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John Elder Esq.

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The Journal
OF THE
Royal United Service Institution.

VOL. XII.

1868.

No. LII.

Evening Meeting.

Monday, May 25th, 1868.

W. STIRLING LACON, Esq., in the Chair.

NAMES of MEMBERS who joined the Institution between the 18th and 25th of May, 1868.

LIFE.

Hay, James Francis Dalrymple, Lieut. Royal Ayrshire and Galloway Mil. 6*l*.
Scott, William, Lieut. R.A. 9*l*.

ANNUAL.

Pym, Samuel, Lieut. R.A. 1 <i>l</i> .	Lennox, Lord A. C. Gordon, Lieut. Gren. Guards. 1 <i>l</i> .
Stevenson, R. A., Captain R.A. 1 <i>l</i> .	Hardy, Chas. G., Lieut. Gren. Gds. 1 <i>l</i> .
Wickham, John, Capt. Hants Mil. 1 <i>l</i> .	

CIRCULAR SHIPS OF WAR WITH IMMERSED MOTIVE POWER.

By JOHN ELDER, Esq.

IN adopting the title selected for the paper I am about to read to this meeting, I think it right to premise, that whilst some results of recent experiments made by me are of considerable interest to the naval architect and to others engaged in those branches of scientific investigation and practice into which enter the consideration of the values of forms and the different properties of solid bodies designed for floating in and being propelled through fluids, and are, I think, likely to prove of sufficient interest to merit special consideration, they could not be properly treated of in the present paper. I hope, however, to be permitted during the early part of the next session of the Royal United

Service Institution, to lay before you, in the form of completed and well digested results, what I believe will prove of interest to the members of this important scientific Institution, and to scientific and practical men generally; when probably they may assist to make clear much that has hitherto been but imperfectly understood in connection with the development of the "theory of the forms of "least resistance," the resistance of bodies passing through "fluids," and other subjects under which such matters have been treated of by the various theoretical writers and scientific experimentalists who have flourished during the last and present centuries. On the one hand, I do not pretend that any great discoveries have been made by me in connection with the investigation of the present subject, or that I am going to revolutionize the whole practice of naval construction, and demolish the entire fabric upon which the construction of ships and the education of their builders have hitherto been based. It must, however, be clear to the minds of every one present, that naval construction is now in a state of transition; that much that has been done upon which the national wealth of this country has been enormously lavished with most unsatisfactory results, is entirely due to a want of that exact knowledge which belongs to other branches of science, and which should (and might) guide the professors of naval architecture in their teachings. It is to be hoped that ere long, practical men will be so well instructed by these professors that they may be able to follow their legitimate avocation of constructing and manufacturing for profit, without engaging in direct or indirect conflicts with natural laws, or producing unsatisfactory and undesired results, which needed not the surroundings of scientific theories for their production, but might have been equally well obtained by the old practice of the "rule of thumb."

I think it also right to premise, that the occasion and the shortness of the time at our disposal induce me to believe that the opportunity now afforded will be best availed of, and employed most to the satisfaction of my hearers, if I avoid all scientific speculation, and theorising; I will therefore confine myself to the briefest explanation of the subject of the present paper, and to describing the various illustrative diagrams, &c., suspended on the walls, leaving the more time for that which to my mind is the most valuable and useful result of such meetings as these, viz., the discussion which is evoked by the reading of papers. I wish to do this especially this evening, as I am favoured with so distinguished an audience, amongst whom I perceive many gentlemen of the highest eminence connected with the several branches of "*l'art naval*," the Commanders of our ships of war, the designers and constructors of the fleets of the past and present, and some who claim to be scientific designers of the "fleets of the future." I will therefore at once proceed to describe my "circular ships of war with immersed motive power," confining myself as closely as possible thereto, and avoiding the use, as far as possible, of all technicalities—as well as of scientific terms, speculations and theories—leaving, no doubt, much unsaid in the course of the reading of the paper, but the more to be evoked and eliminated during the discussion which I trust will follow.

Circular Ships.

I do not in this paper propose to enter upon the question of the suitability of circular ships as sea-going, passenger, and freight-carrying vessels, but intend to limit myself to their applicability for sea-going ships for coast and harbour defence, and may also, if time permit, point out their superiority, general usefulness, and infinitely smaller cost as compared with stone forts constructed in estuaries, channels, and rivers as most important national questions; also their capability as floating platforms for fighting guns of the largest possible calibre with the advantage due to the greater stability and steadiness thus attainable, and their suitability for carrying monster mortars, permitting of the discharge therefrom of shells of greater size, and containing larger explosive charges than heretofore, and with an accuracy never hitherto obtainable in firing from a mortar ship. Beyond, or in addition to these comparisons with existing ships or vessels of war, and with fixed or built forts, I propose briefly to call attention to what for the first time has been possible in connection with naval attack, and which is essentially novel and peculiar to this form of vessel—the peculiar manœuvring powers of which they are capable, and the formidable character of such vessels when so used or employed against an enemy's fleet. I am aware that circular structures have heretofore been projected or proposed as floating buoys and beacons, such as those of the late Mr. Herbert, the late Mr. George Rennie, and Mr. Oldham, of Hull, and all the floating lights, beacons, batteries, and other vessels of Mr. John Moody, of Goole, which are not circular, either on the plane or in the vertical section, but, as described by Mr. Moody, in the specification of his patent, are “of starlike form, with four or other number of arms,” and he adds, they are to be made “with a flat bottom, and over it is a deck, arched in all directions.” Of course any of these last described structures might be fitted with steam power, but it is self-evident that neither of them are designed to be used or employed as steam propelled ships of war for naval attack, nor are they capable of being moved but at very low speeds with the expenditure of great power.

Circular Ships intended for the purpose of Naval Defence and Attack.

I believe it has been generally conceded by the highest professional authorities amongst the commanders and fighters of our naval ships, that the turret or circular, or “all round” system is the handiest and best, the handiest for working heavy guns, and the best form for resisting shot. The question naturally suggests itself what is the best form of vessel in which a turret may be carried?

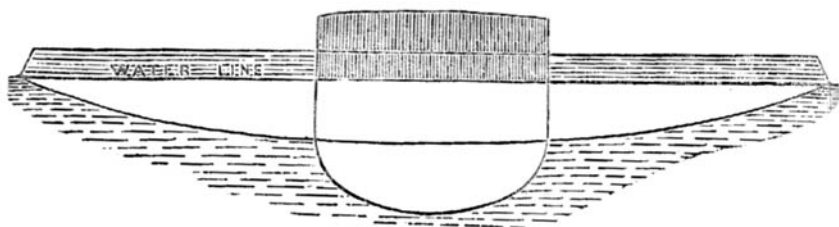
Whilst studying the questions of turret-carrying and gun-fighting, it occurred to me that there still remained another mode of dealing with these questions, namely, that of making the turret carry itself, as it were, or in other words, to make a vessel perfectly circular on the plane and the vertical section representing a small portion of a circle, and the

frame lines of which should all radiate from a common centre, so that any section taken across the diameter would be similar to any other section taken on any other line passing through the common centre, or to use a familiar illustration, to make the shape of the hull of the vessel like a slice cut straight off an orange, the skin representing the skin of the vessel. See Plates xxiv and xxv.

By so constructing a vessel it would be able not only to travel in a straight line in any given direction, whether forward, backward, or angular, but it would also be able to revolve with great facility while so moving or when stationary, but without the use of revolving gear or mechanical apparatus liable to the contingency of becoming jammed; and the turret also might be enormously increased in size, and be capable of carrying a proportionately larger number of guns and mortars of colossal dimensions with perfect safety.

After making some experiments on the resistance offered by various circular forms of vessels in passing through water, I found that the immersed portion of a vessel having for its outline a small segment of a large sphere, so that the vertical or buttock lines were very fine, required no more power than would have to be exerted in order to make an ordinary iron-clad vessel of war, of the same displacement, travel, or move through the water at the same speed. Thus, upon making two models, one of the ordinary form, and one of a circular vessel of equal displacement, and towing them at the same speed through the water by means of a line, having a scale-beam or yoke, interposed, the tractive force upon each tow line attached to each end of the scale beam, being the same, I found that the yoke (or scale beam) interposed between the towing boat and the vessel being towed, was constantly at right angles to the line of forward motion, so that the resistance offered by each vessel was practically the same in each case.

This result will be readily apprehended or understood when it is shown by the accompanying diagram illustrative of the two cross sections,



that the circular model has a much lighter draught than the other, in fact the circular model drew a little less than one-half the depth of water, whilst the breadth of the section is greatly increased, as will be hereafter referred to and explained more in detail.

I may here observe in a general way, that these experiments have thus far proved what might not perhaps have been expected, that there is no reason why a vessel of the same displacement, as one of

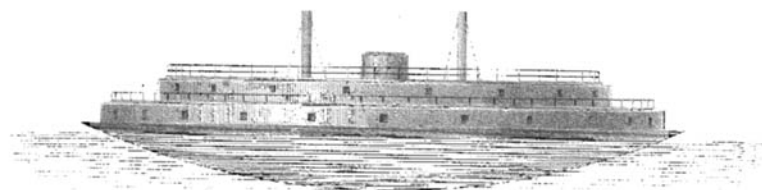
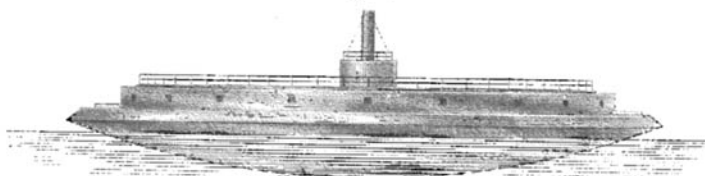
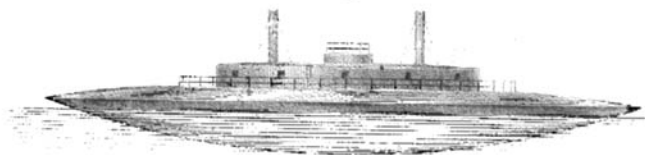
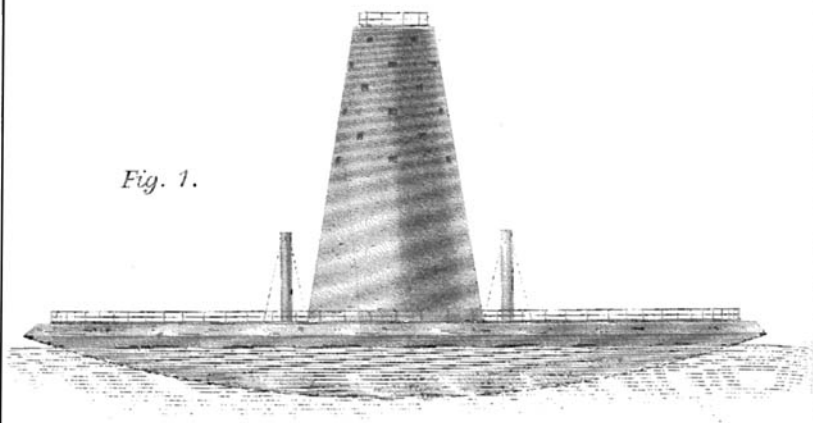
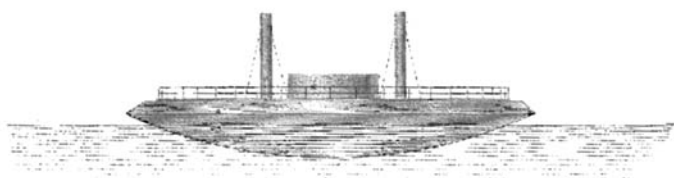
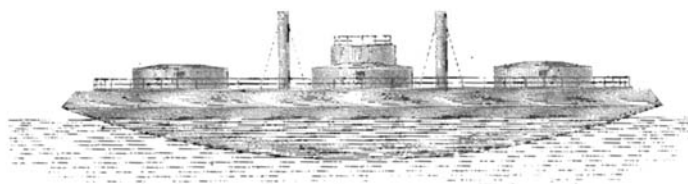
Fig. 1.*Fig. 2.**Fig. 3.**Fig. 4.*

Fig. 1.*Fig. 2.**Fig. 3.**Fig. 4.*

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Fig. 1.

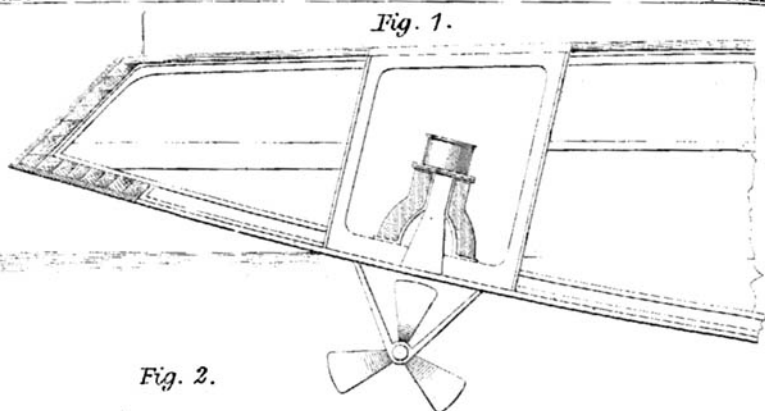


Fig. 2.

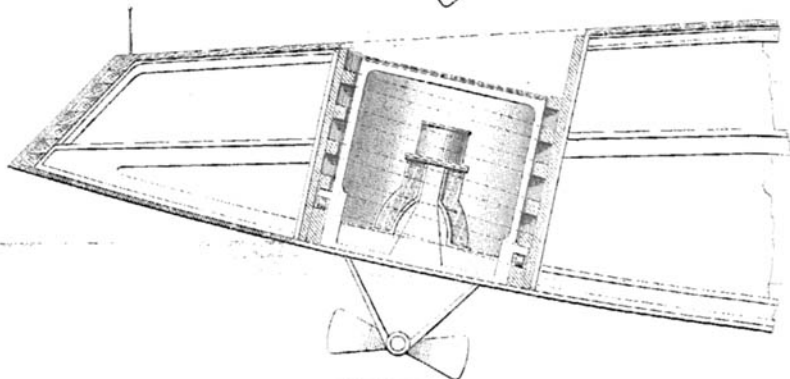
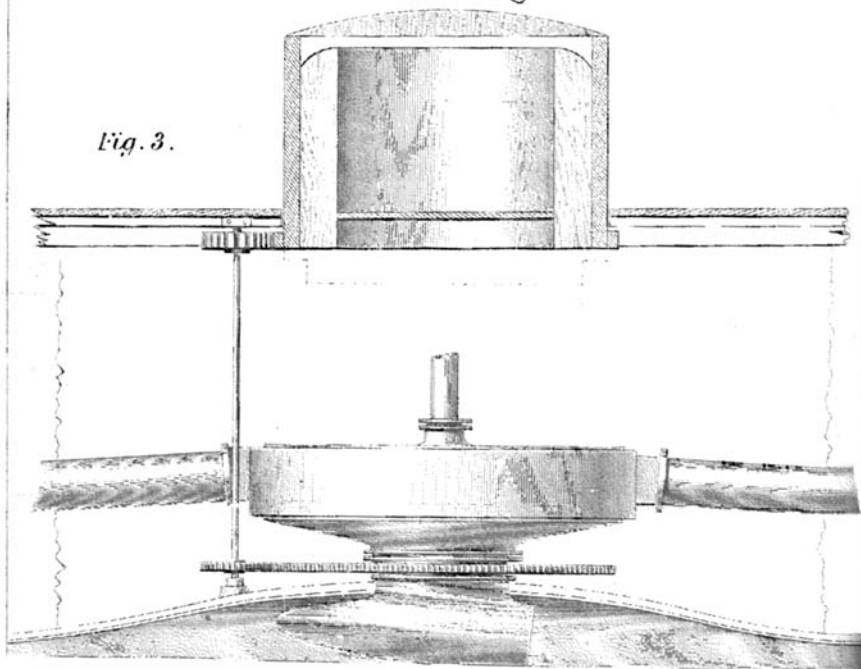


Fig. 3.



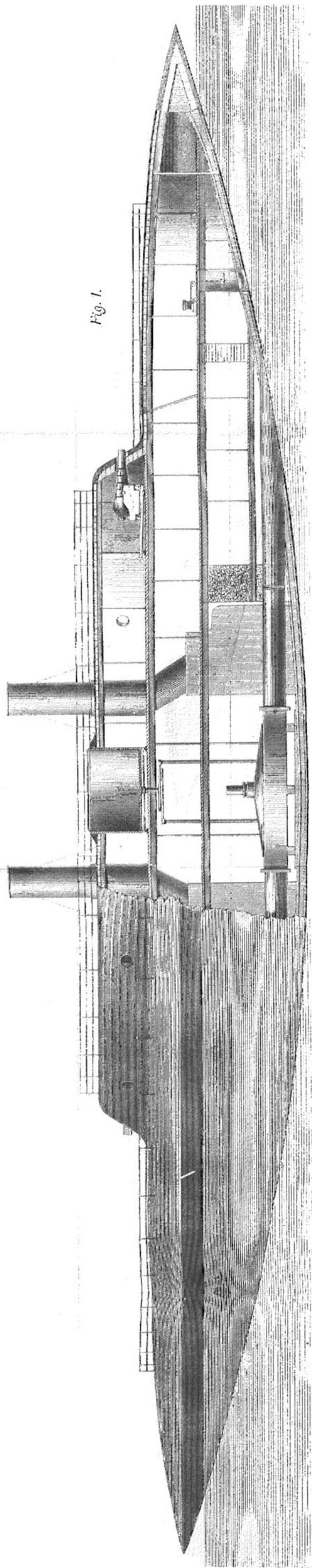


Fig. 1.

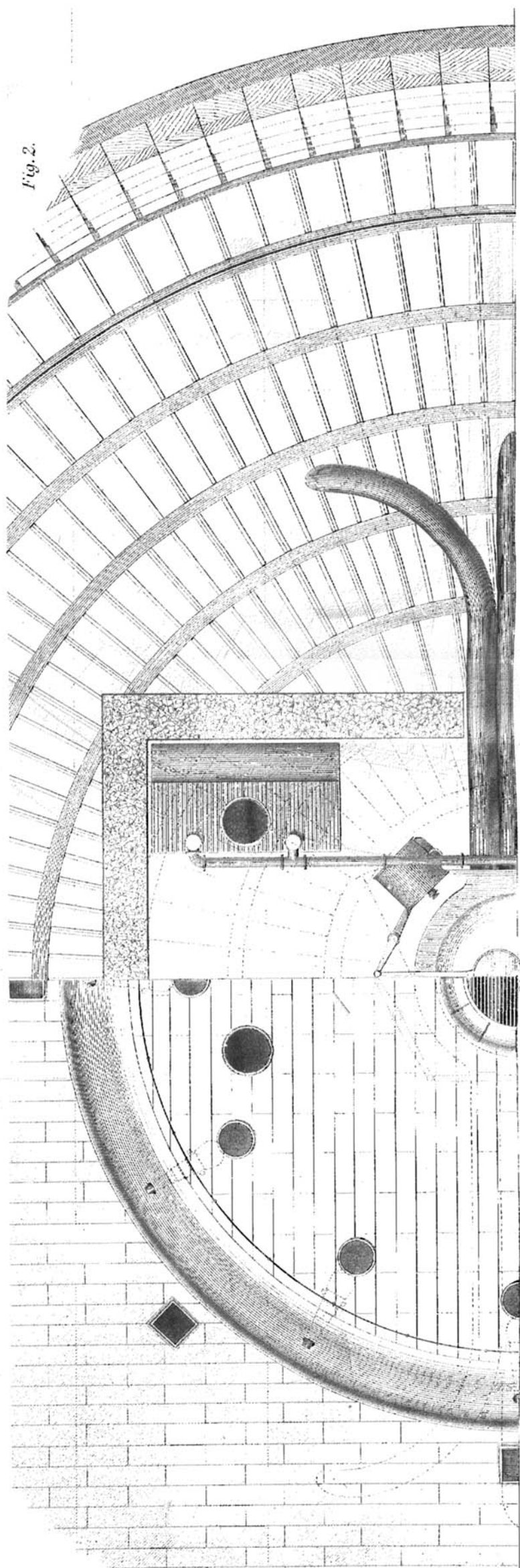


Fig. 2.

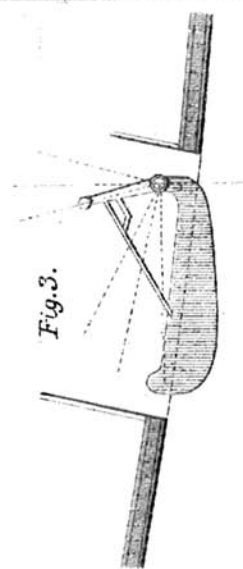


Fig. 3.

our best iron-clads, but circular in form, may not be propelled at an equally high rate of speed, whilst from the very light draught of the circular ship, it would be able to approach and enter many places at present quite inaccessible to our large vessels as at present constructed.

I also found, as might perhaps have been expected, that the circular model was much drier and a better sea boat in rough weather than the ordinary model, and its immense superiority as regards stability is sufficiently obvious to render unnecessary any remarks upon that branch of this subject.

To illustrate the modes of propelling, I have shown in one of the diagrams (Plate xxvi) several ways that might be employed, such as fitting one or more screw propellers supported by brackets (Figs. 1 and 2), fixed to the outer skin of the vessel. Another method might be adopted in which a casing or trunk is formed, so as to admit the crank shaft, and the screw shaft being carried sufficiently low down, as to enable the propeller to work in unbroken water. I have also shown a plan with a water jet propeller (Fig. 3).

The circular vessel from its form, and the very nature of its construction presents an admirable opportunity for placing in the most secure position the machinery and apparatus necessary for transmitting and communicating motion to the propeller, as well as for controlling and manœuvring the vessel whilst in motion, it also offers peculiar advantages for adapting the turbine or emissive jet propeller over any other form of vessel heretofore designed.

I therefore proceeded to arrange and adapt the hydraulic propelling apparatus to my own requirements, and as it will be seen on reference to the drawings (Plate xxvii, figs. 1 and 2), nothing can be more compact and convenient than this adaptation. By this means the contour of the vessel may be preserved unaltered, and it is consequently perfectly free to travel in any direction, or to revolve fly-wheel-like with the smallest possible expenditure of power, there being no projecting parts or pieces either of machinery, gearing, or casings to impede the vessel's movement.

In order that the efficiency of the vessel as a war-ship should be fully developed, it is necessary that it should be capable of manœuvring with the utmost possible rapidity, or that it should be capable of having the direction of its motion or movement changed from right to left, or reversed, or be capable of revolving or pivoting without difficulty or loss of time. In our long build of broadside-battery ships of war, to turn about after firing one broadside to discharge the other, is a matter involving an immense sweep in distance travelled, a vast expenditure of power, and a considerable loss of time, whereas, I foresaw that I might accomplish the object so much desired by every naval tactician and artillerist, by bringing the whole of the guns under his command to bear upon the object of his attack with the greatest rapidity in any required order of succession, without any longitudinal or lateral—in fact without any linear-movement at all of the vessel or gun platform; this at the same time possessed a stability and steadiness which no existing form of floating battery or other ship of war can possibly possess.

Now, for the purpose of effecting the object sought to be attained, I designed the peculiar arrangement of machinery and apparatus which I have shown on an enlarged scale in a transverse vertical section and plan in Plate xxviii, figs. 1 and 2. Upon reference to these views, it will be seen that the machinery apparatus consists of a large turbine or horizontal centrifugal pump, the vertical axis of which is in the central line or axis of the circular ship, and the spindle, or driving shaft, forming the axis of the turbine or pump is rotated at the requisite or necessary speed by means of a steam-engine or engines in the usual way, and is capable of being set in motion, or it may be stopped readily either by the stopping of the engine, or by disconnection, or throwing out of gear by means of a clutch or other convenient apparatus.

For the purpose of causing the vessel to travel in a right line, or of changing its direction of motion at any angle from the line at which it was previously moving, and also for the purpose of giving a compound movement to the vessel whilst in motion, and also for the purpose of rotating the vessel about its own centre, either whilst the vessel has no forward or backward linear movement, and for producing a compound rotary and onward movement, I have contrived several simple and effective arrangements of propelling apparatus, some one or more of which, I propose to describe in connection with the employment of a turbine or centrifugal pump as before mentioned, and shown in Plates xxviii and xxix.

One of the arrangements which I have shown for effecting these various movements is, that in which the outer case or shell surrounding the turbine has four openings, and communication by means of large pipes between it and the water, in which the ship is floating. These pipes are placed at right angles to one another, and each pipe is increased near the turbine to double the area, and is divided horizontally by a web, as shown in the sectional view (Fig. 1, plate xxviii). At this point a valve is placed, and this valve is free to travel vertically, so that when lowered, it shuts the water off from the bottom division of the pipe, but leaves the upper division of the pipe open, and thus when it is raised, the lower division will be open, and the upper one closed, and when placed at half the length of its travel, it would shut off all communication between the turbine, and the external water, and so check the inflowing or outgoing, or admission or emission of the water.

The turbine itself is shown as similarly divided in two parts, my intention being that the lower half should be employed for a suction or indraught, and the other half for the delivery or emission. Now for the purpose of illustrating the action of this propelling apparatus, I will beg your attention for a few minutes to the several parts illustrated in Figs. 1 and 2, plate xxviii.

Now, supposing that the two cross pipes, C and D, are entirely closed, and that the valve in the pipe A is raised to its full extent, and the valve in the pipe B lowered, the turbine will have its lower half or suction open to the water through the pipe A, and its delivery or water jet similarly open through the pipe B, and consequently the

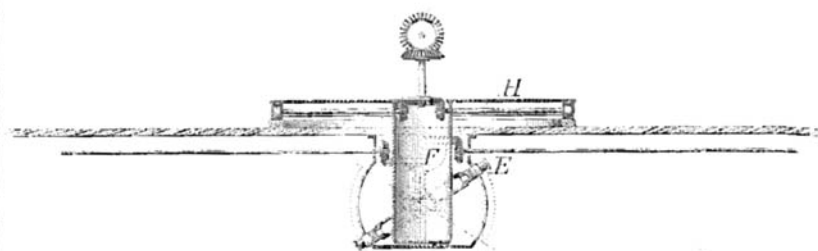
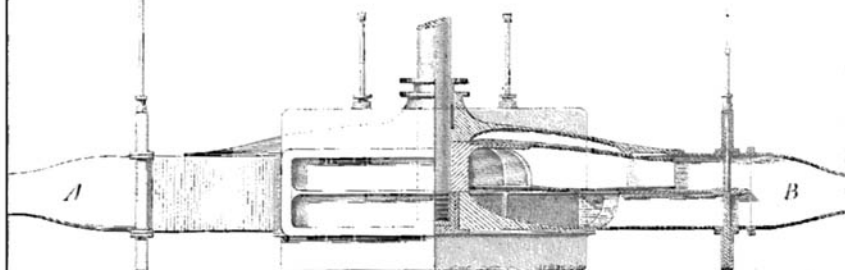
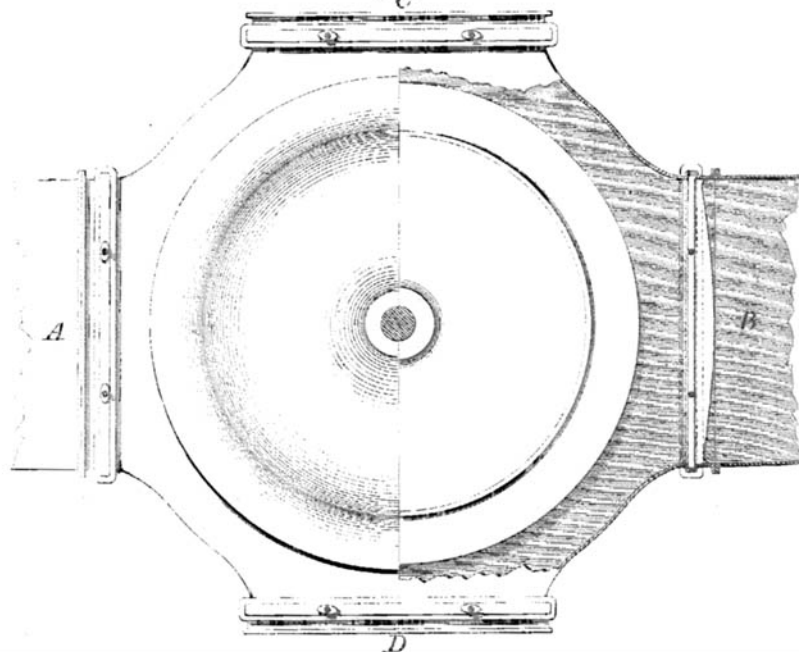
*Fig. 1.**Fig. 2.*

Fig. 1.

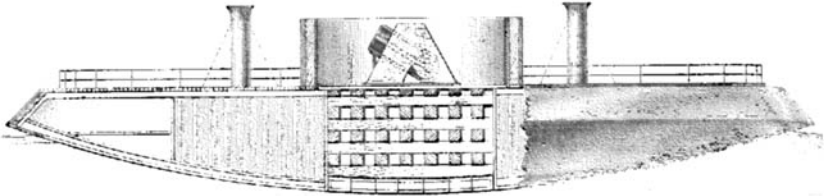


Fig. 2.

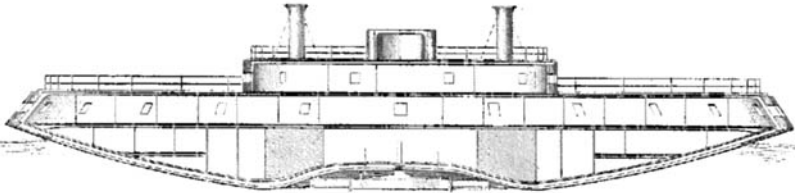


Fig. 3.

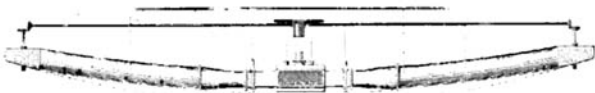
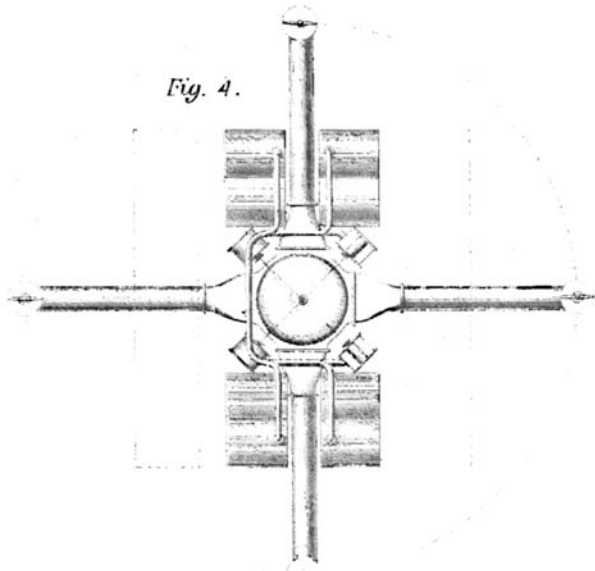


Fig. 4.



vessel would travel in the direction B A. If it were required suddenly to reverse the direction in which the vessel was travelling, it would only be necessary to lower the valve of the pipe A, and raise that in the pipe B. Again, by placing the valves of these two pipes A and B at half their stroke, all communication between the turbine, and the water would be closed, when by operating in a similar manner, as just described, the valves of the pipes C and D, a motion at right angles to the arrow in either direction would be at once obtained.

In order to actuate these several valves in connection with one another, they may be severally attached by means of suitable connecting rods and levers to a circular pulley or disk, E, Fig. 1, fixed at such an angle upon the drum, F, that the vertical distance of the highest to the lowest point is equal to the full travel of the valve, so that the valve B, that is attached to the highest point, is by means of the lever, G, placed in its lowest position, while the valve opposite to it, A, is placed in its highest position, the two other valves being both placed in their central position, of course entirely close the two cross pipes, C and D, and thus the vessel is now ready to travel in the direction B A.

Now, supposing the drum F is turned half way round, the valves of the pipe A will be brought to its lowest position, and the valve of the pipe B to its highest position, and consequently, as already described, the direction of the vessel will be reversed. In like manner, by turning the drum, F, a quarter of the way round only, the two other valves of the pipes, C and D, will be respectively at their highest and lowest positions, and the course of the vessel will be similarly varied. In order to vary the course of the ship in a slighter degree, or in other words, to steer it, balance-rudders (Figs. 3 and 4, plate xxix) are placed just at the end of the pipes and worked in the usual manner. A turntable, II (Plate xxviii), may be attached to the drum, F, and which will consequently revolve with it, so that a person standing upon this turntable with his back to the highest point of the angular pulley, and looking straight before him, will always be looking at the spot towards which the vessel is travelling, and thus by revolving the turntable and bringing himself when in that position to look at any particular spot in any direction, the vessel will travel towards it. By having a line drawn on the turntable, or by having a sight fixed in the proper line, the direction in which the vessel is travelling might be told at a glance, with the greatest precision. The whole of these valves may be worked by means of independent engines carried on the turntable itself, and the only manual power required would be to move a small handle, as from time to time may be necessary.

The vessel may be made to revolve by putting the rudders hard over, but if greater facility for revolving is required, curved pipes (Fig. 2, plate xxvii) would be used, in addition to the straight ones, already described, one being placed on either side of the straight pipe and the three being so worked by a valve that only one of them can be fully open at a time. It will thus be self evident that if the water is taken through one of these curved pipes into the turbine, and delivered

by it through the opposite curved pipes, shown in dotted lines, so that the water travels somewhat in the form of the letter C, both the suction and delivery pipes are tending to force the vessel round. The vessel is thus enabled to travel in any direction, or to revolve by simply actuating the slide valves fitted to the respective pipes, and we have, therefore, a vessel capable of executing the most difficult manœuvres with the greatest rapidity. So much for the form of these vessels and for the mode in which I propose to move or actuate them.

Armour-plating for Circular Ships.

From the peculiar form of these vessels but little breadth of armour-plate will be required of any considerable thickness, as the whole of the lower part of the ship is inclined at such an acute angle with the horizon that it would be impossible to strike it injuriously except with a ricochet shot (see Plates xxiv and xxv).

The Form of the Upper Portion of Circular Ships, whether employed for the purpose of Attack or Defence.

The upper part of the vessel may be made of various forms (see Plates xxiv and xxv), thus the sides may be raised directly from the outer edge and sloped inwards so as to form a cutting edge round the rim of the vessel (Fig. 2, plate xxiv), and also be pierced for guns—a revolving pilot-house being placed in the centre from which the vessel is manœuvred, as before described, and as illustrated in Plate xxviii. The only heavy armour-plating required in this case is, as there shown, about 7 feet in breadth round the outside, and similar plating to protect the pilot-house.

Allowing the thickness of this armour-plating to be 8 inches on these parts and 3 inches on the lower angled portion for about 8 feet in width, the armour-plating would be about 2,000 tons in a vessel of 200 feet in diameter, with 13 feet draught of water, and capable of carrying 26 heavy guns.

As a modification of this plan, a second battery may be placed above this of smaller diameter, as shown in Fig. 1, plate xxiv, when the fighting power of the vessel would be increased by 10 guns, and the draught of water would then be about 14 feet. In Fig. 4, plate xxiv, is shown an elevation of another modification in the shape of the vessel. In this case there are no guns round the outer edge, but this part is made very sharp and immensely strong, and is meant to be used as a ram, or rather as a circular saw and ram combined. Thus, upon coming into collision with another vessel, a rotary motion may be imparted to it by forcing the water through the curved pipes, before described, which would then give the edge a combined ramming and cutting motion sufficient to make a very ugly gash in the side of the strongest iron-clad. The battery is intended to carry ten 300-pounder guns, and it is calculated that with proper appliances, a gun

of this size may be worked so as to fire once a minute; it would only be necessary to cause the vessel to revolve at that speed to deliver ten 300-pound shot against the same spot in the space of one minute. By having a "look-out" in the centre of this battery, with lines of sight accurately corresponding with the lines of fire of each gun, one man might, by means of lanyards, fire each gun as it came opposite the required spot, and thus the only training required to be done by hand would be for obtaining the required elevation.

Upon referring to the elevation, Fig. 4, plate xxiv, it will be seen that this vessel has the deck somewhat rounded, several advantages attaching to this form. In the first place it can be made very much stronger and better adapted for ramming purposes than is possible with a flush deck, the angle formed with the horizon by the plates above and below the cutting edge being about equal.

It would also be impossible to board a vessel with a rounded deck, while any water that might be shipped would immediately run off again.

In Plate xxvii, figs. 1 and 2, is shown a design for a still more powerful vessel, being 280 feet in diameter with 15 feet draught of water, and intended to carry 14 22½-ton guns, each throwing a 600-pound solid shot. In this case the vessel is intended to be manœuvred from a pilot-house above the battery, the arrangement for working the valves from it being shown in the drawing. Various other modifications, as shown in Plates xxiv and xxv, may be made, both in the external form or hull and also in the arrangement of the batteries. Thus the hull, instead of being a section of a sphere, may be in the shape of a truncated cone, which might in some cases be preferred. The vessel might also carry several tiers of guns and for some purposes, such as firing over the walls of a fort or high bank on shore, a turret or tower may be built to a considerable elevation (Fig. 1, plate xxv), the immense stability of this form easily admitting of such an arrangement.

The methods of propulsion, too, may be greatly varied; that shown in Fig. 2, plate xxix, being exceedingly simple. In this case the turbine is outside the vessel in a recess formed for the purpose. This turbine may be turned, by means of a rack and pinion, in any direction, while the same pinion-shaft carries at the other end a similar pinion-gearing into a similar rack attached to the pilot-house (see Fig. 3, plate xxvi), the turbine and pilot-house being turned simultaneously in the same direction. By placing an opening or look-out in the pilot-house, exactly over the suction of the turbine, the spot seen from thence, is the spot to which the vessel is travelling. Now, supposing the Officer in this pilot-house has the means, by the use of a small donkey-engine, or by any simple method, of turning it in any direction he pleases, he at the same time turns the turbine as well, and, therefore, by keeping any particular place in view through the opening in the pilot-house, the vessel will travel in that direction. He has therefore only to look at the object which he desires to approach, in order to enable the ship to be propelled directly to or towards it.

The Construction and Method of Building the Circular Ships, and their General Arrangement.

I propose next rapidly and cursorily to glance at these points, as the time allotted to me is now fast approaching its limit.

Construction.—The construction of these vessels is as simple as that of an ordinary iron ship, only that the frames and floors, instead of extending from keel to gunwale athwartship, radiate from the centre to gunwale at the outer edge, every frame and floor being the same length and form (Figs. 1 and 2, plate xxx); this will greatly facilitate the erection of the structure.

These frames are thoroughly secured in their places by a series of circular keelsons or stringers, placed as deemed necessary. Beams may either be put in straight across (Fig. 1), or to radiate (Fig. 2) (the straight being preferred); the beams on one deck being placed at right angles to those above or below. The beams will be made in straight lengths of about 40 to 50 feet, secured with a long scarf plate, and thoroughly supported by a series of holds. The outside plating will be easily put on, as each strake of plates will have exactly the same "set and say." In some cases it may be preferred, instead of radial framing to frame the vessel with a series of circular keelsons or frames, and the stringers to radiate as the frames do in the first method described; this would answer every purpose just as well, but would be more difficult and expensive to erect.

Steering.—It is proposed to steer these vessels, either by means of ordinary rudders placed at the outlet of the propelling pipes, or by blade rudders similar to those used in the Indus flotilla boats (Fig. 3, plate xxvii), placed at an angle of 42° , fitted in water-tight wells, the one being lowered as the other is raised. Four such rudders would be sufficient for a vessel of this class, and all would be worked by one steering gear.

Bulkheads.—These may be placed in any position, and divide the vessel into as many compartments as may be thought necessary for safety.

Ventilation.—This is to be obtained by means of fans worked by donkey-engines, it not being desirable to have as great a number of skylights and hatches as in ordinary ships, and all openings should be made as conveniently small as possible, and fitted with armoured hatches of the same strength as the deck covering, so that when going into action, all exposed parts shall be of the same relative strength. A ventilator is fitted in the battery deck over each gun.

Mortar Beds.—These vessels are admirably adapted for carrying large mortars, on account of their great stability, and it is proposed to use them for such purposes by forming the mortar bed of a large area, and constructing the same of baulks of timber laid one on the other after the manner of a steam-hammer bed (Fig. 1, plate xxix), the upper portion of the bed may be fitted with a series of india-rubber buffers, or springs to assist in deadening the recoil.

Mooring.—It is proposed to moor these vessels by means of mush-

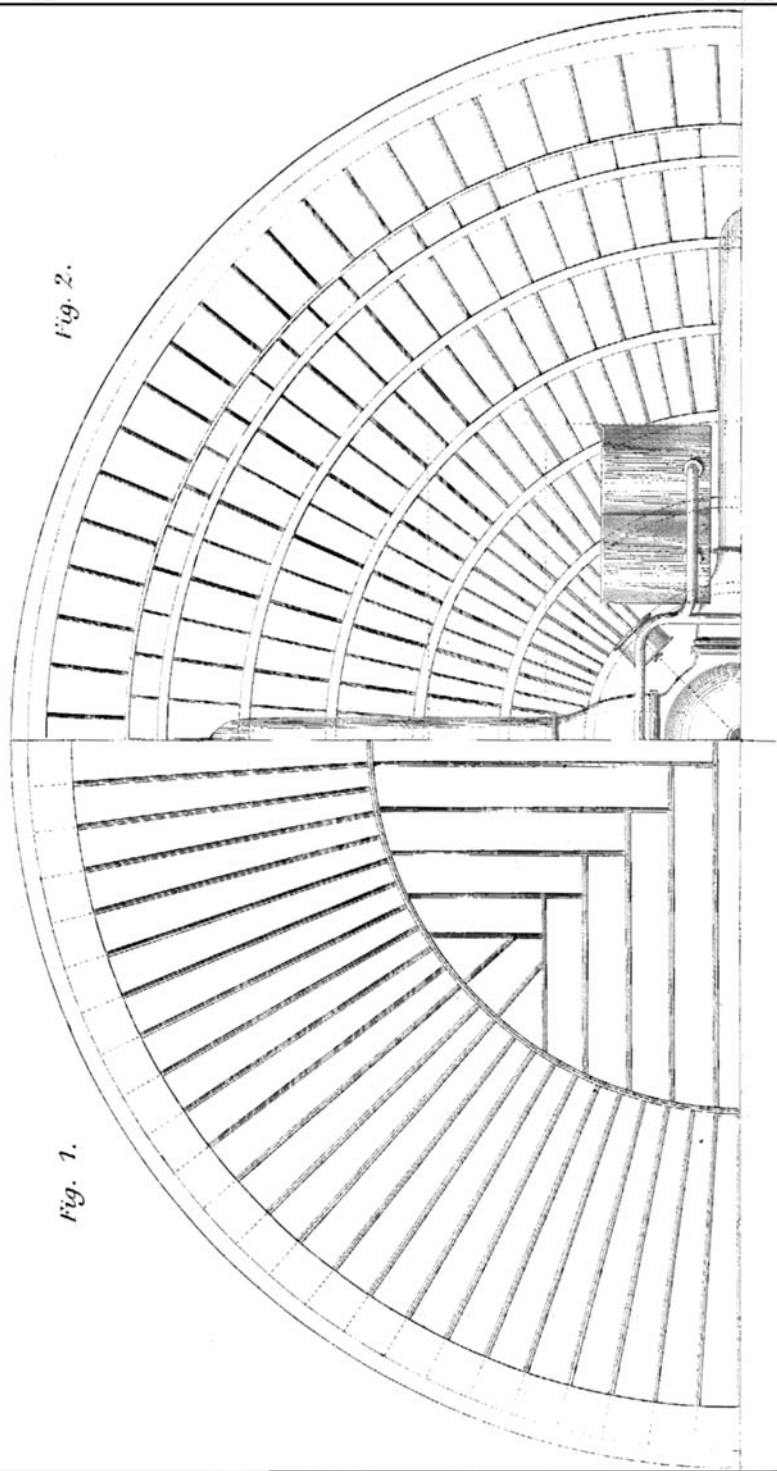


Fig. 1.

Fig. 2.

room or other approved form of anchors, worked by capstans, &c., in the usual manner, but instead of hawsepipes, catheads, &c., we lower the anchors through a well in the ship's bottom (Fig. 1, plate xxvii), and when the anchor is raised, the lower portion of it is flush with the outside plating of the vessel. The well is constructed of a sufficient size, and sufficiently high out of the water to introduce another anchor in the event of losing one.

Turrets.—For the turning gear, the plan usually in practice is proposed to be employed, but the principal object of fitting turrets to these vessels is for fighting the heaviest class of guns when the ship is at anchor, and the whole structure cannot revolve in the water as one turret afloat, until steam is got up. Another advantage is, that we may have these turrets higher out of the water than in ordinary Monitors, and so fire down on the decks of such vessels; but in some cases for harbour defence, we would propose low vessels carrying say four or more turrets as the case might be. In such a class, would be combined all the advantages of a "Monitor," and if need be a most formidable ram when underweigh.

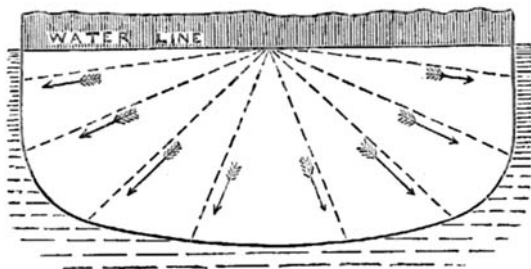
Ram.—Any portion of the armoured edge will act as a ram, and if the vessel is driven at any floating body, before coming in contact with the same, it is proposed by means of its peculiar machinery to cause the whole structure to revolve, which will deaden the shock on the circular vessel to a considerable extent, and enable it to act as a saw against the sides of its opponent, thus doing enormous damage.

Accommodation and Stowage.—Space for fuel is provided all round the central portion of the vessel occupied by the machinery and boilers, and may be of any capacity that is desired. Alongside of the coal-bunkers, so as to be directly under the battery, may be fitted either two or four magazines and shell-rooms, as may be necessary; these having water tanks on the top, and around three sides, with the bunkers on the fourth, will be secure in case of fire, and pipes may be fitted for flooding the same without injury to any other portion of the holds. I have shown in Figs. 1 and 2, plate xxvii, that the main-deck is divided into four segments by strong iron, water-tight bulkheads, and a circular collision bulkhead extending all round about 12 feet from the periphery. On this deck is provided ample accommodation for the Officers, crew, engineers, Marines, &c., in fact from the form of vessel, the amount of space for accommodation is more than will be required. Below are the holds fitted in the usual manner, with store-rooms, bread-rooms, chain lockers, boatswain's and gunner's stores, and all the usual appurtenances of a vessel of war.

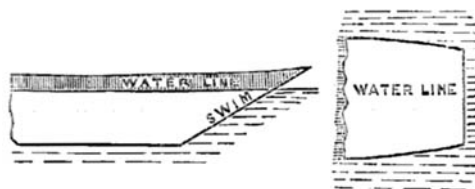
Battery.—Access is obtained to the battery from the deck below, and from its circular form great space and convenience is secured for working a heavier class of guns, and ample room is provided for the cranes, and all the usual gear and machinery for hoisting up heavy shot and shell.

Speed and Resistance.—As I have before stated, a circular vessel of any of the accompanying forms will offer but little, if any, more resistance to the water than vessels of the "Minotaur" and "Agincourt" class. The breadth on the water-line amidships for a vessel of

200 feet extreme diameter, we will take at an average to be 185 feet, with a draught of water in the centre of 14 feet, a displacement of about 7,000 tons, and an immersed area in square feet of about 2,100 feet. Our larger iron-clads—say the “Warrior”—are about 58 feet beam, drawing somewhere about 30 feet of water, which will give an immersed area, allowing for rise of floor and turn of bilges of about 1,500 square feet. Now, as far as this appears at first sight, the difference in area of midship section is greatly in favour of the “Minotaur” class; but at the same time, it must be borne in mind that the draught of water is more than doubled, and for every foot of immersion, the resistance to a moving body is immensely increased. Another matter to be duly considered, and a very important one, is, that all vessels only divide the water in accordance with the form of their water-lines, on and a little below the surface, and on their flat sides amidships, if flat-sided (this vessel has no flat side), from whence the water is displaced or driven under, as shown in the sketch. This



may be proved by examining a steam-yacht's bottom that has been newly black-leaded or painted, and not allowed to dry before making a run, when a number of wavy marks will be found in the direction I have named. Another instance in proof thereof is the swim of the ordinary Thames barge; the longer and easier “the swim,” both fore



and aft, the easier is the barge in tow, or the faster will she sail. And I may mention, as a still further proof of this theory with regard to fine vertical sections, as influencing the speed and resistance of vessels, the fact, that when a well formed steamer gets underway, as she attains her speed so she lifts her bow out of the water to a

certain extent, and the old bluff-bowed vessel, or the vessel with fine water-lines and bluff forward buttocks (and there are many such), and with the vertical sections or buttocks much finer aft than forward, has the tendency to immerse her bow, instead of to rise, consequently proving that for speed, fine fore and aft buttock-lines are of the utmost importance when combined with the least possible depth of immersion. For example, the old "America" yacht, of A.D. 1851, had the finest fore and aft buttocks or vertical sections of any vessel afloat, good beam and light draught; consequently to these qualities is attributable her great speed. Now, with regard to the circular form of ships, it is evident that they have the finest possible vertical sections that can be obtained in any vessel, and putting these facts to weigh with shallow draught against the extra amount of area of immersed section and the fulness of the water-lines, it is evident that the increase of resistance is but of little or no importance, for it will be seen by reference to the first woodcut, that whilst in the circular ship the relation of breadth to depth of immersed sectional area is as 185 to 14, giving 2,100 feet, a ship of the ordinary form of the "Minotaur" class would have a breadth of 59 feet and a depth of 30 feet, giving nearly 1,500 feet

I have now occupied more time than I intended to devote to the reading of this paper, but I trust that this will not militate against the fullest discussion of the subject, which I now respectfully invite; and in conclusion, I shall be happy to answer any questions arising out of its reading, and which are in my power to reply to. If I am fortunate enough to have succeeded in occupying your time without wearying you with so unpopular a subject, I shall at least have done as much as many other abler men have done when they have undertaken the task of inviting public attention to a subject, the ultimate importance of which may not have been understood, and must not be measured by the unpreparedness of the public mind; and on any question which involves the judicious and useful expenditure of money for a specific and well defined purpose as against the lavish and injudicious outlay of money raised by national taxation in a time of national disaster and depression, such a subject as the present, although presented in so unscientific and popular a manner to so distinguished an audience, still merits for itself a share of public attention.

The CHAIRMAN: You have heard the invitation of Mr. Elder, and the hope he has expressed that the value of his paper may be brought out by the discussion that will follow. If any gentleman has any observations to make we shall be very happy to hear them, but I would suggest that any gentleman who addresses us should keep his remarks entirely to the subject before the meeting, and, in order that others may have the opportunity of taking part in the discussion, that he should confine himself to ten minutes. If any one has any questions to ask, Mr. Elder will be kind enough to make a note of them, and at the end of the discussion answer them in gross.

Admiral HALSTED: If you will permit me to say, just to break the ground for a very old friend of mine, for whom I have great esteem, that he must not be surprised if he has taken us all aback, when we have got to consider so utter and entire a novelty as that which he has brought before us.

Captain J. H. I. ALEXANDER, R.N.: I wish to ask what is the proposed manner of heaving the anchor up, for I see in one of the sectional plans the capstan on the

upper deck, which seems to me excessively exposed? not that I can see any difficulty in placing it below the water line, on the next deck. I would also ask what is the proposed thickness of the defence of the upper deck against a vessel high enough in the water to fire down on her? It seems to me that there is a very large space exposed there, and if it is proposed to give a very great thickness, of course it will add very greatly to the draught and tonnage of the vessel. Otherwise, while confessing that, like the gentleman behind me, I am rather taken aback, still I am very much in favour of the plan. It seems to me that, if it were possible to adopt the tortoise-shell form for the upper portion of the ship at an angle which would in all probability glance a shot off, it would be much more secure, and would be equally available for the purpose required.

Mr. ELDER: That is about the angle (showing the model).

Captain ALEXANDER: Even that model which you have there seems to me to be a very insufficient angle for deflecting shot.

Vice-Admiral ROBINSON, Controller of the Navy: The few observations that I was going to make are rather met by the observations that we have heard from the gallant Officer—that the plan before us is a matter of extreme novelty, and that we are rather taken aback by such a novelty. I confess that, having for a great many years of my life, in an official capacity, been dealing with novelties every day, and having been instrumental in advancing some novelties, not exactly towards perfection, but at any rate I hope in the direction of progress, I do not feel absolutely taken aback by the very novel proposition that you, Mr. Elder, have introduced, with great ability, to the meeting this night. I think, on the contrary, it is a proposal that we ought to consider most attentively, and we shall be glad to hear from you answers, which I have no doubt you are perfectly capable of giving, to many objections that must at once suggest themselves; I am sure they suggested themselves to your mind when you were contriving and inventing this machine or ship. The obvious difficulties and objections that must present themselves to any one like yourself, or like most of the gentlemen in this room conversant with the motion of bodies through the water, are in connection with that extraordinary midship section that you have got to deal with. I see before me a midship section, in a ship 300 feet long, I ought rather to say a circular vessel 300 feet in diameter, which midship section cannot be much less than 280 feet across at the water line. One of the ablest naval architects in Great Britain, to whom we all bow, who never speaks or never writes upon any subject without 'both enlightening and delighting us,' Mr. Scott Russell, has said of a midship section, "the midship section of a ship is the thing that you have to drive." Now, I own, and I am sure you did when you first began to think and to consider this important subject, that I look with a little stupefaction at a midship section at the water line, which presents a breadth of something like 280 feet, to be pushed through the water at any velocity whatever. I observed you fell into a mistake of no very great moment, it does not affect your argument, in supposing that the "Minotaur" class draw 30 feet of water; the "Minotaur" class only draw 26 feet of water. Still the excess of draught of water in the "Minotaur" over the circular ship I do not deny is very great, but the immersed midship section of the "Minotaur" class has never at the load line exceeded 1,220 feet—something like that, not 1,500 feet as you suppose. Now I want to know, and I am sure you must have thought of it, and must be able to inform the meeting, and will do so hereafter, how you are going to drive a midship section that has 280 feet width through the water, when a midship section that is 60 feet wide presents such enormous difficulties that engines of 6,000 and 7,000 horse-power are required to drive it? That is one of the first difficulties that presents itself to my mind, but one which I have no doubt you are competent to remove. Another difficulty which presents itself is, with reference to the steering blades or rudders with which you intend to direct the course of your vessel, if I do not misunderstand you, if I do, you will set me right. I am perfectly well aware how you will perform your twirling operations and your little sawing with your machine when you get alongside your enemy, by means of hydraulic power, emitting water on the different sides of your engine by your hydraulic apparatus. But what I do not understand is, how upon a given course, with the sea and wind in a given direction, you will with your

steering-blades and rudder compel a circular machine like that to go on a given and straight line? My own opinion is that both wind and sea will, to use a sailor's phrase, "play the deuce" with your steering-blades and rudders, and that you will find extreme difficulty in propelling the ship on a given straight line. I daresay you have thought of that, and will be able to give us an answer upon that point also. As far as the structural details of the ship go, any person who has ever gone into engineering for a moment must be perfectly aware that they present no difficulty. There can be no doubt that you can have in that circular vessel a solid structure, that you can put upon that solid structure such armour plating as you think right, and that you can arm it with such a battery as you think desirable, and make it a perfect floating defence. Last Monday there was an able lecture delivered here on the subject of floating forts and defences. A very excellent and practical gentleman, Captain Moody, gave us his views, through the medium of Mr. Mackie, a gentleman connected with the press, a very able writer and speaker, who gave, I thought, a most interesting lecture to the meeting on the subject of floating forts, and the facilities they offer, combined with land forts, for defence. Now, if your circular fort was content to abandon locomotion, there is in it, no doubt, something that will be extremely valuable, and which ought to be considered by those whose business it is to fortify our forts and harbours. My question and the few observations I have made—I am sure you will not suppose that they are put with a hostile feeling, or in a spirit of criticism—my object only is to obtain from you that kind of information which will enable those who are sailors to form some sort of judgment of the locomotive power of that circular ship. Without locomotive power, and without steering power, the value you would put upon it, and the value this meeting would put upon it, would be very much lessened, indeed. Therefore I say, without the slightest wish to daunt the inventor—without the slightest fear of embracing any novelty, provided that novelty can recommend itself to the mind and judgment of those who have to carry into practical effect the ideas and inventions of others—without in the slightest degree wishing to put these remarks in a hostile spirit, I make these remarks with the view of telling you the difficulties that occur to my mind, that you may, before we leave this room, give us some explanation on the subject.

Commander COLOMB, R.N.: I had intended to make some remarks, and I had made two or three notes, but the Controllor has entirely cut away the ground from under my feet, because he has said almost everything that I should have said myself, and has expressed in far better words than I can do, the thoughts that crossed my own mind during the reading of the paper. The two points which he has adverted to are those which must have struck the mind of every person who listened,—the possibility of propelling such a vessel at a given speed, and the possibility of steering her when so propelled. In the early part of the paper, mention was made of experimental trials. I hoped at first, on hearing that mentioned, that we should have had more of the experiments and less of the suppositions. However, we had nothing, as far as I heard—I shall be corrected if I am wrong—we had nothing in the way of experiment except the towing of two structures, one against the other, at the end of a balance-rod across the stern of a boat. Of course that goes a certain way. But I must say that my own idea would have been that the only satisfactory way of ascertaining whether it was possible to propel and steer such a structure would be to have myself made an experiment on a small scale before submitting it publicly; and I question very much whether it would be possible to answer Admiral Robinson's questions, except by producing certain experiments. Of course, if those are forthcoming—and I hope we shall have them—then my doubts will be set at rest. I should say that while Admiral Robinson was speaking, a thought struck me with reference to the steering, which is in favour of that structure; that is, that wind and sea will operate equally on both sides of the line that you propose the ship to follow. In a ship which has greater length than breadth, of course the wind and sea will be acting in particular directions upon her; whereas in that ship, as far as I can see, there will be no more action on any one part than on any other. But that, perhaps, you will also advert to in your answer. If it is possible that such a ship can be driven at a speed equal to the present ships, with a lighter draught of water, and carrying a larger number of guns, as I presume she would carry, than the present ships for

their tonnage, then the advantages are such as utterly to startle us. It seems to me, if it is possible that that can be done, that we sweep away at a blow the whole of our ideas on nautical matters from beginning to end. Generally speaking, when such an idea comes across my mind, or is presented to it by the reading of any paper like this, I feel myself obliged to hold back and to keep my mind open, so as not to express a decided opinion either for or against such an extraordinary and novel proposal.

Mr. W. SMITH, C.E.: It seems to me that Admiral Robinson has forgotten that it is not a long box presenting that section throughout, but that the midship section, or section of greatest area, is only to be taken at one particular line, which of course is at the greatest diameter, but that, before and behind, taking the cross section, she should present exactly the same shape. It is a totally different thing from a box, with the same width and depth continued throughout any number of feet. If Admiral Robinson will consider it from that point of view, he will see that what appears to be an astonishing result, is almost self-explanatory, as being due to the remarkably fine buttock lines of these circular ships.

Admiral ROBINSON: I was not fortunate enough to see the experiments that Mr. Elder referred to; and of course I am a devout believer in the Baconian theory; but being a complete and thorough Baconian in my belief, I require rather a large induction before I accept it as satisfactory on any subject. One fact will hardly convey a general principle to my mind. Independently of that, I had not in the least overlooked the fact that this was a circle; and that the particular length I mentioned, 280 feet at the water line, if the diameter of the vessel was 300 feet, was something like the measure of resistance, or rather of the trench that the ship passing through the water had to dig out. But taking the lower part of that midship section, if the other be 280 feet, that lower part must be 140 feet. There is, therefore, though not immersed to a considerable depth, a greater amount to be pushed through the water than in an ordinary ship. I admit there are various refinements of the lines, as there are in an ordinary ship. I do not think that an ordinary ship is like a box. But granting that it were, granting that the ordinary ship did not divide the water forward by its fine lines, even the square box in my opinion—I will not say in my opinion—I would only ask the question whether a square box of 50 feet broad, with a perfectly square head to it, and 400 feet long, drawing 26 feet, which is the draught of the "Minotaur" class, would be more difficult to propel through the water than this, 280 feet at the water line, brought down to 140 feet at 13 feet below the surface of the water. I do not in the least wish to say anything dogmatic, or to assert that I have an opinion on the subject. I am a humble scholar seeking for truth, asking to learn and ready to be taught by anybody; and if Mr. Elder can show a large induction, a sufficient number of experiments to show a reasonable prospect of this invention being successful, there is no one will more rejoice than myself, and more ready to be on his side.

Mr. HYDE: I very much rejoice, indeed, that so able a man as Mr. Elder has presented to you a vessel or ship having a deflecting side. He has come to the conclusion, doubtless, that vertical structures are very vulnerable; and hence he has adopted a double angle all round his ship. It might be interesting to Mr. Elder if I were to show him the midship section of a vessel that is somewhat like the midship section which he has exhibited. I have no doubt he will agree with me that a ricochet shot, or a deflecting shot rather, is likely to do less injury upon a ship of his description, or of this, than any other. I simply call his attention to the fact that deflecting-sided vessels and structures have been for a very long time advocated as being the proper form on which such vessels should be constructed. I have no doubt he can tell us, and answer all questions as regards the probability of shots penetrating the sides of vessels at the angle he has adopted. Such information will be very useful.

Captain ALEXANDER, R.N.: From several remarks that Captain Colomb made, I am under the impression that he believed the plan proposed was for sea-going ships, in fact for all purposes of war; whereas I was under the impression that under present circumstances they were only proposed as sea-going movable forts; and any remarks I made for or against them, were in that view entirely, because I was not at

all prepared to consider them as sea-going men of war. I consider them capable of moving about from place to place on the coast, and even of attacking, but not as sea-going vessels.

Admiral ROBINSON: There is one gentleman in this room (Mr. Laird) whose opinion would be much more valuable than that of anybody else, who has had the greatest experience in designing and constructing ships, perhaps he will favour us with some observations.

Mr. LAIRD, M.P.: I think that the principal objection against the plan has been made by Admiral Robinson. I should like to hear that objection explained by Mr. Elder, how he intends to steer that vessel; also whether he intends it merely for coast defence, or for sea-going purposes. There is no doubt there are many advantages in the plan, and she can be made to turn rapidly. I do not quite agree with Admiral Robinson as to the difficulty of driving a vessel 250 feet wide. Therefore, after hearing Mr. Elder's explanation, if he will explain the objection Admiral Robinson has raised—the question of steering in a sea-way—I think he may get over the other difficulty. I agree with Admiral Robinson that, in the statement made with regard to the “Minotaur” class, Mr. Elder has over-stated the midship section to be driven. But by comparing the actual midship section with the midship section of his own vessel, if he can steer the vessel straight, he will enable us in the present transition state of naval matters to get a powerful vessel. As Admiral Halsted says, I am taken aback. The steering appears to me to be a great difficulty. But if Mr. Elder can only steer the vessel straight, no doubt she will be very formidable.

A VISITOR: With reference to steering the vessel, I beg to say that I have to do with sliding keels, and I have found them very efficient in making a leeway, and also keeping a direct course on the ship with a shallow draught of water. Sliding keels are very beneficial to ships of shallow draught of water. The Honourable Member for Birkenhead has had experience with sliding keels, and he can give us some information on that point.

Mr. LAIRD: It is one of the points that I should like to allude to, with regard to the form of the vessel. There were great difficulties twenty-five years ago in navigating the river Indus. Vessels of common form with straight keels could not do it: they got aground, and could not be got off. I built a vessel of very much the same longitudinal section as that vessel, with two curved ends, and no dead wood at either end. Those vessels were found to answer better than any other; they possessed great speed, and they steered uncommonly well. Mr. Elder may have some means with his water-power of getting over that difficulty; and if so, I agree with Admiral Robinson that Mr. Elder has devised a powerful vessel.

Captain ALEXANDER: While the gentleman who spoke before Mr. Laird was mentioning a sliding keel, it struck me that there might not, to our mechanical engineers and ship-builders be so much difficulty in arranging a pivoting-keel fixed in the centre of the vessel, and turning round on its centre, being movable by machinery. So that in any direction in which it might be proposed to propel the vessel, the keel might be moved to suit the purpose of the intended direction of the vessel.

Mr. ELDER: With regard to the remarks about this being a sea-going vessel, the experiments I made were with a very small ship indeed. It was an open boat built of copper. The vessel that I experimented upon along with that, was of a similar form to iron-clads, with the same proportions as to breadth, length, and depth. I towed them in all manner of seas that I could tow them in, and in the wake of steam-boat paddles. The circular ram-boat rode over the top of the wave in an elegant manner: it slid down into the hollow of the wave, and rode over the top of the next wave, and never shipped a drop of water. Whereas, the open boat in the ordinary form was very soon swamped. The two boats were made of the same weight. They were towed at the stern of a pulling boat at a velocity relative to that necessary to overcome the resistance which vessels on a larger scale would have had to encounter. The scale beam was a beam 10 feet long, with a fulcrum in the middle. The fulcrum was pivoted in the stern of the boat. I pulled my round boat, and the open boat with that scale beam, and as near as may be, the natural velocities

of the two were about a balance. I was convinced then that there was no great reason to object to the round shape on account of its resistance. Then with regard to its behaviour in the waves, I tried them in the very worst form of wave I could put them in.

Admiral ROBINSON: What was the size of the boat?

Mr. ELDER: About 5 feet in diameter.

Admiral ROBINSON: A circle of 5 feet in diameter?

Mr. ELDER: A circle of 5 feet in diameter. I was very much pleased with the behaviour of the circular boat. I must say that I am not enthusiastic, or in favour of any one thing—I try to keep clear of that—but the object to be gained by such a ship was so great, viz., that of having a vessel of immense stability, and one that could move in any direction from a state of rest without turning, for instance, that could move right up between two lines of ships, and also go across them, or go in fact in any way that the commander of the vessel might want it to go, that I thought that was a great advantage, and it might be of very great use, if it could be accomplished. With regard to the midship section which the Controller of the Navy spoke of, he must recollect that the vessel is about at least half as large again as any ship in Her Majesty's Service in dimensions. It seems that I was mistaken as to the draught of water of the "Minotaur" class. That was given to me; the draught of water as given to me was 30 feet.

Admiral ROBINSON: It would not affect your argument much. I only wished to put you right.

Mr. ELDER: I am much obliged to you, for I really am not responsible for the statement. But this vessel has 120,000 cubic feet.

Admiral ROBINSON: Of immersed area?

Mr. ELDER: No, the cubic capacity of the total ship. The total weight afloat is 16,300 tons. Now, I do not think that the largest class ship in the Service is more than 10,000 tons.

Admiral ROBINSON: The largest is 10,900 tons.

Mr. ELDER: At all events, you are comparing the "Minotaur" with a ship which is one-half larger in weight. You will find that she is not only one-half larger in weight, but that she has double the capacity, for stores and crew, and will be able to carry ten times the amount of coal. She will be able to go to America and back without coaling. With regard to the steering, if the case is a good one, we shall not stick for want of some efficient steering gear. Here is the centre of gravity of the ship, if you cause the propelling pressure to act upon this point in any direction, the vessel will certainly be impelled in the said direction whether she is revolving or not. One gentleman has asked what would be the effect if a sea did strike her. Supposing a sea did strike her, the vessel may change her course a little. But then the man in the steering turret, which is placed at the top of the sluices, will immediately open the sluice on the other side; and that self-acting turret has machinery which opens the sluices. I think Admiral Robinson was not here when I described that arrangement of sluices. (Admiral ROBINSON: No, I was not here.) The turret is driven by a donkey-engine. All the pilot has to do is to put the pointer in the position he wishes the vessel to go. That pointer opens the steam to the donkey-engine of the steering turret, and causes it to revolve till the turret points to the direction wanted, and in its course of revolving opens the sluices commanding the jet or jets behind the steering turret. The ship should then move in the required direction. If he finds she will not go exactly as expected, all he has to do is to counter her a little. The steering of the ship is not dependent upon the rudders; the rudders are merely a preliminary appendage. That is the system of steering. But if I have not accomplished it, it is for you to do it, though I feel thoroughly confident that I could do it, and I think the machinery I have prepared would accomplish it. With regard to the resistance of the vessel, I must speak from what I know, and that is described in my paper. With regard to the thickness of the armour upon the ship's deck, the ship has such an enormous displacement, that, suppose you put 6 inches of solid armour there, she would only draw 4 feet more water; 18 feet instead of 14 feet, but it is for artillerists to say whether 6 inches of armour for a flat deck is necessary. However, practice will bring that about. It is not for us to

say that we should stop there if there are other advantages that would enable us to struggle with such a difficulty. With regard to the peculiar form of the resistance, of course theorising upon it, is not so good as experiment. But you can understand that if this ship were divided into parallel strips, each of those strips would present a ship with a curved bottom to it; and each of those ships would please every man present as a good form of ship. Why then, when so many ships separately are good, are they any the worse when they are put together? I cannot understand. The resistance is of course less when the strips are put together than when separate. I believe that this system of hydraulic power is preferable to screw-propellers in such ships on account of its capability of steering the ship thoroughly, because you can steer it in all the various directions you wish to go. For instance, this ship can find her way into the most complicated channel; it will go round the most abrupt corner; and with regard to her draught of water, she would find her way into any harbour, where almost every other ship would have to stop outside. Therefore I think it possesses great advantages on account of that. With regard to its revolving tendency, there cannot be the smallest doubt that if a vessel can be revolved, and at the same time run up between two lines of ships and fire into both sides, it would be a very great property, and I think it can be obtained. With regard to exceptional fighting, I have no doubt this may be a good ship for exceptional fighting. My opinion is that it is more fitted for exceptional fighting than most gentlemen believe. I should like to see it put to the proof. Make the vessel, give it hydraulic power, and ascertain at what speed it will go. I believe you can get vessels of this class that will go 10 and 11 knots, and be able to carry an amount of fuel that will take them across to America and back again. With regard to the edges of the vessel, there is no doubt that the strength of this edge is very considerable, and there is not much of that to fire at. The vessel is very low in the gunwale, and there is only about one-eighth of an inch of edge for the shot to strike. If the shot strikes above, it will, I believe, fly over the ship; if below, it will, I believe, go right into the water. There is very small chance of the ship being damaged; and if it is struck, there is a water-tight ring all round the periphery, so that the internal portions of the ship will be perfectly water-tight. With regard to the power of sawing, it is a queer thing to think of sawing a ship when you come in contact with it. But certainly this ship will go round at the rate of about 25 miles an hour. There are about 1,500 tons of armour in its periphery, and it is all riveted together, and that amount of 1,500 tons going at the rate of 25 miles an hour, coming into collision with a ship even at a small speed will, I think, do considerable damage.

Captain W. J. WARD, R.N.: It will require a fulcrum.

Mr. SMITH: That is what the Controller pointed out, that it has such a large and uniform bearing surface.

Mr. ELDER: That is one great advantage in this knife-edged side; besides being able to resist shot, its shape for attacking makes it a very formidable vessel. I have made arrangements with screw propellers for the same thing. You can put a couple of screws, one on each side if necessary, and there might be a screw propeller at each end. However, that is a matter for you, gentlemen, to improve upon. All I can say is, that I think this may be made a useful ship for our country; I hope it will be so. It will be my greatest pleasure to hear that it has been successful, and that it has answered some service.

The CHAIRMAN: I must confess that I am one of the gallant Admiral's class, I am completely taken aback, so that nothing more can come from me than to request you to return your thanks to Mr. Elder for this paper. I may also mention that this is not the first time that he has favoured us with a paper in this theatre. We had from him a very valuable paper on "Marine Engines." We are therefore extremely obliged to him for coming again.