, of various points which I wish to lay before you. I may here be pardoned for making a personal remark. I have written a good deal in the shipping press upon the question, and the view I take is, that it is quite possible to make the bulk transport of petroleum to any part of the

globe a perfectly safe and legitimate commercial operation. Because I have advanced and supported this view, it has gone forth that I am interested in the development of the new trade to the East. I can only say that I have no connection, either directly or indirectly, with any branch of the petroleum industry. My interest in the matter is purely of an academic nature, and is derived more from a desire to prevent, if possible, a valuable development of British commerce from passing into foreign hands, which will assuredly be the case if we continue a hostile agitation against the bulk oil trade. Furthermore, it is very necessary that those who handle petroleum steamers should clearly understand the special requirements of these vessels, and I do not doubt that a discussion on points connected with the design and construction of these vessels will prove of use to those members who may be called upon to be professionally engaged in the trade.

Petroleum or rock oil is a liquid hydro-carbon which is very extensively distributed throughout the world. Its chemical composition varies, but when refined and purified its general formula is—

$$2\ C_n\ H_{2n} + 2.$$

Commercial petroleum consists of many different components associated together; thus, there are methane, ethane, propane, butane, petane, etc., which, either as liquids or gases, together constitute petroleum. Petroleum as an article of commerce may be classed into two kinds—the refined and the crude. The latter is the oil in its first stage of refining —that is, the oil, after running from the wells, is subjected to a moderate heat so as to cause the most volatile constituents to evaporate. The oil now known as "distillate" is shipped in bulk and taken to factories for refining. Large quantities of "distillate" are thus sent from Batoum to French, German, and Austrian ports. Crude oil is also sent from the United States to Europe, but none is sent to this country, and owing to our legislation on petroleum we are debarred from a very extensive industry. Crude petroleum, and "distillate," contain many votatile components which evaporate off at comparatively low temperatures; it is this which invests this petroleum with its risk and danger. Thus crude oil will give off vapour at 32° F. Refined petroleum will not, however, evaporate until certain definite temperatures are reached, and as we raise the flash point so do we decrease the risk attaching to handling it. Legal oil, viz., that which flashes at 100° F., open test, when exposed as a large surface in free contact with the air, will be perfectly safe so far as evaporation is concerned up to this temperature; above this point vapour is rapidly disengaged. Any variety of petroleum, or indeed any volatile hydro-carbon, can be trans-

ported with perfect safety so long as the vessel is strong enough to contain it, and so long as evaporation is prevented. It is the formation of an explosive or inflammable gas, through the mixture of the volatile products with atmospheric air, which constitutes the principal danger in petroleum steamers.

As instancing the safety which can be assured where the conditions are otherwise unfavourable, I may mention the explosives industry in this country. There are 125 factories and 372 magazines for the manufacture and storage of such dangerous substances as gun-powder, the nitro-cellulose and the nitro-benzol compounds ; yet last year there were but 62 accidents, resulting in 5 deaths and 29 cases of injury. In fact, the manufacture, storage, and keeping of explosives being in the hands of technically-trained people, under very stringent legal supervision, has robbed the industry of its risk, and it is found that it is when these substances are being used by people ignorant of the proper methods of use that danger is incurred.

The transport of refined petroleum is not necessarily any more dangerous or risky than the transport of American cotton or the transport of gas-coal on long voyages. The whole question of safety and immunity from risk attaching to the handling of a steam boiler, a torpedo, a handsom cab, or a bicycle, depends entirely upon two things—the adaptability of the object for its purpose, and the intelligence of the person handling it. Now, how have we proceeded in regard to the question of the bulk transport of oil? Petroleum being an article of commerce differing in the widest possible way from coal, grain, ore, timber, vegetable fibre, etc., it might be thought that a vessel intended to carry petroleum in bulk would differ widely from one intended to carry other descriptions of cargo. On the contrary, the efforts of the designers of petroleum-in-bulk vessels have apparently been directed to producing oil vessels as much like ordinary cargo boats as possible. Indeed, the earlier oil boats were converted tramps. In the later types of oil boats we see certain departures made which tend to differentiate this class of vessel ; but, speaking generally, there has been a decided absence of synthetical reasoning in the design of oil tank steamers, and this attempt to make the design of a vessel, suitable enough for one description of cargo, apply to another and wholly different description, has been attended with the most lamentable results, till at the present time "tankers" are regarded by harbour, dock, and municipal bodies, and by seamen, as being most dangerous vessels ; and when it was proposed to send such vessels through the Suez Canal, it was the danger to other vessels which was thereby apprehended

that caused shipping people to exert every effort to prevent the passage of such vessels.

Lloyd's have from time to time directed attention to the peculiar nature of the treatment that these vessels require, and to Mr. B. Martell and his former colleague, the lamented Professor Jenkins, we owe much of our information on this matter; while another Lloyd's Surveyor, Mr. Heck, has lately made a most useful contribution to the literature of the subject by his practical researches on "Explosive Mixture of Air and Petroleum Vapour." I am one of those who think that Lloyd's should act as a board of technical advice in these developments of modern commerce; that, however, is not its function, but it is abundantly manifest that the owner, to say nothing of the twenty or thirty men who live on board, should have some guarantee that his vessel is properly designed for its intended trade. At present no means exist whereby those who earn their living by going to sea can obtain any reasonable assurance that the vessel is fit for the proposed trade. The classification symbol is an index of construction, but I believe I am correct in stating that the highest classification symbol affixed to a vessel's name is, after all, indicative of nothing more than compliance with the irreducible *minima*. The load disc merely indicates a certain percentage of surplus buoyancy, and this is but, after all, a by no means very important factor in the seaworthiness of a vessel. What we, who handle vessels, want is some hall mark as to the quality of the design. In petroleum steamers experience has over and over again shown that radically bad design is a too frequent cause of disaster. I have frequently in the press urged that the name of the designer of every vessel should be placed upon the ship's register; if this was done defective design would carry its own punishment. The French make their naval architects go afloat and observe practically the result of certain methods of construction. In this way the French naval architect combines scientific training with practical experience at sea. I feel strongly that no person can properly appreciate sea conditions till he has served at sea, and it is highly desirable that those who design vessels should have at least five or six years' sea service.

In the usually accepted type of oil steamer of the *Tancarville* and *Lux* type, you see that the tanks extend as high as the main deck, which forms the tank top; a trunkway or trunkways extend from the main deck to the upper deck. This method is objectionable, as in the event of any leakage in the trunkway the oil flows aft and mingles with the coal which is usually carried there. Again, there is always oil in the after-part of these between decks,

and this evaporating makes the close and confined space in the 'tween decks full of a mixture more or less explosive. No amount of ventilation obtained by cowls or windsails will ever suffice to clear away this heavy gas. Nothing but an actual transference of air at considerable velocity will effect this. I therefore venture to think that the space in the 'tween decks is a mistake, because there is always more or less loose oil therein, and owners and captains cannot resist the temptation to use this space as a bunker; and its efficient ventilation is difficult and costly. It is, moreover, unsuitable as a bunker, as the coal must be first lifted before it can be shot into the cross-bunker. In many vessels the whole safety which is gained by the use of an insulating space or coffer-dam has actually been sacrificed to the facility for bunkering, and a connection by means of that nautical delusion, a water-tight door, has been established between the 'tween decks and the cross-bunker. This was done on the *Lux*, and was the fatal error in design which caused the loss of the vessel and of 26 lives. In these vessels of the *Lux* type, a small trunkway extending through the coffer-dam has been made so as to facilitate the passage of the coal. But this arrangement is open to the same objection, viz., that a means is provided for the passage of any large volume of oil which may collect in the 'tween decks. In the *Tancarville* there is an improvement. As you see, a cross-bunker extends right across the vessel between the boiler-room and the after oil tank, and on the fore side of this bunker is the coffer-dam or insulating space. Provided this cross-bunker has sufficient capacity this arrangement is very good. As you are aware, the *Lux* caught fire and blew up. There was some defect in the expansion trunk, and during heavy weather, when the structure was being very much strained, this defect developed and a large volume of oil escaped; this flowed aft along the port 'tween deck, through the passage provided for it, into the bunker, whence it naturally flowed into the stokehole. Although the oil was refined and had a very high flash point, viz., 89° F., it nevertheless, on being heated, evaporated, and the sequel needs no telling. If we consider the construction of this trunkway we shall see that if regarded merely as a receptacle for oil it was doubtless strong enough to resist static forces; but if we consider it as forming a part of the structure of the vessel, and as such, intended to resist the various racking forces involved, it will, I think, be manifest that its design was defective. This trunkway was 17ft. by 6ft. 9ins., and it was built of plates $\frac{5}{16}$in. thick, stiffened by angle bars 3ins. by 3ins. by $\frac{6}{16}$in., spaced 24ins. between centres; there were also two webs in each compartment $\frac{4}{16}$in. thick, 21ins. wide

at the bottom, and 9ins. at the top, placed at the openings on the main deck; these openings were 10ft. by 6ft. 3ins. Corresponding webs were placed on each side of the longitudinal mid bulkhead, and under the trunk top, between these webs, were fitted plates 12ins. by $\frac{7}{16}$in., bevelled to the beam and attached to the web. There were cross-stays in the trunk, extending from side to side, united to each alternate vertical stiffner, and to the mid-line longitudinal bulkhead. The trunk sides were connected to the main deck by 4ins. by 4ins. by $\frac{13}{32}$in. steel angles, double riveted. The top of the trunk was formed of $\frac{5}{16}$in. plate, connected to the sides by $3\frac{1}{2}$ins. by 3ins. by $\frac{5}{16}$in. angles. The oil hatches on the trunk top were 6ft. by 4ft., and in the after-ones 6ft. by 5ft. If we regard this trunkway as a hollow girder, subjected to bending and shearing forces, I think it will be admitted that the webs, that is the sides, were incapable of resisting any great shearing force, and, as the shearing stress would vary inversely with the thickness of the plating, it is evident that the webs were not calculated to withstand any violent strains. In point of fact, the trunkway failed, and leakage resulted. This, however, would not have caused any great danger had it not been for the opening in the after bulkhead. Instead of carrying the insulating space by means of transverse bulkheads as high as the upper deck, one bulkhead only extended so high, and that was pierced by a door on each side. The Court found that "defective design" caused the loss of the vessel.

The danger of permitting an accumulation of oil, and therefore of air and vapour, in an empty space, is well illustrated by the *Tancarville*. The vessel was "specially designed and built" for carrying oil in bulk. You will observe that in the fore side of No. 1 oil tank is a ballast tank, into which oil was bound to find its way. Above this ballast tank was a coal store, and the coffer-dam, by a curious mental process of the designer, was placed just where it could not possibly prevent any harm and where it did no good. I will not detail the fire and explosion which occurred in Newport on board this steamer, as it is the old story of bad design and construction, supplemented by the absence of any proper system of working the vessel, and with, of course, the total suspension of all law and order when the vessel was in the hands of the ship-repairers. This *Tancarville* is another example of "defective design," and it is not at all surprising that her sister, the *Petrolea*, has just lately exploded at Bordeaux. In the official report of the former we are told "that the constructive details of the vessel generally, apart from the defective character of the ballast tank and the arrangement of the electric light installation, as well as the

arrangement of the pumps and valves, were in many respects extremely defective."

In many modern tankers the tank is also used as a ballast tank, but the usual practice of filling a couple of midship tanks is objectionable, as the unequal distribution of weight over the vessel's length is productive of strains. Of course there have not been wanting instances of the "intelligent master," who, we are assured, always commands a "Tanker," running up a deep oil tank at sea during bad weather, with the inevitable result of weakening the bulkheads and straining the structure, and causing leakage which cannot be cured unless by a process of partial reconstruction. I think that the water-ballast difficulty might be met by working a water-tight flat in the midship compartments. This would in effect introduce the ballast tank, against which there are very grave objections. The difference would be that whereas a ballast tank as such is intended for water only, the division in an oil tank would be to permit the space below to be used either for oil or water. A water-tight flat is a good feature in any vessel, but in a tanker it would possess many valuable advantages, but also be a source of danger, and thus the question of efficiently ballasting these vessels is one which demands very careful consideration. In the event of grounding or striking a rock, a water-tight flat would save the greater part of the contents of a tank. On the other hand, it forms a closed-in space in which vapour may be generated and not easily removed.

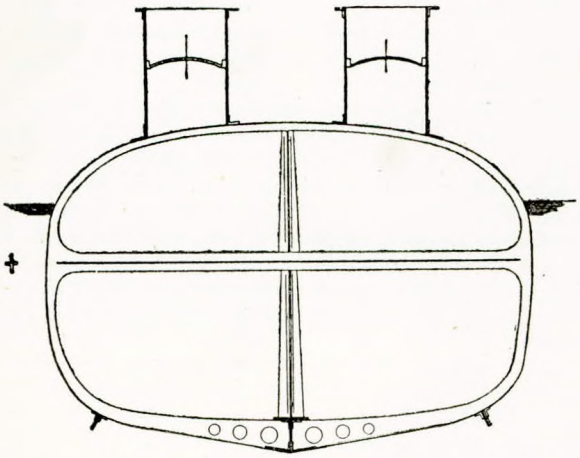
Some authorities advocate the construction of vessels with an inner skin. This method, however good it may be in minimising the results of collision and grounding, yet is not suitable for bulk steamers, because in the event of any slight leakage, the space between the skin would soon be filled with a mixture of petroleum vapour and air, and this would constitute a grave source of danger. Moreover, such a method of construction would be enormously expensive, while to carry a given cargo the displacement would have to be very largely increased.

In their report on the Suez Canal question, Professors Sir F. Abel and Boverton Redwood recommended vessels of the *Sviet* and *Pakuin* types, and they also endorse Mr. Swan's method of conical ballast tanks. I can only say that I do not think any recognized authority would countenance any of these designs for a new vessel; indeed, the principal of ballast tanks has been repeatedly condemned; but I think that the present accepted type of tank steamer is also open to serious objection. This type embraces the bad features of the *Lux* and the equally bad features of the *Tancarville*. Both these vessels have demonstrated the utter unsuitability of the

design, and any vessel built on similar lines will probably meet their fate. I would suggest that the ideal tank steamer should be a modified *Polyphemus* so far as shape is concerned, a *Monitor* as regards freeboard and deck erections, and in general as much unlike an ordinary tank steamer as possible. I do not mean to say that there are no well-designed petroleum-in-bulk vessels; on the contrary, the *Era*, *Oka*, and *Manhattan* occur to me as fairly well-designed vessels.

I would invite your attention to the sketch, Fig. 1, which shows, I venture to think, some improvements on the usual and accepted type of tank steamer. You will observe that the boilers are placed right aft and high up; the engines are placed with the low-pressure cylinder forward; the crew are accommodated aft, and the officers also; the navigation of the vessel is conducted from forward, and the galley is aft. Thus all sources of heat are kept at one end. Usually in oil steamers the boiler is placed as near the coffer-dam as possible, so is the galley; then steam pumps are placed in the middle of the vessel, and steam heaters in the forecastle, doubtless with a view of keeping the vessel warm.

I have here a sketch of the mid-section of a proposed tank steamer (Fig. 2). I need not describe the features of the

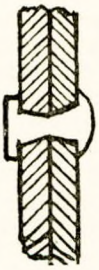


design, as they are apparent. You observe that the frames and beams are continuous. There is a clear run to the channel keel, and externally are two bilge keels. To each tank there are a couple of expansion trunks, fitted with Mudd's pistons. Upon these circular trunks a deck is laid, from which the vessel is worked. The after part of the vessel is similar as in Fig. 1.

It is very desirable that tank steamers should have considerable rise of floor; they are usually as flat as possible, because, I suppose, other cargo steamers are. The disadvantages of a flat floor are that two suctions are necessary, and there is a difficulty in draining the tank. In many tankers there is, after the cargo is supposed to be all discharged, generally 3 or 4 inches of oil washing about on the floor plates; if there is much motion the tank becomes charged with vapour generated by the agitation of the oil. If a considerable rise of floor is given, and flat keel plates employed thus—

the drainage could be effectually accomplished and practically no oil need remain in the tank. Another objection to the retention of flat floors is that it means the multiplication of suctions. The evils of this are so well known to engineers that I need not say anything further. I think that by the adoption of what is really a channel keel the difficulties in connection with the fitting of an efficient longitudinal bulkhead, and in draining, would be surmounted. I need hardly say that no tanker has such a keel, and it follows then that all tankers experience the inconvenience and danger resulting from incomplete drainage. This is perfectly true. Thus, on one occasion, in the *Wildflower*, or, as she has been termed, the "*Wildfire*," when her cargo was "discharged" (*sic.*), there was left in No. 1 tank, 6½ in.; in No. 2, 2 in.; in No. 3, 1 in.; in No. 4, 5 in.; in No. 5, 15 in.; in No. 6, 7½ in., which the pumps could not deal with. Another objection to the flat bottom is that should, as is not unfrequently the case, the vessel have a very slight list during the discharge, the oil gravitates into the wings, and even if wing suctions are fitted, as I think they should be in such vessels, the diameter of the suction, some 5in., will prevent the suction of oil when it is just below this depth, that is, so long as the suction is covered the pumps will suck, but directly air is admitted it fails, and there may be yet tons of oil in the tank. Again, such oil collecting in the wings materially decreases the righting power of the vessel, and if the initial stability is small, the consequences of an accumulation of oil in the wings might be most disastrous. Much of the difficulty in draining tanks proceeds from the defective joint-

ing of the pipes. Usually flanged pipes are employed of cast iron, 5in. or 6in. in diameter, the flanges being connected by screw bolts. As the pressure set up in the pipes is that due to the atmosphere, little care is taken to make the joint properly, and usually there is a deal of leakage at the flanges, I don't think cast iron flanged pipes by any means suitable, but prefer wrought iron, with screwed couplings with 8 or 10 threads to the inch. Such piping can be made to remain tight with oil under pressure, and I may say that it is easier to make a high-pressure steam joint than a low-pressure petroleum joint. The subject of rivetting is one of the highest importance in tank steamers. Lloyd's give very full directions for rivetting in ordinary vessels, and if their rules are carefully observed, good and tight work results. It is hardly enough to specify for a tank steamer that "the rivet holes must be regularly and equally spaced, and carefully punched from the faying surfaces, opposite each other in the joining parts, laps, lining pieces, butt straps, and frames, and countersinking to extend through the whole thickness of plate or angle bar." I venture to suggest that it is important to see that all the rivet holes are exactly fair, and that they should be rimered out and countersunk on both sides ; thus :—



I would also suggest whether the barbarous and unscientific punching process should not be, for at any rate this class of works, superseded by drilling. Of course the usual objections, which were advanced when it was proposed to drill all holes in boilers, will be made. But it is found that there is no reasonable guarantee of oil-tightness when the holes are punched and the plates riveted in the ordinary way. And inasmuch as absolute oil-tightness is essential, especially when carrying crude oil, I think that the extra expense incurred for drilling would be more than repaid by the superior and more satisfactory character of the workmanship. Many attempts have been made to ensure oil tightness by closer spacing of the rivets. For ordinary steel vessels

Lloyd's specify that rivet holes are to be spaced *not more* than $3\frac{1}{2}$ diameters of the rivet apart from centre to centre in the butts of the inside plating, upper, spar, and middle deck stringer plates, and *not more* than from 4 to $4\frac{1}{2}$ diameters apart in the edges of the plating, and all other parts except in the keelsons, floors, frames, outside plating and beam angles, where they may be 7 diameters between centres. The rivets in the flangs of gunwale angle bars to be spaced not more than $4\frac{1}{2}$ diameters apart between centres, and those connecting steel decks stringer plates to the beams to be spaced from 7 to 8 diameters apart. In the butts of deck plating 4 diameters and in the edges from 4 to $4\frac{1}{2}$ diameters apart.

In many oil steamers the rivets for the plating and butts, wherever oil will be next them, are spaced but 3 diameters or 3·3 diameters apart, and yet difficulty is found in preventing leakage. I need hardly say that there is a very good reason why rivet holes should not be spaced too closely. I am not competent to say in a given plate the minimum spacing which is desirable without unduly weakening the plate, but I can say from observation in many petroleum steamers, that close spacing of the rivets and punching the holes is not any way necessarily associated with oil-tightness. If the riveting is most carefully done, caulking will be unnecessary and indeed harmful. It is seldom that a leaky oil seam can be rendered tight by the caulker. There is, however, a method of caulking coming into vogue which promises to get rid of all the difficulties in obtaining really tight work for oil boats. I refer to the fusion of the edges by means of the electric arc, on the system first introduced, I think, by Dr. Bernardos. So far, it is possible to fuse the edges of, say, a joint when the latter is horizontal, but when the arc is struck in a vertical joint the metal fuses and runs, leaving a depression, and, in short, doing harm rather than good. If this difficulty in the use of the arc can be surmounted, oil-tightness will be a simple matter.

It is also an interesting question, what is the most suitable method of joining the outside plating of oil steamers? To ensure the maximum of strength and rigidity, and therefore of oil-tightness under strain, the treble-riveted butt strap is employed. More frequently the ordinary double-riveted butt strap is used. In many vessels the plates lap thus :—

The method, however, which is unquestionably the correct one, and one which is the more economical, is the overlapping butt, as introduced by Mr. Wilson, of Harland and Wolff, thus :—

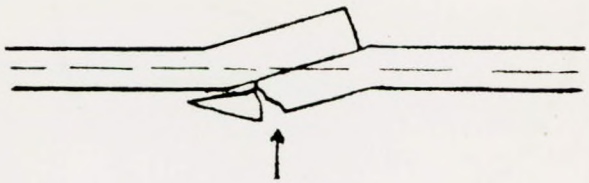
It may be useful to compare the resistances to stretching with the strengths of some forms of butt joint. Taking in all cases treble riveting, $\frac{3}{4}$ in. plate and $\frac{7}{8}$ in. rivets, and the double butt treble riveted joint as unity—

the strength of Wilson's lapped butt is 98 per cent. ; that of the liner lap—

is 57 per cent. ; while that of the ordinary butt—

is but $23\frac{1}{2}$ per cent. It has been found that a treble-riveted Wilson lap is equivalent to a double strap double-riveted. Lloyd's require a treble-riveted strap to be for such plating $\frac{3}{4}$ in. by 19 in. broad. By using a treble-riveted butt strap the butt has to be $10\frac{1}{2}$ in. There is thus a saving in weight of about 55 per cent., accompanied by an increase in strength of 74 per cent. Apart from the questions of strength and weight, there is also that of the distribution of the material, so as to ensure the least distortion. You will see that if these sections are exposed to a tensile strain, the material tends to deformation, as it endeavours to set itself in the axis of the force. The treble-riveted, double-butt

strap joint will not alter in shape, unless stretched to rupture; the liner butt will assume this shape—



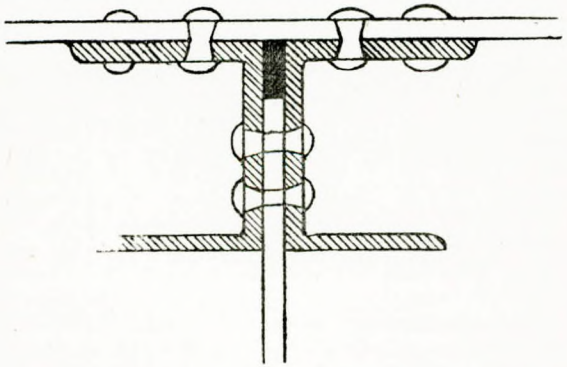
while the Wilson joint will retain its natural original shape, because the axis of strain already coincides with its axis of form; thus:—

I am not, of course, telling you any new thing, as you are all probably more familiar with the question than I am. What I do wish to draw your attention to is, that the better form of butt is not used to the extent it should be, and especially in petroleum steamers.

Another most important detail is that of bulkheads. Many people have an idea, especially those who write about ships in the daily papers, that bulkheads can be easily fitted, and when a vessel founders we hear a lot about what might have been done had bulkheads been built, etc. Another person who is learned in the matter—I mean the man who writes about naval matters in the press—glibly talks of cells and sub-divisions, as though running a bulkhead were as simple a task as building a wall. I need hardly remind any of the gentlemen here that bulkheads, if intended to be efficient, and oil or water-tight, require the greatest care in fitting them, so as to make an efficient water-tight connec-

tion with the side. It is easily seen that a row of rivet holes extending completely round the ship thus :—

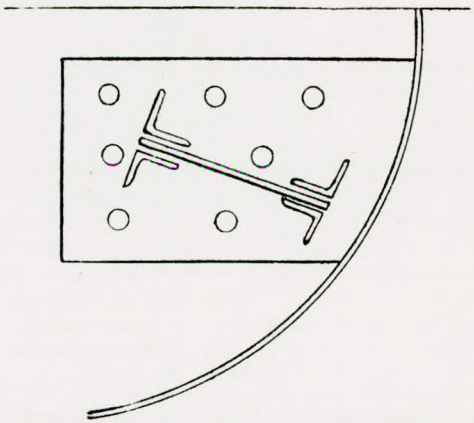
weakens the structure to a serious extent. In ordinary vessels the bulkheads are riveted to the frames, and close spacing of the rivets on the flange of the frame is not objectionable; but the leakage in oil steamers would take place between the frame and the shell plating, and under ordinary methods of construction the rivets are spaced 7 diameters between centres. This spacing is not sufficient to ensure oil tightness, but if it is closer to bore a series of perforations extending right round the vessel. It is difficult to meet this case, but I suggest that oil-tightness might be obtained by a modification of the present method. I suggest that the junction at the sides should be made thus : —



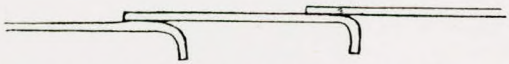
Two channel bars would form a H frame, and be riveted to the skin by usual methods; the bulkhead plate would be

riveted to and between the backs of the bars, as shown ; and in the dark space a mixture of glue and chalk would be injected while hot and under pressure. Glue, I may say, is the only substance at once cheap and plentiful that will resist oil.

It is also a matter of great difficulty to make oil-tight connections between the bulkheads and the plating in the way of keelsons, stringers, etc. In many cases the keelsons and stringers have been cut, and bracket pieces fitted, but this method is hardly a satisfactory one. Considering the object of keelsons I would suggest whether the difficulty might not be overcome by the use of castings, which could be made to conform to the shape of the keelson or stringer, and, by the use of the indispensable paper pulp and glue, a thoroughly tight joint could be secured thus :—



In fitting the bulkheads to oil steamers we should regard these partitions as materially contributing to the strength and rigidity of the whole vessel, and not merely as partitions. We should therefore not make the thickness of the plating to vary with the head of oil it has to carry, but rather make the thickness and the sizes of the stiffeners such, that it forms an integral part of the structure of the vessel. The system of forming bulkhead plates with an angle, thus:—



as adopted in the *City of Paris* and *City of New York*, has, I think, much to recommend it for oil tank steamers. I will not dwell further upon the subject of bulkheads, as Mr,

Martell has in this, as in other matters of ship construction, brought his profound knowledge to bear. I merely make a few suggestions.

A very defective and dangerous part of a modern tank steamer are the expansion trunks and hatches; usually these are made of light plate, and covered with an iron plate, which is bolted down by some scores of bolts to the angle bar at the edge of the trunk. Making the joint, lifting off the cover and replacing it, is a long job, while, should the tank be filled too high, the oil, in expanding, either leaks out through the joint, or else sets up a pressure in the weak expansion trunk till a seam starts, and then the oil issues forth and runs aft. In many vessels this hatch is formed as a lid, bedded upon a seating, and secured by butterfly bolts. The expansion cylinder just brought out by Mr. Mudd, of the Central Marine Works, West Hartlepool, is undoubtedly the most satisfactory means yet proposed for dealing with the expansion of oil, and the prevention of evaporation. These cylinders are built just like engine cylinders, and are accurately bored, and fitted with a light steel dished piston. The upper end of the cylinder is open to the atmosphere, being merely roofed in for shelter, and the lower end is open to the oil hold and fitted with stops to prevent the piston falling out at the bottom. The piston would lie upon the surface of the oil just as the ram lies upon the water in a hydraulic cylinder or pump, without any space between, thus entirely doing away with the gaseous space now existing over the surface of the oil in the usual expansion trunks. It will be at once seen that this arrangement allows for expansion of the oil, whilst at the same time it keeps it entirely enclosed from the atmosphere; for as the oil expands in bulk, it lifts the piston in the cylinder, thus making more room for itself; and when it contracts the weight of the atmosphere above pushes the piston down, keeping it always in contact with the surface of the oil. No air whatever would be allowed access to the underside of the piston, and if any gas accumulated there it would be harmlessly discharged at intervals, if thought desirable, by means of a small pipe and cock attached to the piston, and passing up to a considerable height above it, the cock being shut and locked as soon as the gas was discharged. The piston would be packed with metallic packing, in a similar manner to an engine piston, and if desirable this could be supplemented by a textile or cup packing, above or below the metallic packing. If it were still found that a small amount of oil leaked past the packing to the top side of the piston, this could be rendered quite harmless by carrying a quantity of water above the piston; any leakage of oil would then rise to the

surface of the water, and thus be cut off from the piston, so that if it were accidently ignited no flame could even get down to the top side of the piston. To prevent this layer of water over the piston from surging about too much when the ship is rolling, the top of the piston would have bars across it, fore and aft, forming cells, or trenches, to retain the water. The weight of the piston will be regulated so as to avoid causing undue pressure in the oil. As the piston will be of large area, and can be made light in weight, it will probably not be necessary to balance it in any way, but weights or floats partially or wholly balancing the piston can easily be fitted if found desirable. The piston would preferably be dished upwards, so that gas would accumulate first in the dish, and if it were thought to be better guided by means of a piston rod, that rod could be made hollow, and thus form the gas escape-pipe, which would only need a cock on the top end of it. Means could be provided for moving the piston a little by hand, to prove its freedom in the cylinder.

The electric lighting arrangements in tank steamers are seldom very good, and defects in this important part of the equipment have caused the loss of more than one oil steamer. As a rule the insulation is not only very low as regards durability and resistance, but it is liable to soften and deteriorate in presence of petroleum or its vapour. The system usually adopted is to make the hull the return lead. This vicious method has over and over again been condemned for any steamer, but for petroleum vessels it is positively courting an explosion. Switches and cut-outs are not enclosed in gas-tight and uninflammable cases. There is, indeed, great room for improvement in this part of the equipment of oil steamers. Lloyd's issued a circular on the electric light on steamers some two years ago, which contained some useful recommendations. I would suggest that shipowners should employ a properly qualified electrical engineer to test the insulation and conductivity of the circuit, and to make a professional report every six months. The cost of this might be five guineas; yet we find an electric light plant put on board and entrusted to men, doubtless good mechanical engineers, but who are not in most cases able to use the "galvanometer" and "bridge." To those who know how a leak or fault will develop, the difficulty of locating it—to say nothing of the positive commercial loss involved in coal—it is surprising that this part of a vessel's plant does not receive more attention.

Ventilation in tank steamers possesses an importance which can hardly be over-estimated. It is not only necessary to keep all enclosed spaces free from any accumulation

of vapour, but the tanks themselves at times must also be cleared of gas. To effectually do this is impossible with ordinary cowl ventilators or windsails, although these means are useful in a limited degree. There should be fans driven by electro-motors (the latter in air-tight cases) situated in different parts of the vessel, and by a suitable arrangement of light iron trunks a powerful current of air, at, say, half an inch or three-quarters of an inch of water pressure, could be directed into any tank. In clearing a tank of vapour it has been found that owing to the great density of the vapour it is not sufficient to direct a current of air into the tank. What is desirable is that the air should be led down to the bottom of the tank, and by blowing up, the vapour will be expelled. It has been proposed that plugs should be fitted into the bottom of the tanks, and in dry dock they could be removed and the vapour would then pass out. Another method of getting rid of an accumulation of oil and vapour is to inject steam into the tank ; there are, however, I think, several very grave objections to this. When a tank is emptied of oil we have very large surfaces covered with an oily film, and hence there will be a rapid disengagement of vapour at moderate temperatures. If steam is introduced this formation of vapour proceeds at a rapid rate, and the mixture of air, steam, and oil vapour would be exceedingly inflammable or explosive. I don't think it would be wise to create such a large volume of dangerous gas. It seems to me that by breaking up the oil by means of steam we are making the former more liable to be ignited or exploded. We are in effect using a regenerative process, and are doing all we can to ensure the perfect combustion of the oil.

The method of testing the condition of the air in tanks as proposed by Mr. Heck is the most useful and practical one I know of. A chemist would require to make a long and tedious analysis before he could estimate the degree of inflammability of an atmosphere, but Mr. Heck's method is so simple and so sure that it deserves to be as widely known as possible. He merely takes a glass syringe and fills it with air to be tested. By ejecting the contents of the syringe against a very small jet in a darkened chamber the character of the air can be at once estimated. If petroleum vapour is present in the sample, there is a small blue flame between the syringe and the flame ; if there is but little vapour, there is only a foggy appearance at the end of the syringe. I have used this method with various petroleums, ranging from benzine to mineral sperm, and in testing some common lamps lately I found it extremely useful, as indicating the condition of the space above the oil in the receiver.

I now come to the question of handling these vessels. If

we analyse all the disasters which have so far occurred we cannot but be struck with the fact that the responsible officials employed by the owners were in all cases unacquainted or, at any rate, very imperfectly conversant with the subject of petroleo technics. Owners, I am bound to say, have not used proper discrimination in appointing men to the charge of these vessels. Here we have a very special trade demanding for its safe conduct special means of transportation, and demanding special knowledge on the part of those concerned. It is obvious that a seaman, be he a mariner or engineer, cannot evolve a knowledge of physics and chemistry from his inner consciousness. He needs instructing, and it is high time the Board of Trade instituted examinations, not only for those engaged in the carriage of explosives but also for those in other branches of engineering which are now employed on board ship. I refer to refrigeration and electric lighting. Unfortunately, the Board of Trade has done absolutely nothing in the direction indicated. Engineers demand a higher rate of wages for professional services on board petroleum steamers, and very properly so, not only on account of the risk incurred, but because of superior or more extensive knowledge being required for these vessels ; but so long as any average shipmaster is thought qualified to command these vessels there will always be a grave risk. Really, the masters and officers of these vessels should possess a good practical knowledge of ship construction, design and stability, of physics, and of chemistry. We do not make a coachman a locomotive driver, nor do we think that a soldier is the best man to manage a factory ; but it certainly does seem that, in many cases, these petroleum vessels are placed in charge of men, not for what the latter know, but for what they have omitted to learn. Till owners recognise that a mariner, skilled in the carriage of grain and coal, is not necessarily by any means even at all suitable for petroleum vessels, we must expect a recurrence of accidents of which the *Lux* and *Tancarville* are examples.

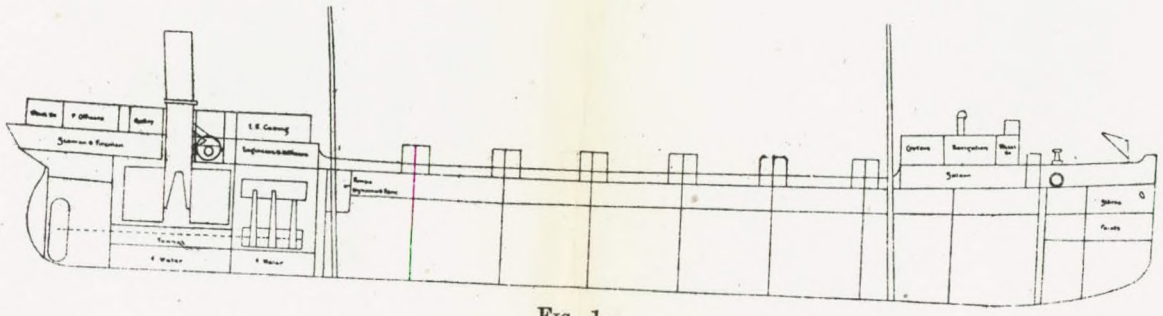


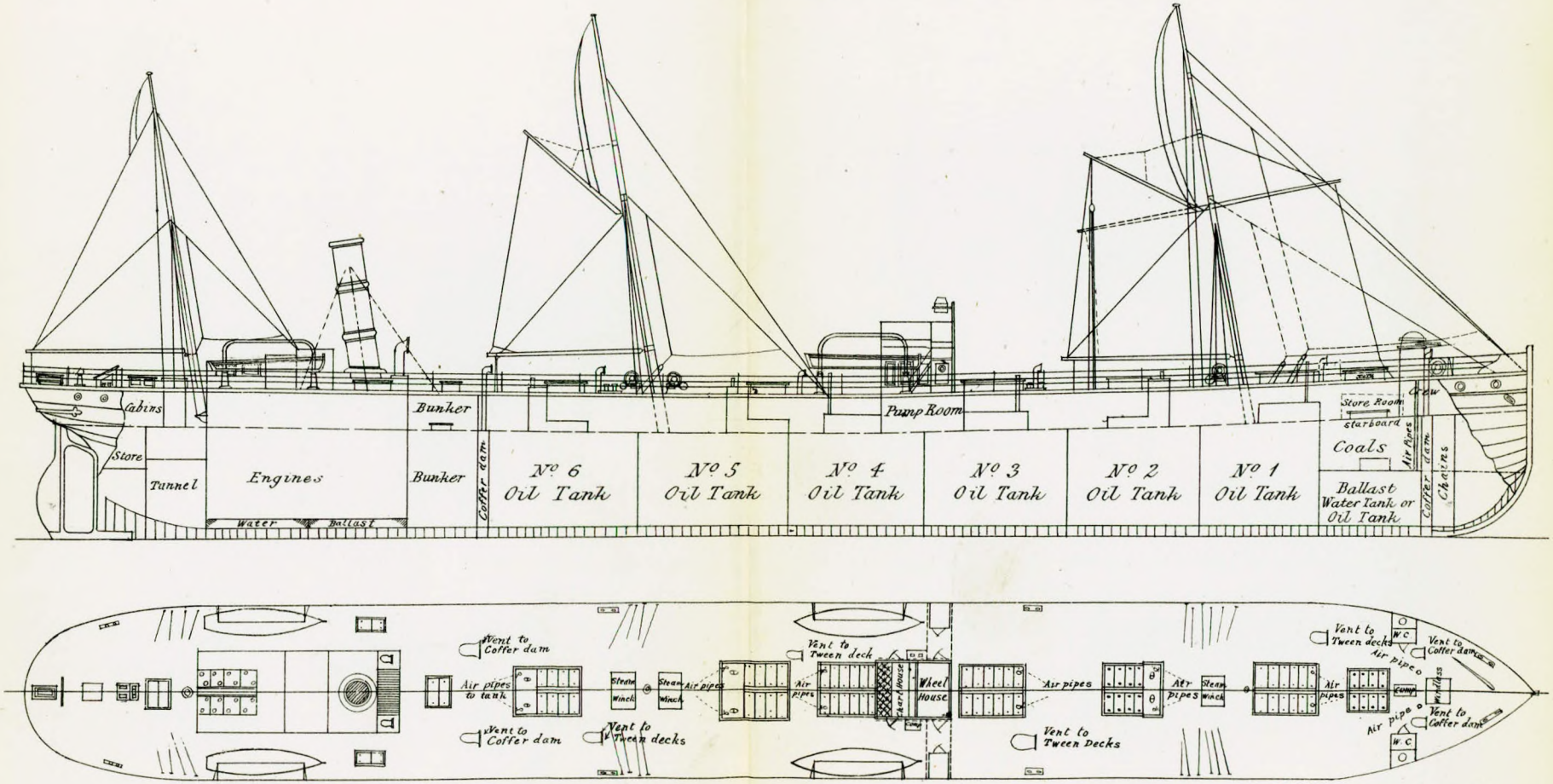
FIG. 1.

(Report No 48.)

Fig 1. A.

S. S. TANCARVILLE.

Scale $\frac{1}{32}$ in 1 Ft.

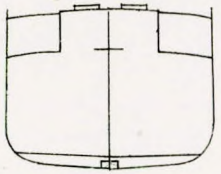


S. S. Lux.

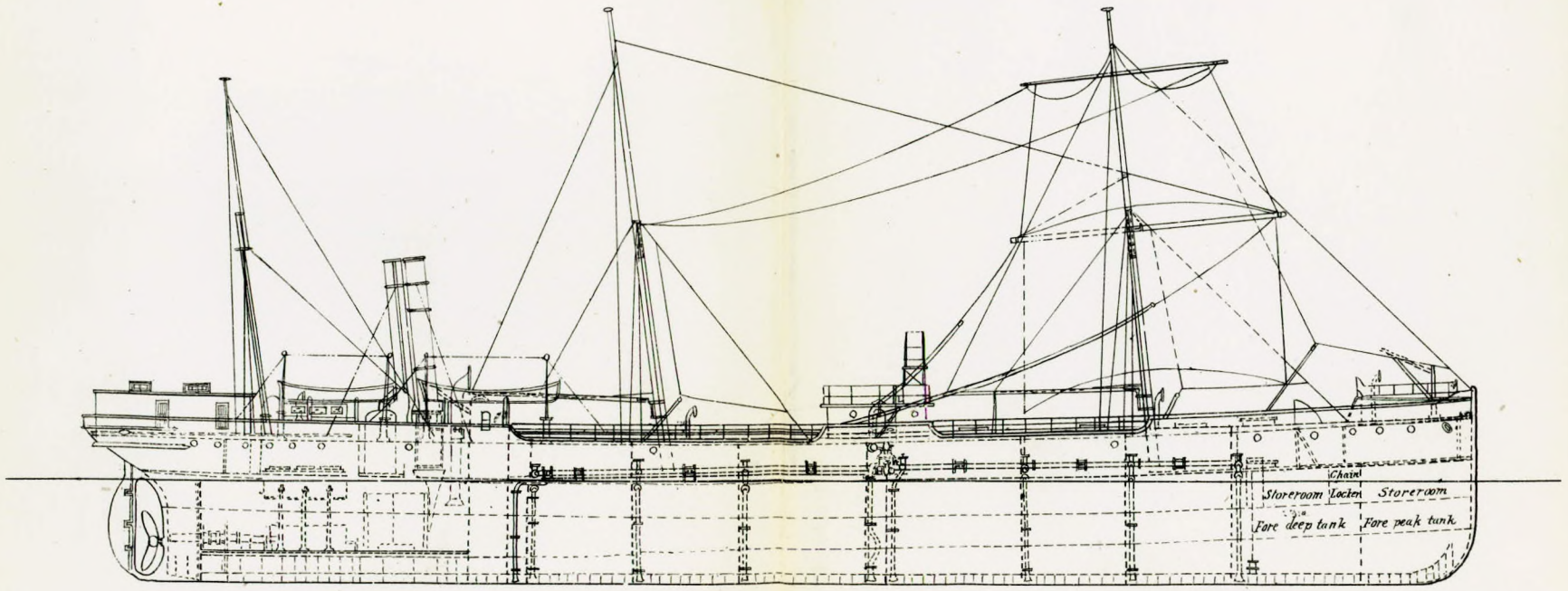
Fig. 2.

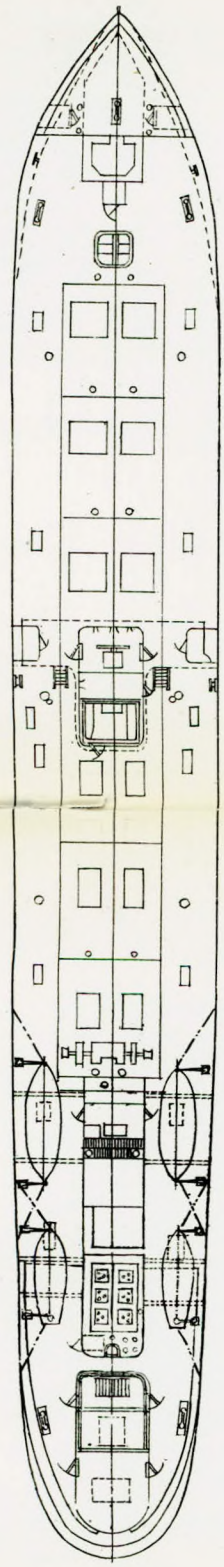
PRINCIPAL DIMENSIONS.

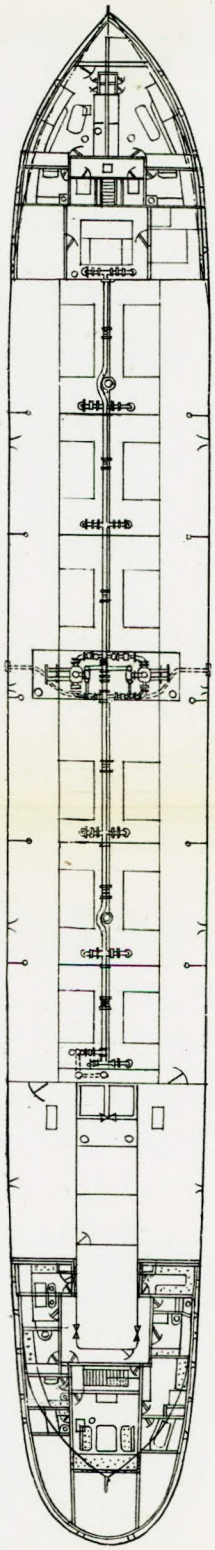
Scale 1/32 inch = 1 foot.



	Feet.	Inches.
Length overall	260	0
Length between perps	250	0
Breadth extreme	35	2
Depth moulded	25	0
Depth of Hold	23	11½
Draught of Water		







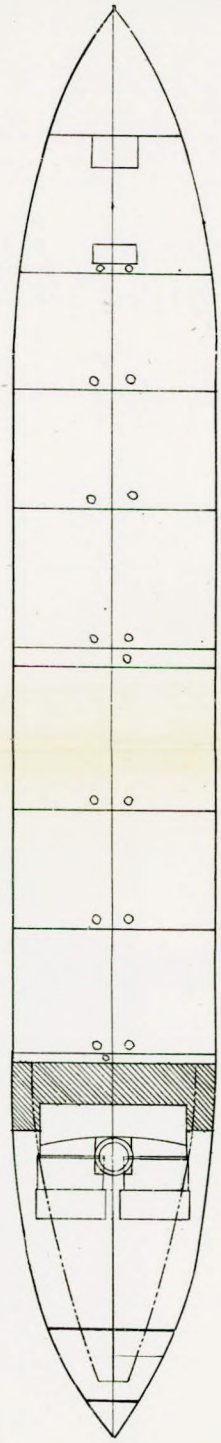


Fig. 3.

SVIET.

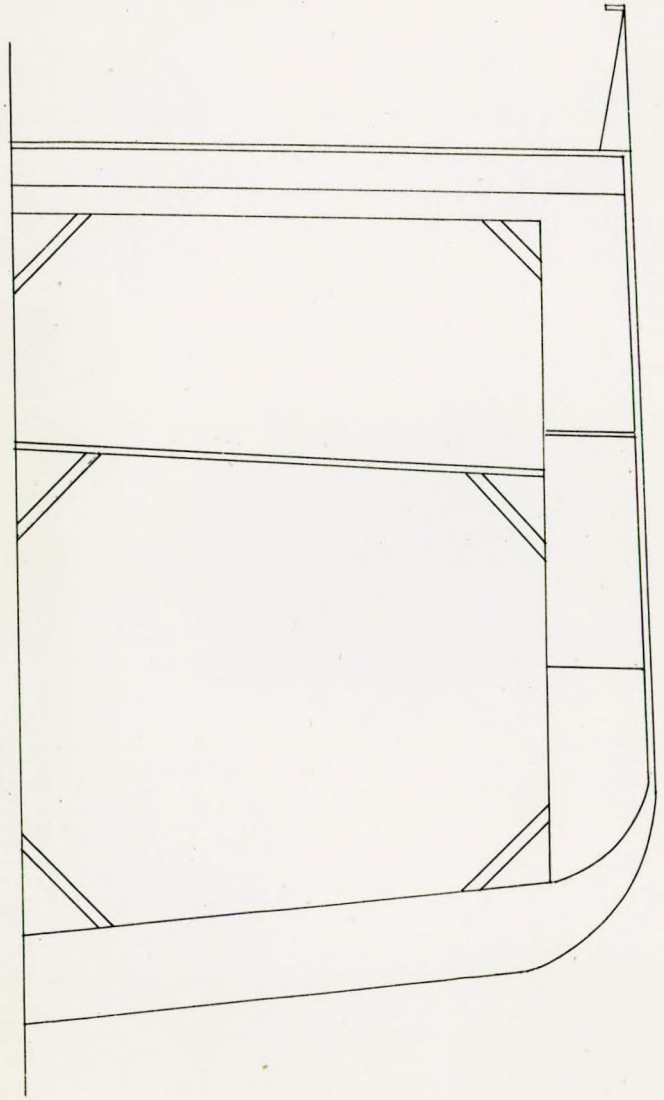
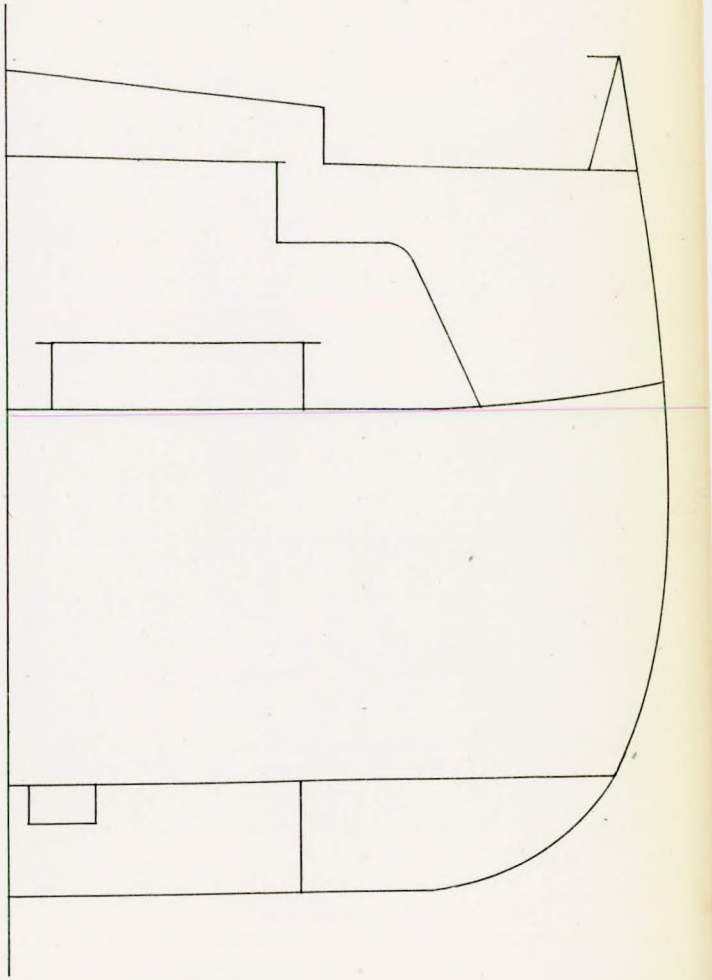


Fig. 4.

BAKUIN.



INSTITUTE OF MARINE ENGINEERS.

SESSION 1892-3.

LORD KELVIN, PRESIDENT.

DISCUSSION

ON THE

THIRTY-SEVENTH PAPER

(OF TRANSACTIONS)

PETROLEUM TANK STEAMERS

BY

MR. G. H. LITTLE

(HONORARY MEMBER),

READ AT

THE GRESHAM COLLEGE, BASINGHALL STREET, E.C.

ON TUESDAY, JULY 12TH, 1892,

AND AT

THE UNIVERSITY COLLEGE, CARDIFF,

ON WEDNESDAY, FEBRUARY, 8TH, 1893.

Stratford:

PUBLISHED AT THE PREMISES OF THE INSTITUTE.

DISCUSSION

ON THE PAPER ENTITLED

PETROLEUM TANK STEAMERS.

BY

MR. G. H. LITTLE

(HONORARY MEMBER).

Read at the Gresham College, Basinghall Street, E.C., on Tuesday, July 12th, 1892.

THE CHAIRMAN (MR. W. H. NORTHCOTT).

(*Vice-President.*)

We have listened to a paper of a most interesting character, and on a subject which has been, and is still being, keenly discussed, we are thankful to Mr. Little for introducing the question of oil tankers to our notice in this paper, and I now invite remarks upon it. Before calling upon any one I should like to ask a question and have a fuller explanation on one point. It has reference to the method mentioned by Mr. Little for testing the inflammability of the oil or vapour, will Mr. Little kindly explain further the process advocated.

MR. G. A. LAWS.

(*Manager Shipping Federation.*)

I do not rise for the purpose of criticising any of the many technical points dealt with by Mr. Little in the course of his very able and instructive paper, except perhaps to remark that the method suggested by the lecturer for making the bulkheads oil tight by using a packing of paper and glue or chalk and glue, seems to be deserving of very careful consideration. My object in

rising is for the purpose of offering an observation or two with regard to the safety of this system of carrying oil in bulk. Mr. Little evidently considers, and perhaps properly so, that petroleum tank steamers are quite as safe as any steamer wherein petroleum is carried in cases. I doubt, however, whether Mr. Little would be able to convince most people on that point, and I do not think that there is anything in the comparison instituted by the lecturer between oil tank steamers and vessels carrying gunpowder or coal. There does not seem to me to be any fair comparison so far as their relative safety as cargo is concerned, between coal or gunpowder, and such an extremely dangerous fluid as petroleum. Mr. Little has said that the proposal to allow the transport of oil in bulk through the Suez Canal had caused a great storm. In my opinion, if there is a dangerous place for these tank steamers that place is the Suez Canal. I arrive at this conclusion because the danger of collision in the Suez Canal is much greater than anywhere else, and curiously enough this danger of collision seems to be increasing for a very peculiar reason. Formerly one vessel was brought up and held in position in a gear or kind of siding while another ship passed, but now they are widening the canal so that vessels may pass each other without stopping in this way. It seems to me that nothing could be a greater source of danger than for one of these tank steamers to be meeting ships going the other way, in a place like the lake at Ismailia for instance, where all the large passenger boats stop to embark and disembark passengers for Cairo and other places. I have seen an enormous amount of tonnage brought up at that spot, and I want to emphasize the great danger there would be of a collision occurring. I do not care how well the tank steamer might be constructed My point is that a collision might occur which would cause one of the tanks of these steamers to be cut into and 300 or 400 tons of petroleum might instantly be released. The oil would spread over the water and become ignited, the result being that there would soon be a vast lake of fire which would kill every living thing upon the lake, and in all probability cause great destruction at Ismailia. I put this as one of the reasons why shipowners were rather staggered at the decision of the Suez Canal Company to allow steamers carrying oil in bulk to pass through the canal. I consider that the regulations which have been laid down are totally inadequate to ensure the safety of life and property in the canal. The only really safe method of taking one of these tankers through the canal would be to let her have the waterway entirely to herself from the time

she entered it at Port Said until she left it at Suez, the owners, of course, being charged dues accordingly. I am afraid that the syndicate which proposed to carry on the trade have looked too much at the profit likely to arise, without having regard to the probable dangers of the traffic, and I do not think it is quite fair to suggest that the opposition was due to those engaged in the case oil trade. Shipowners insured their own ships to a very large extent mutually, and the safety of the lives of those on board their vessels as well as the safety of the ships themselves, is therefore to them a matter of the greatest interest and importance. Certainly wherever there is risk of collision, the danger of these tank steamers is very great indeed. In the course of his paper Mr. Little has rather suggested that shipowners have not exercised sufficient care in placing bulk oil vessels in the hands of scientific masters and officers. I would very much like to ask Mr. Little to point to the schools where these masters and officers could have gone to obtain instruction in what he termed the technics of petroleum. The best officer for a tank steamer—above all others—is the man who could avoid colliding with another vessel, but it takes two men to avoid one collision, and as soon as a serious collision occurs with a Petroleum Tank Steamer in the canal it seems sure we shall have most lamentable consequences to deplore.

Mr. THOMAS A. ADAMSON.

There is no difficulty but can be surmounted in constructing a tank steamer of sufficient strength to resist any strain likely to be brought upon it. It is simply a question of superior workmanship, indeed it should be equal to the boiler work of the present day; in order to provide bulk oil steamers to go through the Suez Canal, all that is necessary is to make the shell of sufficient strength in construction; using armour plates if necessary, to resist the effects of collision. I am simply dealing now with the possibilities from an engineering and shipbuilding point of view, in which the difficulties are surmountable; of course carrying capacity and displacement has to be considered. There is, however, another very important factor, and that is, skilful navigation and care required on board so as to prevent collision, stranding, and fire, as far as possible. Past experience is, that collision, stranding, and fire, have happened with skilful men in charge. But really there is no difficulty in designing and constructing the steamer that is required to carry petroleum in bulk through the canal, and to do this safely and without

risk to other property, the tanks in my opinion must be protected. There are several ways of doing this; when placing the contract, the owner should not cut the price too fine, as it is not a question of how cheap can a steamer be built; the primary question should be how well and suitable can it be designed and constructed for the purpose of carrying oil in bulk. If a shipowner put the matter in the hands of competent persons to design and construct a steamer that is required to do a certain thing, that can be done, but the question of price must not be the first consideration. It is not as Mr. Little inferred in his statement. There are plenty of men in this country who could design and construct steamers to carry oil or any thing else with safety, but for specialties they should know the requirements as to pressures and conditions to which the steamer would be subjected internally and externally, in the trade in which she would be engaged. Great trouble and expense is oftentimes experienced by the oil penetrating around the rivets and through the joints. What is needed is a coating of some solution for the rivets and joints, which could not be penetrated by petroleum either refined or crude. The component, whatever it be, is very searching, and eats through or dissolves the rust from off the rivets and faying surfaces of the joints, hence the cause of some of the leaks which are so apparent at the joints and around the rivets, when the vessels are seen in the Dry Docks.

CAPTAIN FROUDE.

(*Secretary Shipmasters' Society.*)

The subject of the paper for which we have to thank Mr. Little is both interesting and important, and with your permission, Mr. Chairman, I venture to place my ideas of it before the meeting. First, as to the design of so-called tank steamers. Those driven by one screw are the common type; I would prefer them if propelled by twin screws and built with a longitudinal bulkhead, extending from stem to stern, sufficiently strong to admit of some reduction in scantling of the sides. The side oil holds should be sub-divided by transverse bulkheads in the usual way. A coffer-dam of one or two feet width, not more, should be constructed at each end of each group of oil holds. The deck of the oil holds should be exposed without working 'tween decks over it. The proportions of depth to beam of these double holds should be from about 0·60 to 1. Through and on the deck of these oil holds cylindrical or rectangular expansion trunks of sufficient capacity and suitable strength should be constructed. The engine and boiler rooms and bunkers should

be situated nearly amidships, so as to avoid the change of draft due to consumption of fuel from one end of the vessel; above the space so occupied might be placed accommodation for the captain, officers, engineers and crew, and if necessary some deck room over the oil holds forward and aft could be used, or the crews may be placed in forecastle and poop as is customary. I would avoid any sleeping or living places below the oil holds deck. The shaft of the screw or screws could be carried through single or double tunnels; if single tunnels are adopted, then, when laden with oil, these would be kept full of water or *oil* (I cannot see any feasible objection to this), and the coffer-dams would be made tight and complete by man-hole doors at the ends of the tunnels. In the case of double tunnels the annular spaces could be kept full of water in connection with the coffer-dams, or not. A spare tank, fitted with pumps where the expansion trunks are limited, would appear to be a necessity. The water-tight door feature in bulkheads in these vessels is exceedingly objectionable, and in them as in the main bulkheads of ordinary traffic steamers, they may be done without. Special care is necessary to avoid the possibility of petroleum and its vapours passing from the oil holds into the engine, boiler, bunkers and living places. By the form of construction advocated, the oil holds are effectually shut off by coffer-dams from the other parts of the ship. Those dams protect the ends, whilst the sea and atmosphere surround the bottom, sides, and top. Having reference to the terrible accidents which have happened to petroleum steamers, I would merely say night work loading and discharging should be avoided. Many of the explosions recorded have occurred after dark, careless handling of lights being the cause. The use of artificial light should be discountenanced, and when it is necessary it can be supplied with the greatest safety by means of electric hand lamps. The safety fuses and switches of electric light installations often give off sparks which are very dangerous, but this is a matter of material, workmanship and careful supervision. In a general way and during daylight, oil holds of moderate capacities would not require artificial lighting.

Mr. F. W. SHOREY.

(*Member of Council.*)

I have been much interested in what I managed to hear of the paper, but most of us on this side could not catch all that has been said. When Mr Little spoke of glue being the only substance at once cheap and plentiful that will resist oil, it occurred to me that, after the tanks had been well made

and caulked, it would be a good plan, and one which could be easily done, to melt glue or some such substance and pour over all the joints and seams of the tank, and, if necessary, cover all the plates as well; you would then have a perfectly tight tank, and the glue being of an elastic nature, it would not be affected by the working or expansion and contraction to which such tanks are subject. It may have been noticed how clean and dry the casks of paraffin are sent over here from America. I have been given to understand that these casks are made by machinery in great numbers, and when finished they are washed out with a kind of gum or resin, which makes them perfectly tight and impervious to the oil. I venture to think something of this might be used with advantage in our tank steamers, and thus prevent many accidents due to leakage.

MR. R. LESLIE.
(*Honorary Treasurer.*)

I contend that good workmanship in the construction of tank steamers, which should be of the character of good boiler work, is all important. If a ship of good construction is well navigated I do not think there is much fear except in very remote cases, such as severe collisions, &c. Petroleum is like gunpowder to a certain extent, and requires great care in handling. I recommend that every hole in the bulkheads should be drilled and not punched, as is too often the case; it is my conviction that if we had more boiler work about ships of this class and less of what may be termed ordinary shipbuilding work, there would be a great reduction in risk. With regard to the suggestion that oil should be carried in the tunnel, I have had experience of two or three broken shafts, and on those occasions have seen a good many sparks flying about from the fractured shaft. Under such circumstances would not oil in the tunnel have been a source of grave danger in a case of this kind?

MR. A. W. ROBERTSON.
(*Vice-President.*)

I am of opinion that by placing the boilers and engines right aft in these steamers there is secured a very great factor of safety; of course the bunkers are filled with coal at starting, and as the coal is used the weight aft would decrease; but the bunkers could be so fitted as to be available for water ballast, which would serve to maintain the trim of the ship. By having a coffer dam at the fore end of the engine room and boiler compartments any leakage through the bulkhead of the oil tank could be at once and conveniently

dealt with. I would prefer that the boilers should be aft of the engines ; another advantage in having the machinery right aft, is that when the ship is empty she would be down by the stern ; the cocks or sluices between the several tanks could then be opened so that whatever oil remained in the tanks would drain aft, and there would thus be a much better opportunity of getting all the oil out. With regard to the mixture of glue and chalk, or glue and paper pulp suggested by Mr. Little for jointing purposes, I would point out that a bulkhead is dependent, in a great measure upon its attachment to the shell of the ship, and I think that any composition that might be used in the manner described would prove of very little service. Shipowners might rest assured that petroleum tank steamers might be run with safety without any danger to life or property so long as proper precautions were taken. The only danger which presents itself to my mind is that of collision.

MR. W. J. CRAIG.

(*Member of Council.*)

I think that nearly all the points which have been brought before us have already been well threshed out, and are generally admitted. While so much has been said with regard to the scarcity of a proper kind of petroleum-resisting coating or filling, and the inefficiency of those in general use to prevent the evaporation of this searching volatile oil through the seams and riveting of hulls or tanks, which for other purposes would not be considered "defective," yet it appears this adjective must be used when this oil is contained in them. In case this might be considered a question of faulty construction, to be met and overcome by the conditions of first-class work, which would certainly tend in that direction, one would think ; still it would appear from the agreeing opinions of those we have heard in this discussion, and who have had exceptional opportunities of experience to guide them, that this insidious oil, or its vapour, is not to be resisted by considerations of workmanship alone, as it seems to pass into and through the pores of the iron itself by a sort of evaporative, or a sweating process, or perhaps a combination of both, thus affecting the matter of "material" as well and as much as that of "workmanship," and as these conditions give rise to other very important considerations, such as the deterioration of the iron hull, and perhaps the quality of the petroleum itself, and the much more serious one of the actual risk to life from the percolation of a highly inflammable vapour through the material, all this, in my opinion, forcibly points out that an improvement of this

condition of things must be looked for in the direction of some petroleum-resisting composition or coating which, by confining the oil to its container, and the non-saturation of that receptacle itself, would do much to minimise the danger to life, and the damage to the vessel or her oil cargo. As little has been brought forward in the paper or the discussion regarding such a desirable kind of composition that would fulfil these conditions, and to add to the interest and information of this important paper, I might mention one such, that occurs to me, though I have no experience of it myself, but what is claimed for it in its descriptive trade circular, in special relation to petroleum-resisting qualities, justifies me in calling attention to it as a matter relative to the subject, and as another point for consideration, and, perhaps, a trial test by those whom it more immediately concerns, and because no one has apparently any knowledge or experience of it within the range of the paper and discussion. Knowing little of it myself, except its name and existence as a marketable commodity, I am only able at the moment to name it, and quote from memory what its claims are, and in doing so I would say that the usual characteristics of a modest trade circular are present in the one referring to it, and these struck me as claiming to be most specific with regard to petroleum, and therefore as pertinent to the subject of this paper. It is designated "Ironite," and is stated to be an "Elasto-Metallic Flux or Liquid Composition, absolutely impervious to and unaffected by Petroleum, &c., &c.," naming many other materials, and by the simple expedient of coating the interior of the hull or any receptacle for containing petroleum, all the above and many other difficulties are removed. I have seen samples of this "Ironite," and must say they look all they claim for, as far as can be judged from appearance and usual sample tests, and one rather exceptional test of its quality was a wire-gauze box coated with it, and remaining perfectly imperious to the petroleum it contained. Of course it is said to be suitable for many other purposes as well, and these are also set forth in its circulars, but its special reference to petroleum and this discussion is my justification for calling attention to it now, as it may induce some one interested to thoroughly test it, and give the literature of our Institute the benefit of their opinions, or experience of it at some future meeting.

Mr. LITTLE.

I think the danger of the transport of petroleum in bulk through the Suez Canal has been greatly over estimated

by Mr. Laws. The per centage of collisions and serious groundings in the Suez Canal is extremely small, and in the canal itself vessels always meet end on. Petroleum, however, is not carried in the ends of vessels. The speed at which ships go through the canal seldom exceeds five knots an hour, and even if there was a chance of a vessel being struck at right angles I think the danger of the possible consequences have been altogether exaggerated. Even if the contents of one of the tanks of these steamers were to be released, the oil would not catch fire. The water of the Suez Canal seldom has a temperature of over 95 degrees, but the oil proposed to be carried has a very high flashing point. This oil would not flash in an open vessel until it reached a temperature of 120 degrees, and the water of the Suez Canal was certainly never of that temperature. Therefore, even if the oil did get on to the surface of the water, it could not by any possibility become ignited. With regard to the qualifications of shipmasters and officers I have no doubt that if shipowners want their vessels manned by university men they could get university men to-morrow. It seems simply a question of supply and demand. Shipowners, however, do not want educated men to man their steamers; they want working men. I do not see that any advantage would be gained by having the engines and boilers amidships, while the risk or danger would be greatly increased. I certainly agree with Captain Froude in regard to night work, and also agree that all the work in these tank ships should be like good boiler work. I also approve of the idea that the tanks should drain aft, although I do not agree that the oil should drain into the engine room. I think the oil should above all things be kept out of the engine room.

Mr. LAWS: I would observe that Mr. Little has not answered the question as to where captains and officers could have obtained the scientific knowledge which he said they ought to possess.

Mr. LITTLE: There is the Royal Naval College at Greenwich and other places where the information could be obtained. Indeed there is no lack of means by which an officer could obtain any knowledge he required, and there is no excuse for an officer not having a knowledge of everything connected with his profession. All that is wanted is that shipowners should give their officers some encouragement in this respect.

Mr. L. P. COUBRO: I propose we should accord a hearty vote of thanks to Mr. Little for his paper on a subject which is of not only great interest but great moment to many of our members.

Mr. JAMES ADAMSON : In seconding the motion, I would propose, in view of the interest and importance of the subject, that another meeting should be held for the further discussion of the paper, and, if possible, that another paper on the subject should be obtained, in order to amplify what Mr. Little has already presented.

The CHAIRMAN : I see the motion is carried unanimously, and hope that the suggestion of the Honorary Secretary may be carried out, as it is evident the subject requires consideration and discussion in all its bearings. It is my pleasing duty, before closing this meeting, to propose a hearty vote of thanks to the Committee of Management for so kindly granting us the use of this hall for our service this evening, and I ask you to join with me in desiring the Honorary Secretary to convey to the Committee our sense of the obligation.

THE BRISTOL CHANNEL CENTRE.

At a Meeting of the Bristol Channel Centre Members, held in the University College, Cardiff, on Wednesday, February 8th, presided over by Mr. David Gibson (Vice-President, B.C.C.), the paper by Mr. G. H. Little was read by the Honorary Local Secretary, Mr. Geo. Sloggett.

The subject excited a considerable amount of interest and the discussion, which was very animated, is reported as follows :—

THE CHAIRMAN (MR. DAVID GIBSON.)

In opening the discussion, I may say I consider these vessels are very far from perfection. It is time some steps were taken to correct the existing evils. I differ from the author of the paper in putting the transport of oil on a par with cotton as regards danger. The latter gives some notice of trouble, but a petroleum explosion is instantaneous.

Mr. CHARLES RYDER.

(*Hon. Treasurer.*)

The greatest danger is when the oil is out, not when in the vessel. The parts where the expansion tanks join the deck are weak points. When leakage begins the only thing to do is to stop it at once with patent cement. Caulking will not do it. I have met with some instances of sheer carelessness on the part of the crew in handling lights from ignorance of the consequences, and consider with ordinary care and common sense a great deal would be done towards minimising the risk.

Mr. J. HECK.

(*Member.*)

Having expended a good deal of time and labour in conjunction with this subject, I would call attention to a few points, and first I would remark that it is necessary to distinguish between vessels carrying refined and those carrying crude oil. Those taking the refined are safer than when laden with some kinds of gas coal. I only know one case of accident with a refined oil steamer. It is most necessary to isolate the engine-room from the carrying department, and coffer-dams should in all cases be carried to the upper deck. Every vessel carrying crude oil is dangerous, and nearly all the accidents happen with these. The direct application of light or an electric spark of some volume is sufficient to cause an explosion. I shall be glad to show to the meeting some very interesting and simple experiments for testing the explosive tendencies of any oil, and I believe if shipmasters and engineers were instructed in the use of these easy tests, and made use of their knowledge, it would go far to reduce the serious losses of life so frequently recurring.

Mr. WAILES.

I would suggest an efficient plan for compensating for the weakness at the bulkheads. I propose placing a doubling frame, about two frame spaces wide, around the girth of the ship between the frame and shell. This will amply compensate for the loss by riveting.

Mr. M. W. AISBITT.

(*Member.*)

I consider the great and foremost question is the prevention of explosions, and Mr. Heck has in a great measure

shown us how this might be done. After this comes the construction of the boat, so as to ensure her turning out her cargo in a safe condition and without mixture with salt water. All the later types of boat carry the oil against the skin. The principle of an inner skin is bad. It is sometimes overlooked that what is wanted is not exactly to keep the water out, but to keep the oil in. No boat has yet contained oil for four years without leaking it out. In ordinary methods of shipbuilding, the riveting, caulking, &c., is done from the outside ; this process should be reversed for petroleum steamers, and the rivets laid up and the caulking done from the inside. I think the turret type of vessel will make a good oil ship. The loss of the "Bar Creek" was, in my opinion, due to the weakness of the bulkheads. Each bulkhead is a point of great stiffness, and the intervening spaces are comparatively weak, hence (as known to all acquainted with mechanics) the structure may be actually weakened as a whole by these, unless they are properly connected together. Only by experience can the necessary knowledge be gained in order to perfect these matters. It is all very well to say efficient steamers ought to be built, but considering the extent of this trade, I think great credit is reflected on shipmasters and engineers that so few accidents have happened comparatively speaking. No naval architect will bear out the author in having so much rise of floor. Trough keels are the best form certainly in my opinion.

Captain YOUNG.

I have had command of this class of vessel for several years, and beg to offer the following suggestions for preventing accidents. If the coffer dam is kept filled with water the vapour will not get to the hot air of the engine-room at all. I have not seen much leakage into the 'tween deck bunkers, and it is easily stopped when so leaking. Having coals in 'tween deck bunkers is an advantage when the vessel is loaded, as the centre of gravity is raised and the vessel is easier—a great advantage in crossing the North Atlantic.

Captain POMEROY.

I have listened to the paper and discussion with the greatest interest. When I saw the three poor men carried by me at Cardiff Docks some time ago—I refer to those who were injured by an explosion—I felt that if there was any means of teaching them how this danger to life might be obviated, it is our duty to advance the knowledge in every possible way. The experiments shown us by Mr.

Heck deserve to be spread over the length and breadth of the land. I consider it within the range of such an Institute as this to teach the men what should be done and what precautions are necessary to reduce the serious calamities so frequently witnessed. I thank the members of the Institute for their invitation to be present this evening, and I say the work they are undertaking in bringing forward such subjects for discussion merits every encouragement.

Mr. JOHN McCALLUM.

(*Member.*)

It is evident, from what we have heard this evening that Mr. Little thoroughly understands the subject he has taken in hand. He has shown us how essential it is that we should foster this industry, which is increasing year by year. He has also pointed out the faulty construction and the weak points of this class of vessel, and has suggested improvements. Great credit is due to him when we take into consideration that he has had no practical training on this subject, that he is neither a naval architect nor an engineer, and that only through strict research and observation has he been able to lay the matter so practically before us. Other experts have given us their opinions on the same subject, notably Mr. Eldridge, Mr. Heck, and Mr. Wailes, of Newcastle; all of whom agree in pointing out the same defects mentioned by Mr. Little. It has been my privilege to visit several petroleum steamers of the old type, and from the accounts I heard, it is surprising the accidents have not been more numerous. When we hear that in firing, great care has to be taken, we might say agility, in avoiding the outrush of flame from the boiler furnace mouth immediately a shovel full of coal is thrown in the furnace, we can easily understand how necessary it is that we seriously consider how to prevent in the design, construction and workmanship of a tanker, such a dangerous element as the impregnation of the bunker coal, with petroleum or its gas. Aside from the faulty design and construction of this class of vessel, evils which will doubtless be overcome as we gain experience, is the fact that there is not a perfectly oil tight tanker afloat, and we hear repeatedly accounts of them leaving an oil track behind when at sea, and forming in themselves an immense and most efficient wave subduer. Although Mr. Little and others have explained to us the improved methods of riveting, it is my opinion that it is far from efficient as yet in preventing leakage. In some measure to overcome

this difficulty, I would suggest that all plates, rivets and angles used in the construction of the vessel be treated to a pickle to remove the scale, as is customary in Government yards, and also that the rivets be heated in a charcoal fire or by means of gas to ensure their freedom from scale, and my reasons for advocating this treatment is that petroleum is so insinuating, so penetrating, that it is customary in daily practice to take advantage of these properties to loosen parts of machinery which have become corroded and set fast It acts directly on the scale and rust, and its action is similar in attacking the thin scale under the rivet head, and which can only be avoided by the treatment I have previously mentioned. We are all aware of the danger in effecting repairs in the oil tanks of this class of steamer, and many suggestions have been made and patents taken out to remove the dangerous gases which accumulate at the tank bottom. Some superintendents have a plate removed in each tank bottom, which is a more expeditious way of getting rid of the gas than by means of plugs.

MR. GEORGE SLOGGETT.

(*Hon. Local Secretary.*)

I beg to announce that the next meeting will be held on February 22nd for the purpose of reading and discussing a paper on "The Expansion of Water by Heat," by Mr. G. W. Buckwell.