No. 689,821. Patented Dec. 24, 1901.

C. H. HOWLAND-SHERMAN.

HULL CONSTRUCTION.

(Application filed Aug. 7, 1900.)

(No Model.)

10 Sheets—Sheet 1.

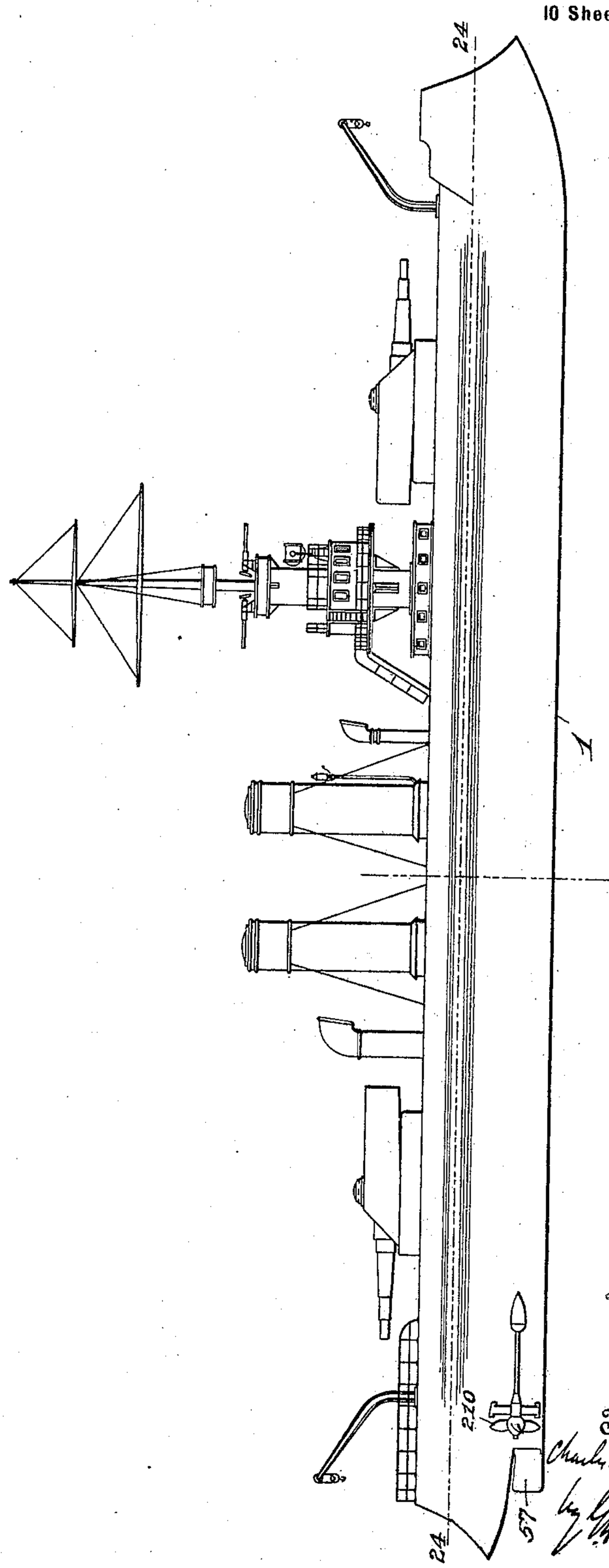

Fig. 1.

Witnesses
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No. 689,821. Patented Dec. 24, 1901.

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10 Sheets—Sheet 2.

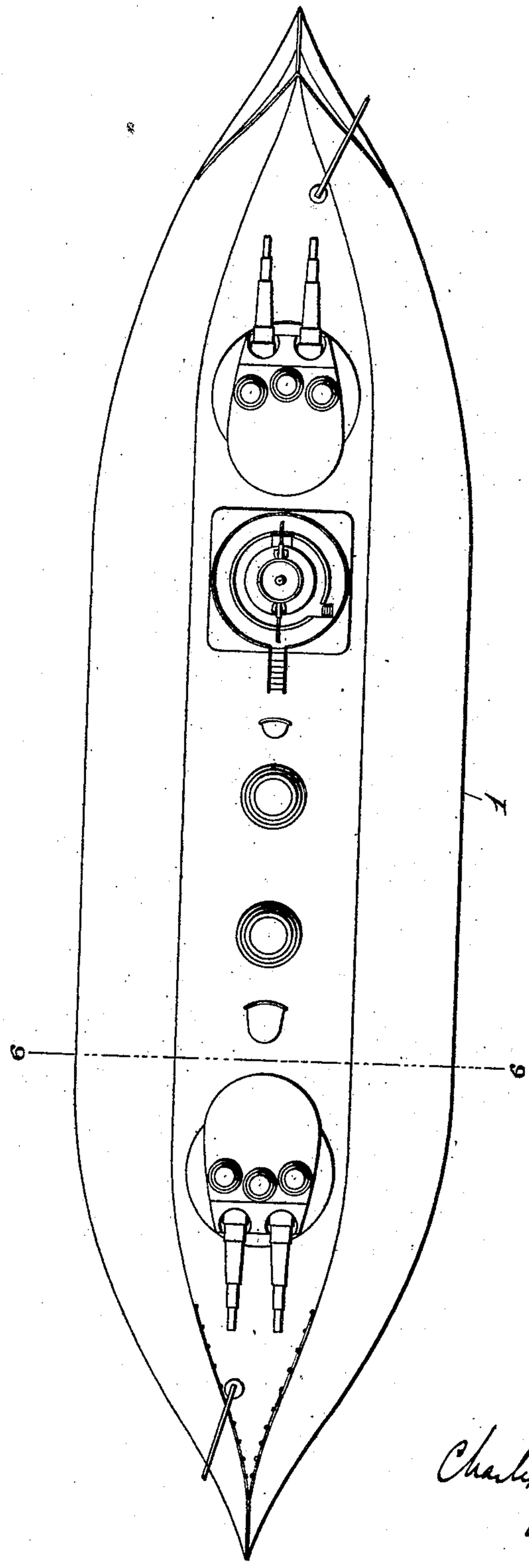

Fig. 2.

Witnesses
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No. 689,821. Patented Dec. 24, 1901.

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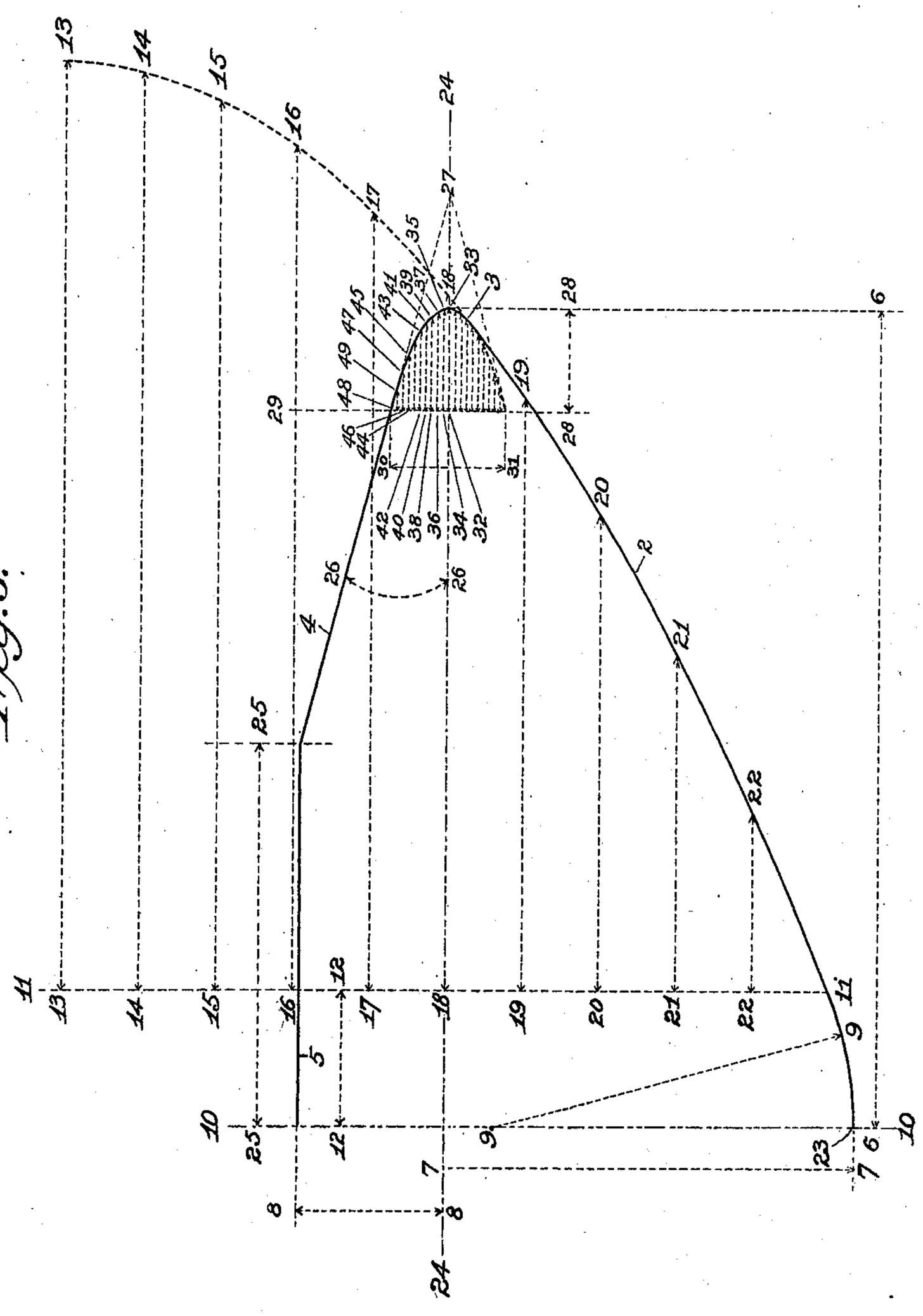
HULL CONSTRUCTION.

(Application filed Aug. 7, 1900.)

(No Model.) 10 Sheets—Sheet 3.

Fig. 3.



Witnesses
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HULL CONSTRUCTION.

(Application filed Aug. 7, 1900.)

(No Model.) 10 Sheets—Sheet 4.

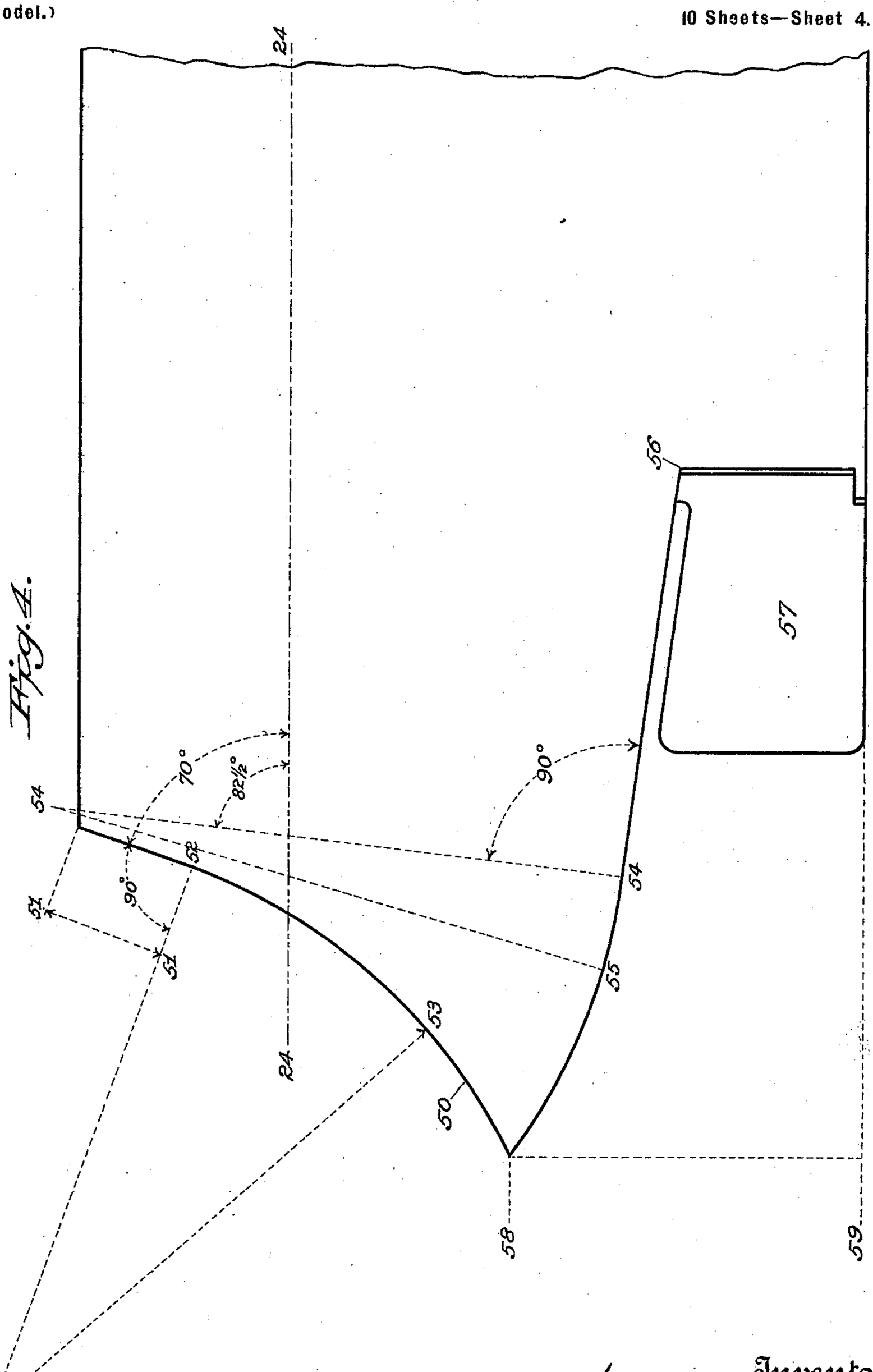

Fig. 4.

Witnesses
G. S. Elliott.
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(Application filed Aug. 7, 1900.)

(No Model.) 10 Sheets—Sheet 5.

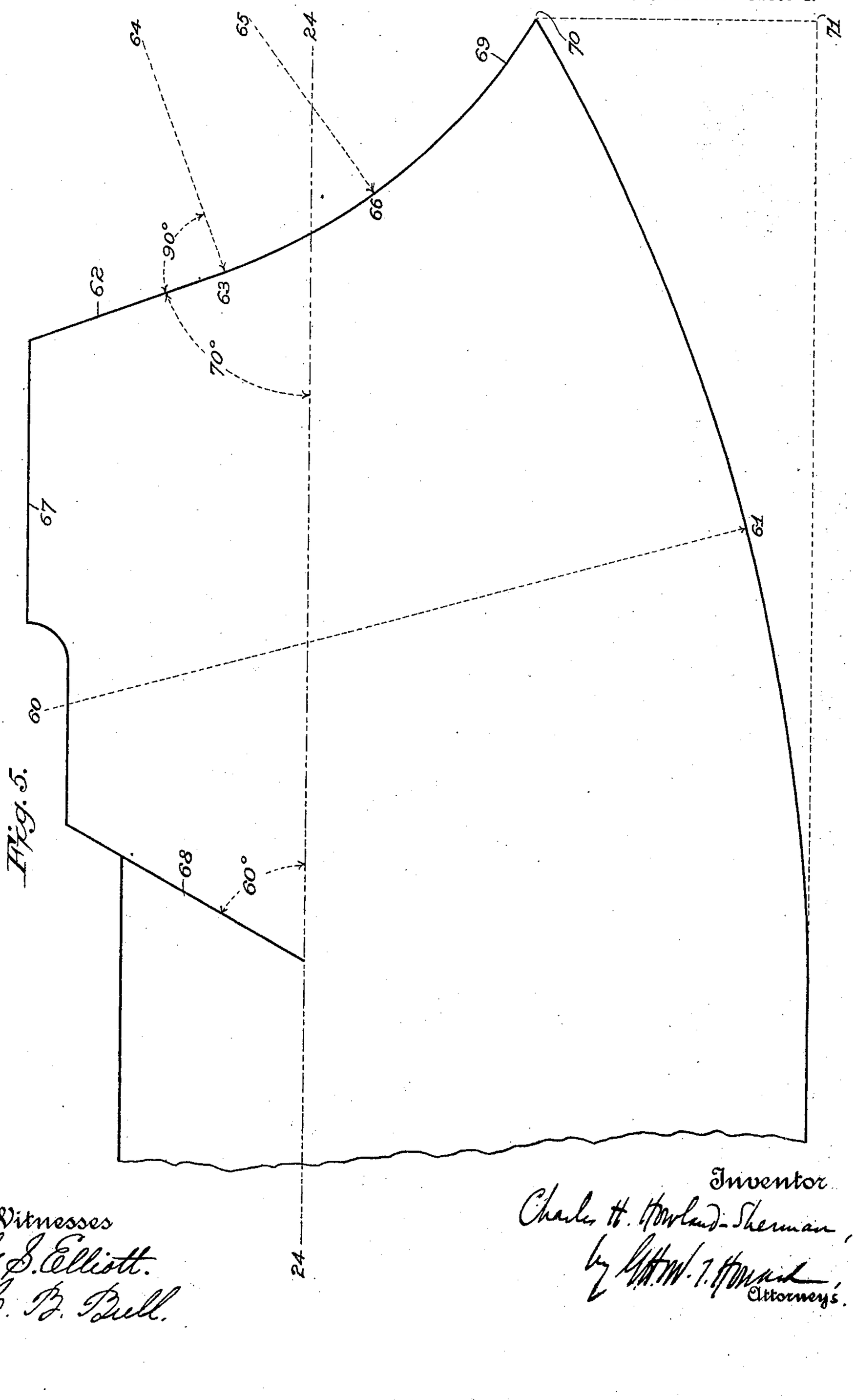

Fig. 5.

Witnesses
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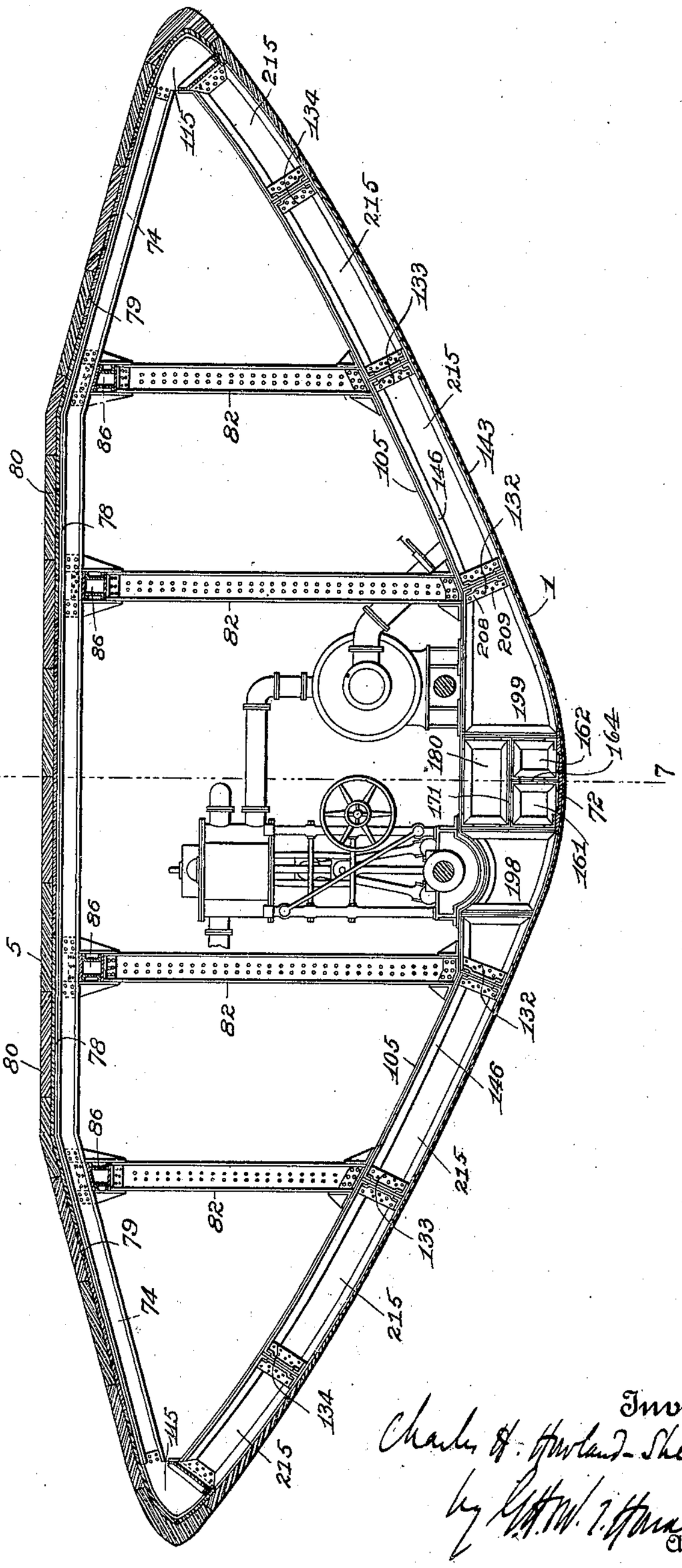
HULL CONSTRUCTION.

(Application filed Aug. 7, 1900.)

(No Model.) 10 Sheets—Sheet 6.

Fig. 6.



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HULL CONSTRUCTION.

(Application filed Aug. 7, 1900.)

(No Model.) 10 Sheets—Sheet 7.

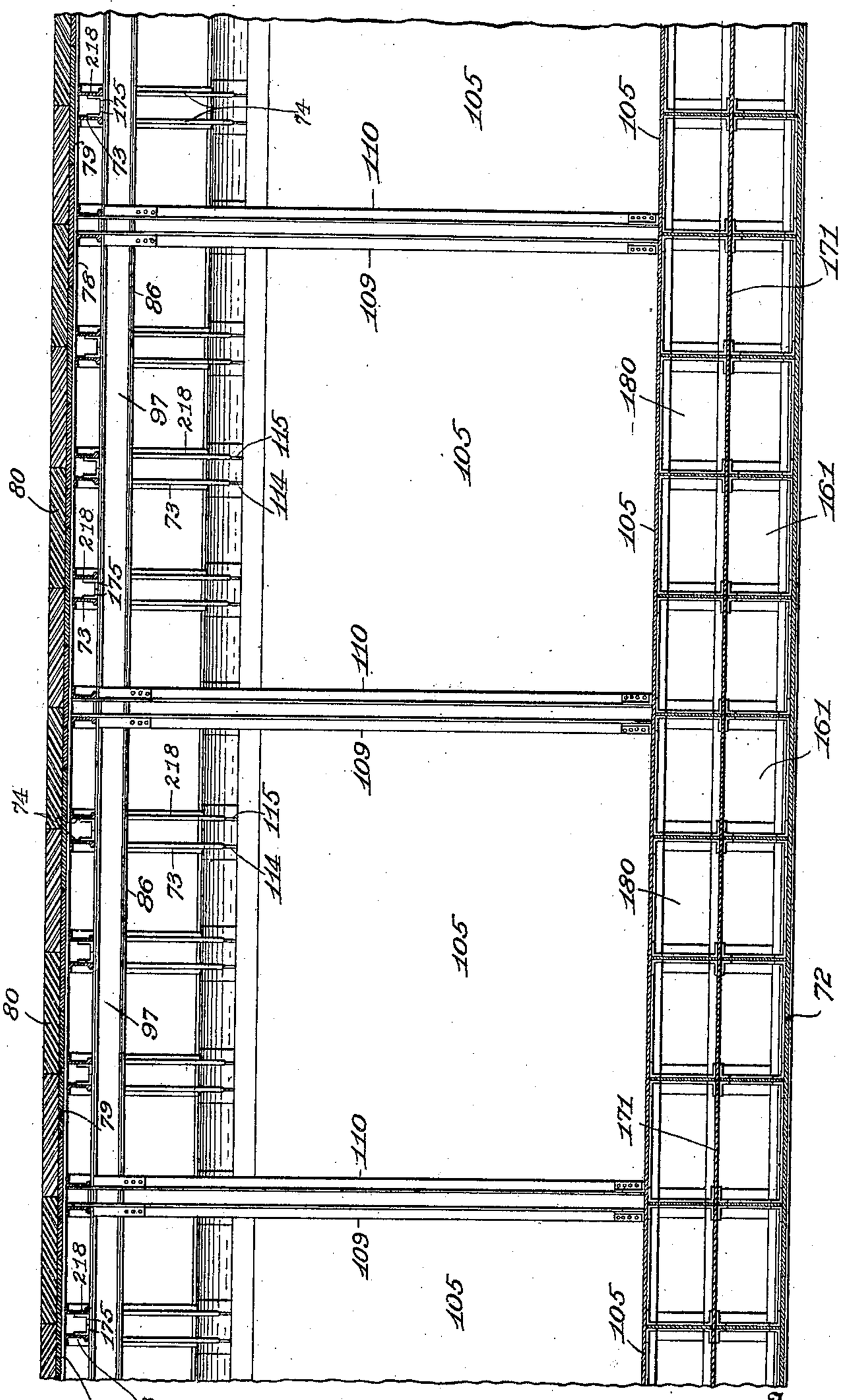

Fig. 7.

Witnesses
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HULL CONSTRUCTION.

(Application filed Aug. 7, 1900.)

(No Model.) 10 Sheets—Sheet 8.

Fig. 8.

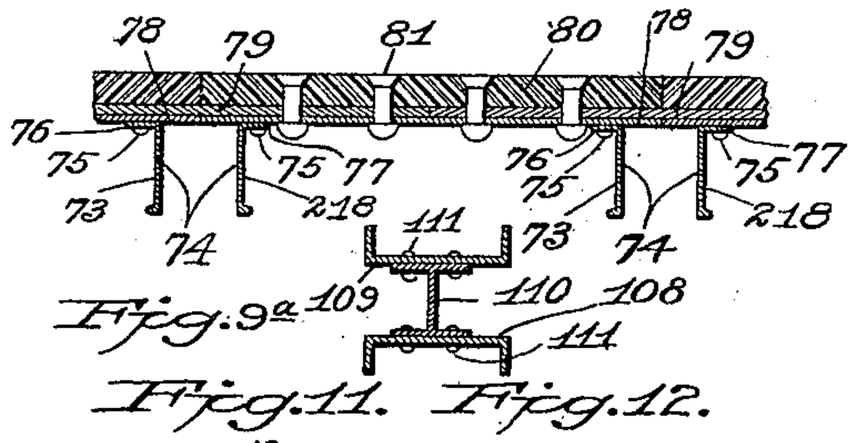


Fig. 9a.

Fig. 9.

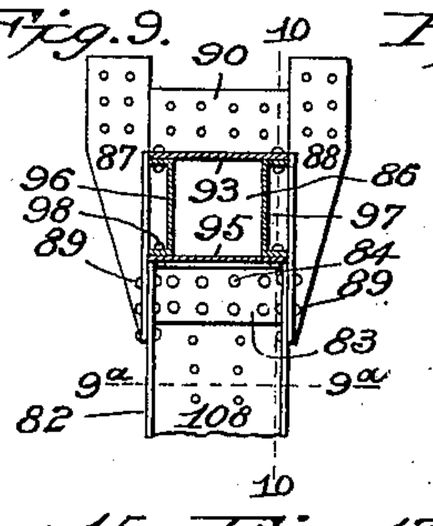


Fig. 10.

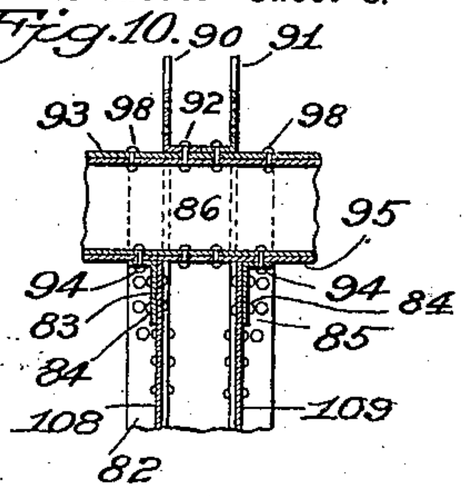


Fig. 11.

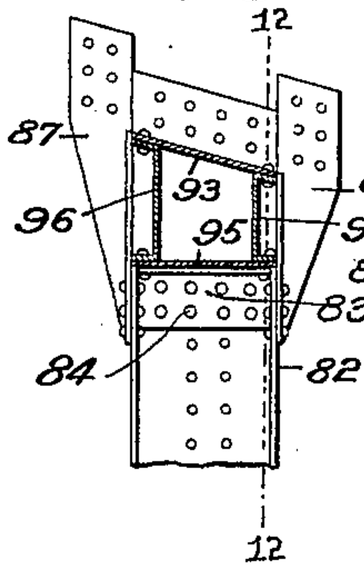


Fig. 12.

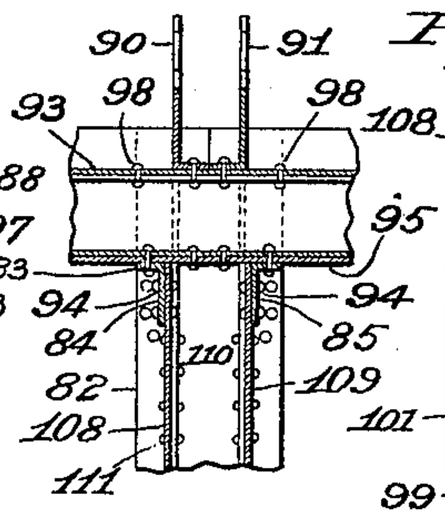


Fig. 15.

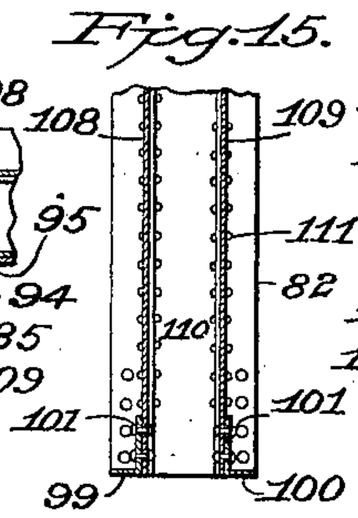


Fig. 13.

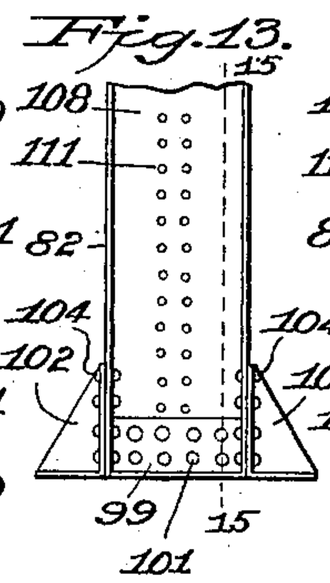


Fig. 14.

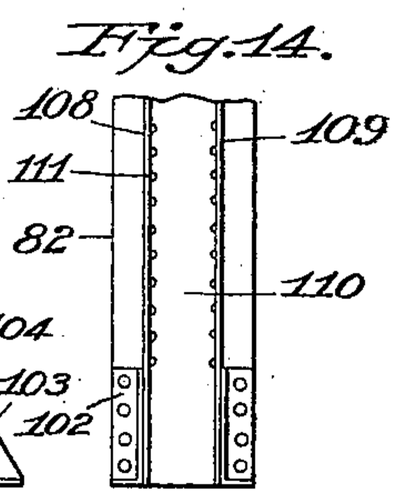


Fig. 16.

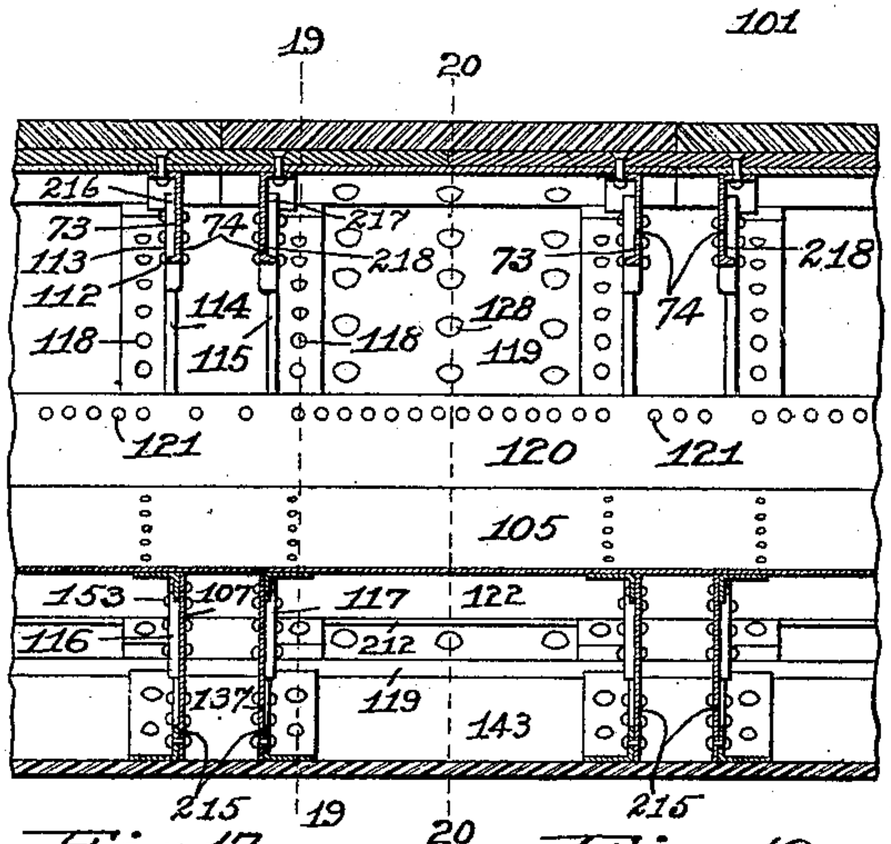


Fig. 17.

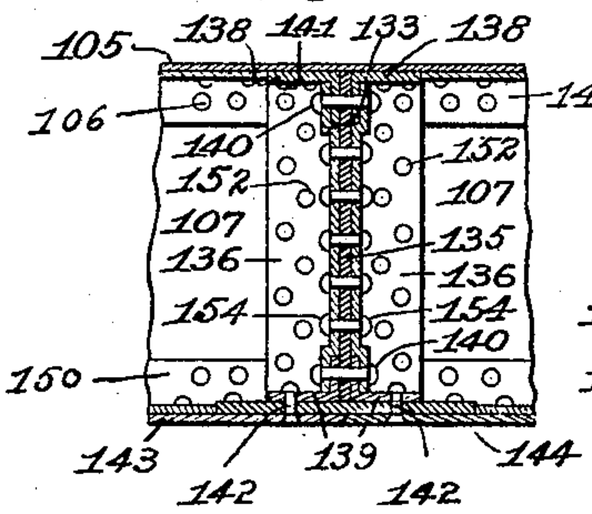
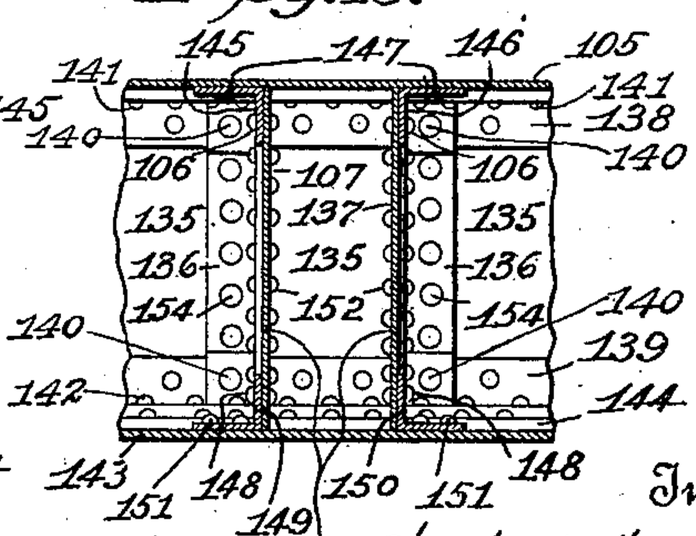


Fig. 18.



Witnesses
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HULL CONSTRUCTION.

(Application filed Aug. 7, 1900.)

(No Model.) 10 Sheets—Sheet 9.

Fig. 19.

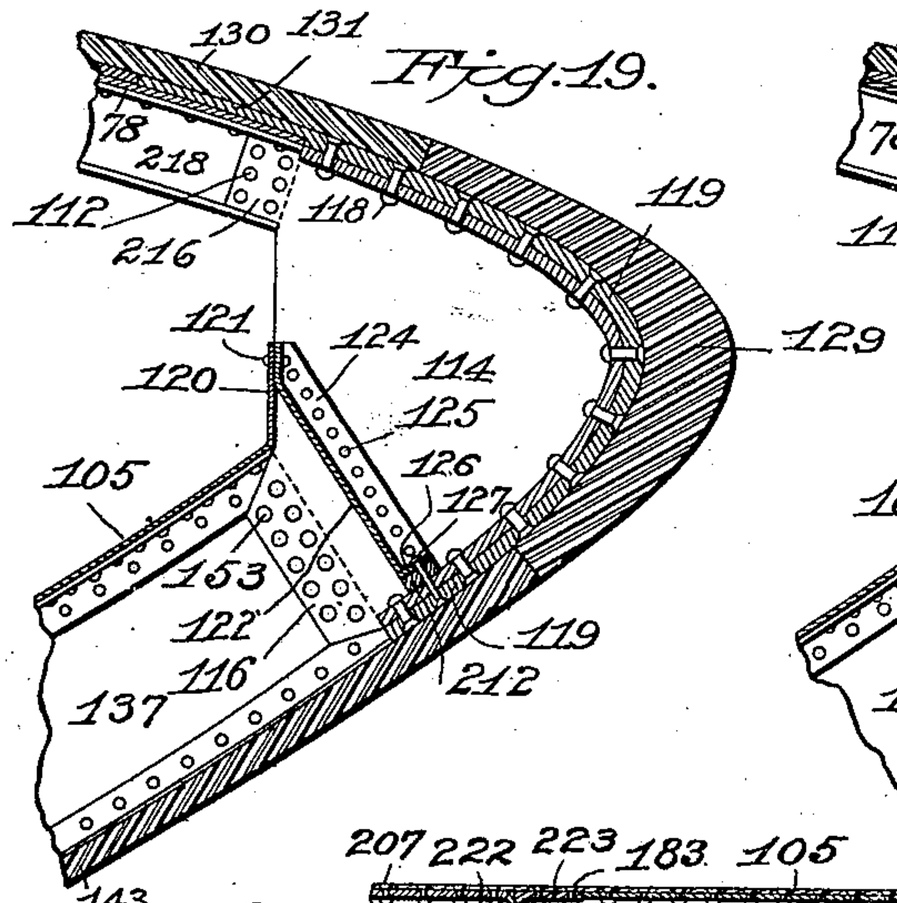


Fig. 20.

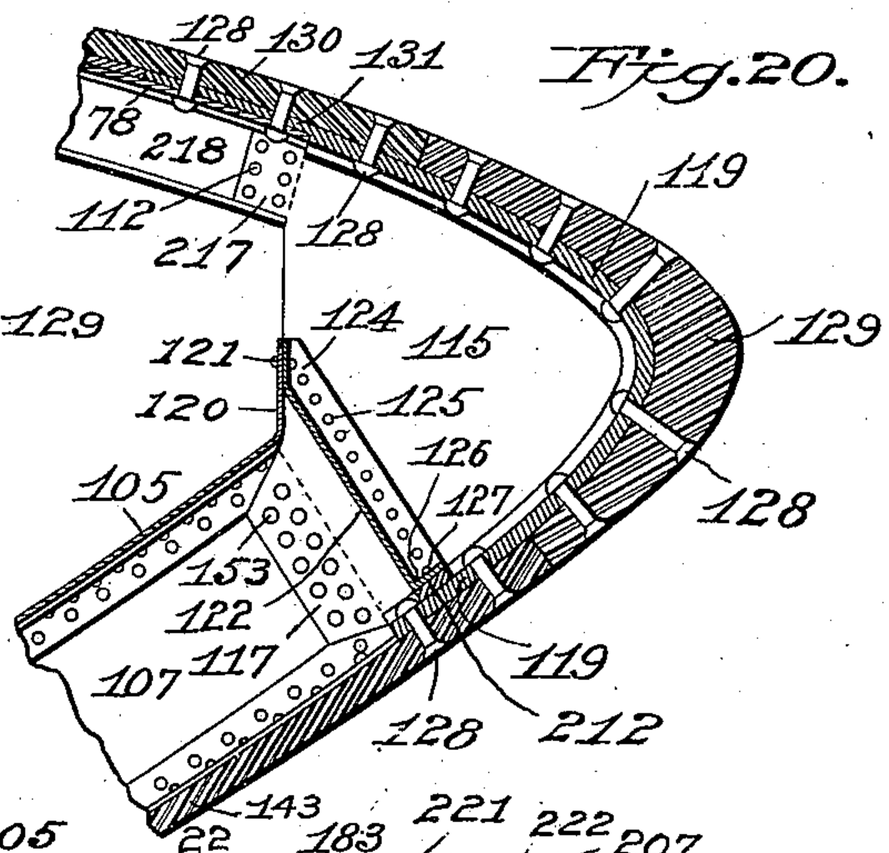


Fig. 21.

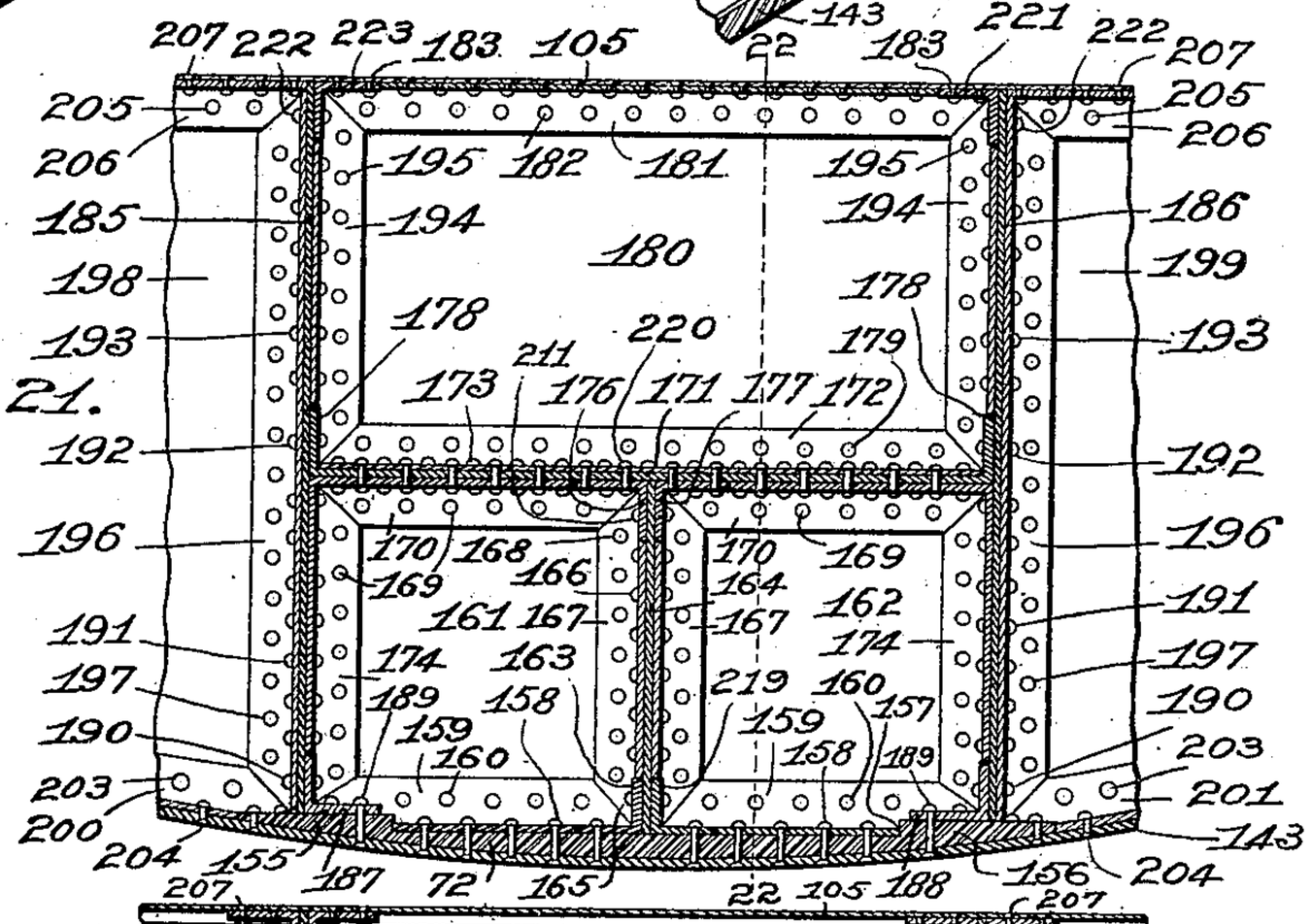
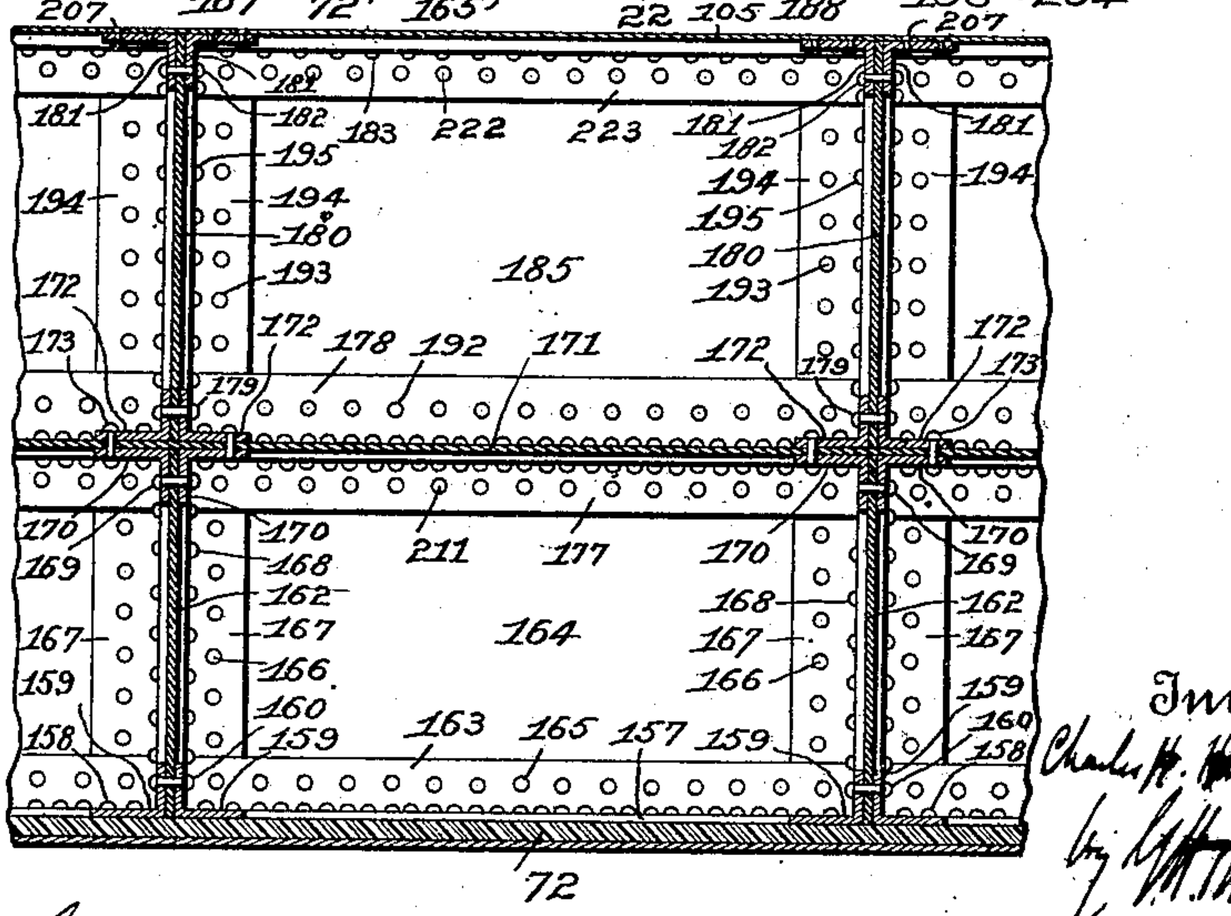


Fig. 22.



Witnesses
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No. 689,821. Patented Dec. 24, 1901.

C. H. HOWLAND-SHERMAN.

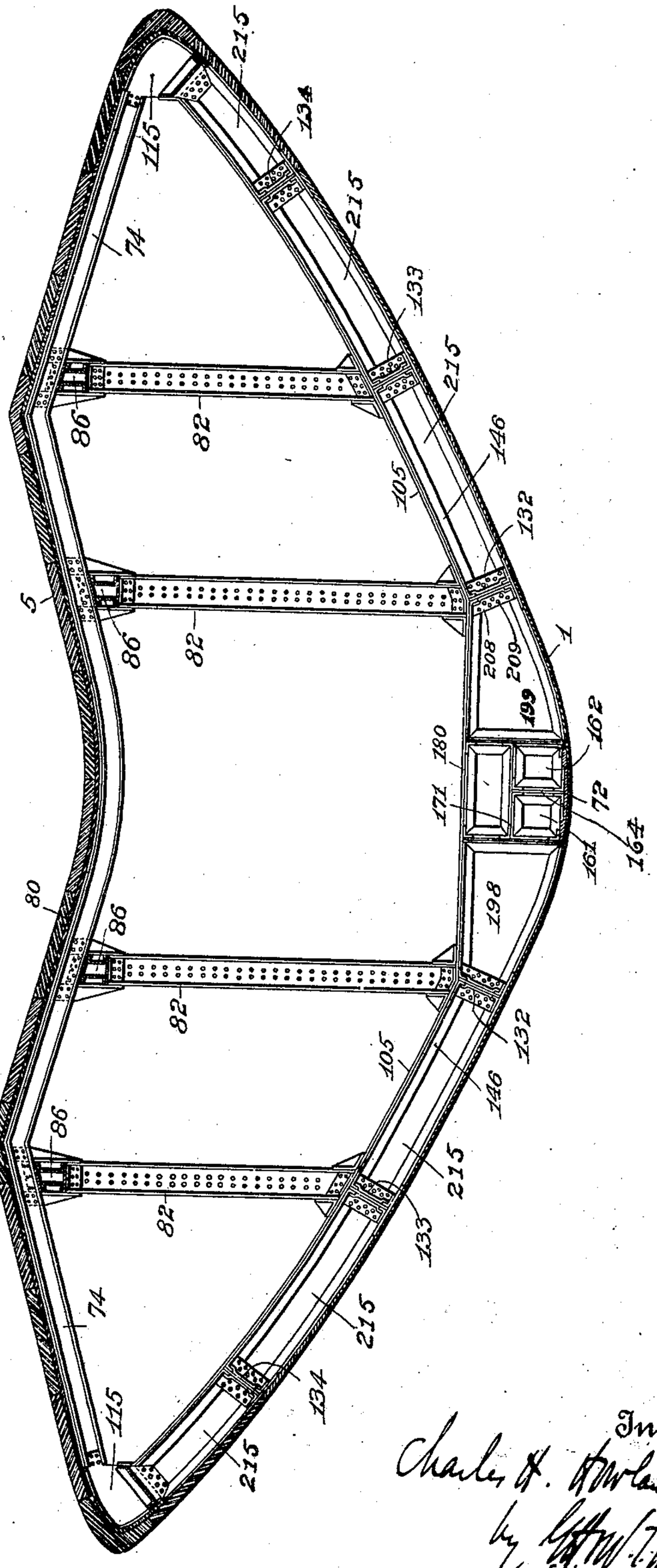
HULL CONSTRUCTION.

(Application filed Aug. 7, 1900.)

(No Model.)

10 Sheets—Sheet 10.

Fig. 23.



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UNITED STATES PATENT OFFICE.

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HULL CONSTRUCTION.

SPECIFICATION forming part of Letters Patent No. 689,821, dated December 24, 1901.

Application filed August 7, 1900. Serial No. 26,175. (No model.)

To all whom it may concern:

Be it known that I, CHARLES H. HOWLAND-SHERMAN, a citizen of the United States, residing at Washington, in the District of Columbia, have invented a new and useful Improvement in Hull Construction, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings and to the numerals of reference marked thereon.

My invention relates to improvements in hull construction, it being especially applicable to steel ships of the standard liner, cruiser, and battle-ship types.

Certain descriptive and illustrative matter is herein included, which while not forming the basis of claims herein presented is necessary to an understanding of the general construction and character of vessel to which the improvement claimed is adapted. Thus there is comprised in this application descriptive and illustrative matter of the prow and of the stern ram and also showing the theory of the amidships-section construction of the vessel, which matter is not claimed as a part of the present invention.

The objects of my invention are the following: First, to provide a hull which is absolutely unsinkable from ramming or collisions of any kind; second, to so construct a hull that it shall be when armor-plated in the usual manner substantially impenetrable to all shot of any character now known delivered in supramarine attack; third, to provide a hull construction which shall afford the minimum possible liability to injury from submarine attack; fourth, to secure a hull of maximum displacement and steadiness of flotation at the minimum draft attainable; fifth, to so construct a hull that its entrance and wakeway action shall be very similar and that its general amidships-section shall in relation to entrance and wakeway, respectively, present the least possible resistance to its propulsion through the water; sixth, to provide a hull for battle-ship purposes which is capable of having its displacement so arranged as to avoid large superstructures, with the heeling and unsteadiness they necessitate in heavy weather, while conveniently carrying heavy armament of the usual type, and, seventh, to restore the balance of advantage in naval warfare by increasing the general indestructibility of battle-ship hulls to a point relatively compensating the great increase of efficiency in modern offensive armament.

While in several aspects my invention is fully as applicable to vessels of the merchant-marine, I have chosen to show its construction in a cruiser, for the reason that such type of my invention best illustrates the method of attaching armor-plating and armament thereto.

I accomplish the objects named by the structure illustrated in the accompanying drawings, hereby made a part of this specification, in which—

Figure 1 is a side elevation of a cruiser built upon this system. Fig. 2 is a top plan view of the same cruiser. Fig. 3 is a diagram showing the theory of the transverse section of the hull. Fig. 4 is a diagram showing the theory of the stern construction. Fig. 5 is a diagram showing the theory of the prow construction. Fig. 6 is transverse section through the hull on the line 6 6 of Fig. 2. Fig. 7 is a central longitudinal section taken amidships through a part of the hull, on the line 7 7 of Fig. 6, forward of the engines. Fig. 8 is a longitudinal section of a part of the deck construction. Fig. 9 is a rear elevation of the capital of one of the central supporting-columns, showing its embraced deck-stringer in transverse section. Fig. 9^a is a transverse section of the supporting-column, taken on the line 9^a 9^a of Fig. 9. Fig. 10 is a vertical section taken on the line 10 10 of Fig. 9, showing the same capital, with its inclosed deck-stringer sectioned longitudinally through the flanges of one of its side channels. Fig. 11 is a rear elevation of the capital of one of the angular side columns, showing its inclosed angular deck-stringer in transverse section. Fig. 12 is a vertical section through the same capital, taken on the line 12 12 of Fig. 11, showing its inclosed angular deck-stringer sectioned longitudinally through the flanges of one of its side channels. Fig. 13 is a rear elevation of the base of one of the supporting-columns, showing the special method of angling the same for attachment to the floor of the hold. Fig. 14

is a side elevation of the same column-base. Fig. 15 is a vertical section through the same column-base, taken on the line 15 15 of Fig. 13. Fig. 16 is an interior elevation of a part of the side of the vessel, showing the manner in which the floor-ribs and deck-beams join directly by means of a series of bulkhead-gussets along load water-line without the intervention of any of the usual side ribs or timbers. Fig. 17 is a transverse section through the sister keelson, taken intermediately between two of the lateral bulkhead-plates. Fig. 18 is a transverse section through one of the floor-ribs, taken intermediately between two of the longitudinal bulkhead-plates. Fig. 19 is an intercostal section through the side of the hull looking aft, taken on the line 19 19 of Fig. 16. Fig. 20 is an intercostal section through the side of the hull, taken on the line 20 20 of Fig. 16 looking aft. Fig. 21 is a transverse section through the keel structure looking aft and taken intermediately between two lateral bulkhead-plates, showing the special method of assembling the plates of the rectangular keel-bulkheads to each other and to the keelson, keel, and floor-ribs. Fig. 22 is a longitudinal section through one complete tier of the superposed rectangular keel-bulkheads, taken on the line 22 22 of Fig. 21 looking starboard and showing the hold-floor, keelson, keel, and side-bulkhead plates in section. Fig. 23 is a transverse section taken amidships through a hull constructed in accordance with a modified form of my invention, in which the deck is hollowed out for the purpose of deflecting armor-piercing shells.

Similar numerals of reference indicate similar parts throughout the several views.

1 may represent generally the hull, which will be seen by reference to Fig. 1 to bear a strong resemblance to ordinary hulls in general exterior appearance, excepting that the superstructure rises relatively less above load water-line. Fig. 2 also shows that the hull is made upon the usual scientific lines of entrance and wakeway adopted in current naval architecture, being susceptible of all their customary variations at pleasure. The cruiser illustrated in Fig. 1 is typical of the application of this hull to war-ship constructions, and the same method of construction is designed to be followed throughout in building merchant-liners, with the exception of the omission of the prow and stern rams and the erection upon the top of the central flat deck (clearly shown in Fig. 2) of a superstructure containing the usual deck-houses, saloons, &c., whose weight will exert proportionately no more effort toward unsteadying the hull than does the lower-lying heavy armament carried by the cruiser shown.

The theory of constructing the hull will be best understood by reference to Fig. 3. The essential idea is that the ordinary side and freeboard of the vessel shall be entirely dispensed with and replaced by a new structure, consisting of a modified upwardly and outwardly inclined bottom 2, united by a suitable curved or other body 3 to the upwardly and inwardly inclined sea-deck 4, which joins angularly with a central horizontal deck 5, greatly reduced from the usual width in proportion to the beam of the hull, as will be apparent also by reference to Fig. 2. The inclined bottom and sea-deck referred to may of course either or both be constructed as planes intersecting at an angle at any point either above or below load water-line; but substantial departure of such intersection from load water-line is inimical to the best results of my invention and is therefore not advised. Such planes are also preferably replaced in practice by the construction described below. Fig. 3 is a radial theoretic diagram of one-half of a typical immersed amidships-section made upon this principle after one of the approved forms of my invention. The radial beam 6 6 of the vessel, its draft 7 7, and height 8 8 of superstructure above load water-line 24 24 being given, the design procedure is as follows: A suitable radius 9 9 is swung from a point on the central vertical plane 10 10 of the vessel, preferably above its center of buoyancy, from the keel outwardly to a point 11 at a distance 12 12 from said vertical plane, the variation of whose length determines the sharpness of recedence of the hull-bottom. Parallelizing said vertical plane 10 10 the line 11 is produced and a portion thereof taken as the base of a parabola defining the principal bottom-section. This parabola has an abscissa 13 13 and ordinates 14 14, 15 15, 16 16, 17 17, 18 18, 19 19, 20 20, 21 21, and 22 22 of such character that the parabola defined by the same shall exactly tangent at the point 11 with the arc 23 11 described by the radius 9 9 and likewise of such character that the central or fifth ordinate 18 18 shall coincide with the load water-line 24 24 of the hull. The permissible radial width 25 25 of the deck is then determined in accordance with the probable perils to which the hull structure will be subjected, it being, for example, broader for passenger and narrower for warship service. The deck 5 is projected for said width 25 25, and the desired angularity 26 26 of the attached sea-deck 4 is selected, the line of said sea-deck being projected to its point of intersection 27 with the load water-line 24 24. The distance 28 28 is then selected, which shall define the point of tangency of the curved side structure 3 with the sea-deck 4, and a line 28 29, projected upward, parallelizing the central vertical plane 10 10. The distance from the point of intersection of said line 28 29 with the plane of the sea-deck 4 to load water-line 24 24 is now made half-base of a parabola, whose abscissa 32 33 coincides with said load water-line. The base 30 31 of this latter parabola is then laid by taking an equal distance along said line 28 29 below load water-line, and a parabola is constructed there-

on having an abscissa 32 33 and ordinates 34 35, 36 37, 38 39, 40 41, 42 43, 44 45, 46 47, 48 49, of such character that the upper leg of the parabola shall precisely tangent with the sea-deck 4 at the intersection of the line 28 29 with the plane of said deck and that the lower leg of the same shall tangent with the parabola 13 11, defining the under side of the hull at the outer end of the latter's lower central or fifth ordinate. It is preferable that the line 6 33, parallelizing the central plane 10 10, should as nearly as practicable cut the focus of the large parabola on its abscissa 13 13; but this exact result is difficult to attain in practice. The effect of the structure given is that shot reaching the hull below load water-line always generate with the departing leg of a parabola, this being the easiest line of surface to follow and most difficult to penetrate in nature. Shots reaching the hull in broadside above load water-line either land upon the upper departing leg 30 33 of the small parabola with similar effect to that above described for the large parabola or will generate with the sharply-receding sea-deck 4, which discharges them into the air at its intersection with the horizontal flat deck 5. In defense against broadside attack the special advantage of the hull is that the unusual narrowness of the deck 5 enables it to carry more than the customary thickness of armor throughout its length without increase of aggregate weight; but it is not claimed that the trajectory of distant shots cannot be trained to fall upon this as upon other decks of the kind. Clearly the special advantage of the hull is in close broadside engagement, where no practical opportunity for penetrating it exists at any point.

The theory of the stern is best demonstrated from the diagram given in Fig. 4. Its chief peculiarity consists in the formation thereon of a ram 50, similar in type and function to rams now in use on the prows of warships. The outer side of this ram is formed by the erection of a short straight-faced body 51 51, built upon a similarly-inclined stern-post, both having preferably an angularity of about seventy degrees to load water-line 24 24, and the erection of a line 52 52 perpendicular thereto at its base, from a point upon which, and therefore tangent to the lower end of said flat, a suitable radius 52 53 is dropped to define the nose of the ram. A line 54 54 is then erected at a slight declination from the vertical—preferably about eighty-two and one-half degrees—to load water-line 24 24, and from it a radius 54 55 is swung to intersection with the arc defined by radius 52 53, thus completing the definition of the point of the ram. The under body of the ram-supporting structure is then completed by tangenting a straight body 54 56 to the arc described by radius 54 55 at the normal perpendicular ninety degrees to the line 54 54, as clearly indicated in the figure. This construction gives great strength to the ram, enables it to penetrate the body of a vessel for a large distance before the stern-post of the vessel ramming is reached without the slightest intrusion upon the functions of rudder 57 or propellers 210, as will be clear from Figs. 1 and 4, and enables the shock of ramming to be directly transferred along the line of the supporting structure 54 56 to the heavily-resisting keel structure of the hull.

The above process of defining the stern-ram 50 enables its point to be located at any desired height 58 59 above the keel by simple variation of the radii outlining its contours without in any manner changing the philosophic character of the ram or its efficiency of operation.

The procedure for constructing the prow-ram, Fig. 5, is very similar to that commonly in use upon war vessels of the day. A principal radius 60 61 is swung tangent to the keel from a point on a line perpendicular to the latter erected at the rear extremity of the ram. The prow 62 of the vessel is then erected at a suitable angularity, preferably the usual one of seventy degrees, and at ninety degrees thereto a perpendicular 63 64 is erected, from a point upon which is struck the fore radius of the ram 65 66 to intersection with the arc of the under body of the ram described by the radius 60 61. The remainder of the cut-water is finished by the usual free-board 67, ending with the sweep 68 at load water-line 24 24, to which it sustains the customary angle of about sixty degrees. The foregoing process of describing the prow-ram is adapted to the attached hull structure and conveniently enables the point of the ram proper, 69, to be located at any required height 70 71 above the keel.

Within the contours whose theoretic philosophy has been explained in connection with Fig. 3 the structure of the hull is built, as clearly shown in the general transverse section of Fig. 6, taken on the line 6 6 of Fig. 2. The details of this structure being elsewhere specified, this general figure is sufficiently clear by noting that the parts consist in the main of the keel 72, web-keelson 164, flange-keelson 171, side keelsons 132, sister keelsons 133, stringer-keelsons 134, rectangular keel-bulkheads 161 162, superposed bulkheads 180, side bulkheads 198 199, and floor-ribs 215. All of these compartments formed by the bulkheads in the skin of the vessel may be conveniently drained by longitudinal pipes entering their lowest portions, as ordinarily practiced in draining ship-compartments. This bottom structure is united by the gussets 115 to the transverse deck-beams 74, longitudinally connected by the angular and straight deck-stringers 86, respectively supported by the angular and straight distance or supporting columns 82, resting upon the hold-floor 105 directly over the sister keelsons 133 and side keelsons 132. Over this entire framing structure the bottom-sheathing 143 is plated in the usual manner, and above it

the deck-sheathing 78, or, as in the case of the cruiser illustrated by Fig. 6, the deck-armor 80, is also superiorly attached with intervening backing-plates 79 by the usual methods.

The assembled view given in Fig. 7 of a central longitudinal section of a part of the hull will be clearly understood by stating that it is taken on the line 7 7 of Fig. 6 at a position forward of the engines, nearly amidships, and showing in longitudinal section the same keel 72, keelson 171, keel-bulkheads 161 and 162, straight supporting-columns 82, deck-stringer 86, gussets 114 115, deck-beams 74, united thereby, and deck-sheathing 78. It will be evident from this figure that the effect of the structure is to give great strength not only in sustaining shocks to the deck, but in resisting under-concussions against the bottom of the ship and minimizing the probability of its destruction by such shocks as those of submarine torpedoes or shells.

The construction of the deck is shown in detail by Fig. 8. The deck-beams are formed of duplex bulb-angles 73 218, attached to the deck-sheathing 78 and backing-plates 79 and turned with their bulbs facing away from each other toward the two exterior sides of the beam. These two bulb-angles constituting each deck-beam are situated at such determinate distance from each other that they act with the dynamic effect of a single member, being effectively united by means of their attachment by through-rivets 75, passing completely through their flanges 76 77 and the deck-sheathing 78 and backing-plates 79, which latter therefore become efficient as a box-plate of the beam, uniting its bulb-angles 73 218. Said deck-beam 74 has no under box-plate, the moment of inertia of such plate being replaced by the equal combined moments of inertia of its bulbs, so that the beam structure is substantially equivalent in value to a box-girder of its respective depth. In the case of ships of the merchant marine the first deck-sheathing 78 can of course run in longitudinal strips, supplying the box-plate action described above as furnished by the backing-plate 79 in the war-ship deck typified by Fig. 8; but in the case of such decks as the latter the transverse arrangement is more convenient and is made equally effective by the union of the successive backing-plates 79 by the agency of the exterior armor-plates 80, united by the large through-rivets 81 to both the backing-plate 79 and deck-sheathing 78, thus adapting the standard three-part deck of battle-ships as now made to my special deck-beams.

Fig. 9 shows a detail structure of the capital of one of the straight supporting-columns 82, which consists, essentially, of the butt-angle 83, attached by rivets 84 to the webs of the column-channels and supporting the deck-stringer 86 directly upon their upper flanges, the side angles 87 88 being secured by rivets 89 89 to the flanges of the column-channels in such manner as to inclose between them the deck-stringer 86. The cap-angles 90 91, as indicated in Fig. 9 and clearly detailed in Fig. 10, taken on the line 10 10 of Fig. 9, are secured by through-rivets 92 to the top web-plate 93 of the deck-stringer 86. By reference to Fig. 7 it will be seen that the deck-stringer 86 is strongly attached throughout its length to each of the bulb-angles 73 218 of the deck-beams 74, supported by it in series by means of the deck-angles 175. The section at which Fig. 10 is taken more clearly exhibits the manner in which the butt-angles 83 85 are attached vertically by the rivets 84 to the channels 108 109 of the column 82 and horizontally secured by rivets 94 to the bottom web-plate 95 of the deck-stringer 86. The deck-stringer, as shown in both Figs. 9 and 10, is substantially a rectangular box-girder, its side channels 96 97 being secured to its top and bottom plates 93 95 by rivets 98 in the usual manner.

Fig. 11 shows a rear elevation, and Fig. 12 a special section on the line 12 12 of Fig. 11, of the angular modification of the supporting-column capital required to adjust the same to the support of the inclined sea-deck. The functions of all parts of this angular capital are identical with those of the straight capital shown and described in connection with Figs. 9 and 10, the sole difference being the elongation of the side angle 87, the cap-angles 90 91, the channel 96, and top plate 93, with corresponding shortening of the side angle 88 and channel 97, while the bottom plate 95, the butt-angles 83 85, and all riveting remain the same as for the straight capital.

The base of the supporting-column is shown, respectively, in rear and side elevations by Figs. 13 and 14, and its structure further exhibited by the special section, Fig. 15, taken on the line 15 15 of Fig. 13. It consists, essentially, of the duplex base-angles 99 100, attached by rivets 101 to the webs of the column-channels 108 109, as shown especially in Figs. 13 and 15, and the quadruplex brace-angles 102 103, attached to the flanges of the column-channels by rivets 104, and likewise attached by rivets passing through the hold-floor 105 and the floor-angles 146, secured to the web-plates 107 of the floor-ribs 215, as will be evident from Figs. 6, 16, and 18, the latter two showing the duplex character of said floor-ribs. By inspection of Figs. 9ª, 10, 12, 14, and 15 the nanner in which the supporting-column section is constructed of the channels 108 109, united by the I-beam 110, secured to said channels by rivets 111, will be intelligible.

The construction of the edge of the vessel at load water-line, whose strength forms a highly essential feature of my invention, is shown by Figs. 16, 19, and 20. The bulb-angles 73 218 of the duplex deck-beams 74, as seen particularly in Fig. 16, are united by rivets 112 to extensions 216 217 on the duplex gussets 114 115, which have also lower extensions 116 117,

similarly riveted to the web-plates 107 137 by the rivets 153. These gussets thus directly unite the deck-beams to the floor-ribs in such manner as to complete a framework reinforcing the edge construction of the vessel with great strength. The gussets 114 115 are attached by rivets 118 to the longitudinally-continuous backing-plate 119, as more particularly shown in Figs. 19 and 20.

The highest of the intercostal compartments is sealed by the structure indicated in Fig. 16 and more fully detailed in Figs. 19 and 20. The hold-floor 105 has a vertical flange 120 at its outer extremity, which is attached by rivets 121 to the water-line bulkhead-plate 122, which has side flanges 124, attached by rivets 125 to the webs of the respective gussets 114 115, and bottom flanges 126, attached by rivets 127, passing through both the calking-strip 212 and the backing-plate 119, as clearly indicated in Figs. 19 and 20. As shown in Figs 16 and 19, rivets 118 attach the gussets 114 115 to the beam-backing plate 119, which in turn is similarly attached by intermediate rows of much larger rivets 128 to the water-line armor-plate 129, as fully detailed by Fig. 20. The uppermost rows of said rivets 128 likewise pass entirely through the sea-deck armor 130, through an angularly-reduced extension 131 of the backing-plate 119, and finally through the deck-sheathing 78, attached to the bulb-angles 73 218 of the deck-beams 74, as particularly exhibited by Fig. 20.

The transverse section of the sister keelson 133 (shown by Fig. 17) will be found upon comparison with the similar transverse sections of the side keelson 132 and stringer-keelson 134, (see also Fig. 6,) to be identical with the latter and substantially identical with the former in construction, with the exception of its angular top. It is therefore deemed sufficient that said sister keelson 133 should be analyzed as characteristic of the keelson group of structures. All of the keelsons named consist of central web-plates, as typified by 135, which are longitudinally continuous throughout the length of the hull, interrupting the floor-rib plates 107 of the floor-ribs 215, Fig. 18, to which they are united by the mechanism of Fig. 17. The sister keelson 133, for example, consists of the central web-plate 135, forming the keelson proper, which is attached by rivets 154 to the rib-angles 136, which angles are in turn screwed to the floor-rib plates 107 of the floor-ribs 215, Figs. 17 and 18, by the rivets 152. The rib-angles 136 are bent around the vertical flanges and abut upon the horizontal flanges of the top and bottom keelson-angles 138 139, which run continuously for the length of the keelson itself, said rib-angles being attached to said keelson-angles by the tie-rivets 140 140, which are lengthened at the position of the rib-angles 136 to include the same in this union, as shown in Fig. 17, but are at all intermediate positions of simply sufficient length to attach the keelson-angles 138 139 to the central web-plate 135. Smaller rivets 141 attach the top keelson-angles 138 to the hold-floor 105, and larger rivets 142 unite all three thicknesses of the bottom sheathing 143, the calking-plate 144, and keelson-angles 139 together in a solid water-tight joint, which is preferably coated between all its plates with red lead in the usual manner prior to having the calking-plate 144 calked down upon the bottom sheathing 143.

A complete view of the transverse section of the floor-ribs and the details of their top, bottom, and bulkhead connections is given by Fig. 18. They consist, essentially, of the vertical floor-rib plates 107 137, united at the top by rivets 106 to the floor-angles 145 146, attached by rivets 147 to the hold-floor 105, said floor-rib plates being attached at the bottom by rivets 148 to the calk-angles 149 150, which are attached by rivets 151 to the deck-sheathing 143 and calked down thereon along their entire edges. The effect of this structure is that the floor-rib is dynamically equivalent to a box-girder in efficiency, whose base-plate is formed by the sheathing 143 and top plate by the hold-floor 105. This structure enables the rib to give exactly as efficient a support to the skin of the ship and floor of the hold, respectively, as though a complete box-girder of the usual form had been interjected between the same and is lighter throughout its length by deduction of the weight of the top and bottom plates of such box-girder. The duplex floor-rib 215 is interrupted by the longitudinally-continuous central web-plates, as 135, of the keelson 133 in Fig. 18 and is united by rivets 152 to angles 136, which are secured in turn by rivets 154 to said central web-plates 135. At these points of interruption, as will be clearly seen from inspection of Fig. 18, the floor-rib plates 107 137 of the floor-rib 215 are cut to contour around the calking-plate 144 and the keelson-angles 139 138 in such manner that said web-plates shall rest directly against the sheathing 143 and hold-floor plates 105, as shown. This in no manner interferes with the formation of the water-tight joints of the hull-bottom, which all run longitudinally, as shown by and described concerning Fig. 17, the intermediate joints of the sheathing-plates at the extremities of their lengths being planned to fall intermediately between the ribs and to have overlying said joints calking-plates of the ordinary type, which therefore are not shown in the drawings.

The keel structure is shown in detail by Figs. 21 and 22, of which the former is a transverse section looking aft and taken intermediately to lateral bulkhead-walls, and the latter a longitudinal section looking starboard and taken intermediately to longitudinal bulkhead-walls on the line 22 22 of Fig. 21. This structure consists, essentially, of the inferior keel-plate or keel proper, 72, which is preferably a continuous heavy forged-steel plate of the sectional character

shown, whose bottom contour interiorly parallelizes the radius 9 9, Fig. 3, of the hull-bottom, so as to fit tightly against the inner face of the bottom sheathing 143. The keel 72 has special longitudinal enlargements 155 156 at its sides, whose upper faces are perpendicular to the central vertical axis 10 10, Fig. 3, of the hull. The upper side of the keel 72 consists of a straight rectangular cavity or channel 157, whose bottom is perpendicular to and whose sides parallelize the plane in which lies said central and vertical axis 10 10. The keel 72 is attached by rivets 158 to the sheathing 143 beneath and to the keel-angles 159 above, whose vertical flanges are in turn secured by rivets 160 to the transverse keel-bulkheads 161 162 of the port and starboard keel-compartments, respectively. The longitudinally-continuous keel-angles 163 219 have their horizontal flanges assembled by continuations of the rivet series 158 to form a three-ply structure with the keel 72 and sheathing 143 and inclose between their vertical flanges the web-keelson 164, to which they are secured by rivets 165 in such manner that said web-keelson 164 rests directly upon the keel 72. Rivets 166 secure the web-keelson 164 to central angles 167, attached to the keel-bulkheads 161 162 by rivets 168. Rivets 169 attach the keel-bulkheads 161 162 to the inferior keelson-angles 170, which are united to the flange-keelson 171 and the superior keelson-angles 172 by the through horizontal staggered rivets 173. The inferior keelson-angles 170 have webs bent in the flat, with triangular-shaped bodies removed from their transverse flanges to admit of their being bent downward to form continuously therefrom the side angles 174, attached by similar rivets 169 to the keel-bulkhead plates 161 162. The longitudinally-continuous corner-angles 176 177 embrace the top of the web-keelson 164, to which they are attached by rivets 211, while their horizontal flanges directly support the flange-keelson 171, to which they are attached by the rivets 220, forming at the keelson-bulkheads 180 continuations of the rivet series 173. Similarly, the flange-keelson 171, which is a trough-shaped steel plate, has vertical side flanges 178 and has attached to its base the superior keelson-angles 172 by rivets 179 to seal the bottom of the superposed keel-compartments, all being as clearly shown in Fig. 21. The top sealing of these superposed keelson-bulkheads 180 is completed by the central floor-angles 181, attached thereto by the rivets 182 and to the hold-floor 105 by rivets 183. Deep continuous web-plates 185 186 complete and longitudinally seal all of the lower or inferior rectangular and superposed keel-compartments defined by the bulkheads 161 162 180, said web-plates resting directly upon the projections 155 and 156, respectively, of the keel 72 and having directly upon their upper edges the hold-floor 105. Said web-plates 185 186 are secured inferiorly at their bottom edges by the longitudinally-continuous bed-angles 187 188, attached by rivets 189 to the keel projections 155 156 and by rivets 190 to said web-plates 185 186. Passing upward, the web-plate connections interiorly engage by means of the rivets 191 the side angles 174 of the transverse keel-bulkheads 161 162, by means of rivets 192 the vertical flanges 178 of the flange-keelson 171, and by means of rivets 193 the longitudinal flanges of the lateral angles 194, which are in turn secured by rivets 195 to the transverse keelson-bulkhead 180, complete its lateral sealing. Its longitudinal sealing is then effected by the attachment of said web-plates 185 186 through rivets 222 to the longitudinally-continuous framing-angles 223 221, which are integrated with the hold-floor 105 by the continuation of the same series of flooring-rivets 183 hitherto described. This entire keel structure is adapted to resist severe vertical and transaxial shocks to the vessel-bottom in the most efficient manner with the least possible weight of material. The effect of upward concussions transmitted through the sheathing 143 to the keel 72 with the web-keelson 164 is to render it, considered dynamically, as a separate body equivalent to a solid forged keel of T-section, the resultant from shocks to whose horizontal flanges would be distributed upon its vertical web. This is the weakest possible manner of considering the keel structure shown; but it is actually entitled to be considered, with respect to all vertical shocks, in conjunction with the deep and rigidly-attached web-plates 185 186, the web-keelson 164, the flange-keelson 171, and the hold-floor 105, the combined effect of which is to render the keel substantially equivalent in strength to two longitudinally-continuous hollow rectangles at the base connected with the distributive superposed rectangle (the keelson-bulkhead) 180, designed to take off the shocks occurring to the lower rectangles (the keel-bulkheads) 161 162 and distribute them effectively to the series of side bulkheads 198 199, to the entire flooring 105, and through these members to the floor-ribs 215 and up to the directly-attached deck-beams 74, by which all shocks are instantaneously and generally distributed and absorbed throughout the structure of the ship. The process of longitudinally translating the disintegrating effects of concussions or strains to the bottom of the ship is simultaneously conducted by all the continuous longitudinal members—such as the keel, the web-keelson, the flange-keelson, the web-plates, the side, sister, and stringer keelsons, and the beam-backing plate 119—all of which harmoniously equalize such strains, wherever their point of occurrence, between all of the lateral bulkheads united by these members. This rapid and wide dissemination of all shocks to or in the neighborhood of the keel affords a very useful and secure means of obtaining strength at small cost of weight and tends to minimize the probability of destruction of the hull from submarine explosions.

At the outside of the keel structure the web-plates 185 186 are attached by the same series of rivets 190 191 192 193, relating interiorly to the various members of the keel structure secured to said web-plates, (see Figs. 6, 21, and 22,) to the longitudinal flanges of the side-bulkhead angles 196, which are secured by rivets 197 to the side bulkheads 198 199. The bottom sealing of the transverse plates of these large side bulkheads 198 199 is completed by the bilge-angles 200 201, attached thereto by rivets 203 and attached by rivets 204 directly to the sheathing-plates 143. The top sealing of the side bulkheads 198 199 is completed by their attachment through rivets 205 to the sealing-angles 206, which are attached directly by rivets 207 to the floor-plates 105 at their points of occurrence throughout the length of the ship. The outer side of these side bulkheads is sealed by the side keelson angles 208, attached thereto by rivets 209, as more clearly shown in Fig. 6, where the modification of port-side bulkheads 198 at the proper point of imposing the engine-bed is seen. Of course such modification is strictly limited to the short length of the engine-bed itself. Attention is called to the fact that the great depth, approximately triangular form, and very rigid connections of these side bulkheads 198 199 cause them to importantly reinforce the strength of the keel structure lying between them and that their large distributing-surfaces readily take off transaxial shocks to the vessel-bottom, as well as the resultants of shocks sustained by the web-plates 185 186. It is also obvious that shocks occurring intermediately to the width of these bulkheads 198 199 will be equally distributed to both port and starboard and respectively absorbed by the longitudinal web-plates 185 186 and the side keelsons 132.

The special arrangement of my invention by which its most approved form consists of upwardly-inclined parabolic bottoms whose abscissæ parallelize the central deck presents an immersed amidships-section, which is introduced and succeeded very smoothly by the tapered entrance and wakeway shown in Fig. 2 and causes the vessel to be driven with very little resistance through the water in a manner conducive to the highest attainments of speed. This effect is enhanced by the fact that the parabolic bottoms entirely displace the usual sides of the ship, dispense with the great hydraulic pressure to which the immersed portions of such sides are always subjected, and thus tend to minimize the skin friction to but a slight excess over that portion of the total friction which is sustained by the bottom only of a ship constructed in the usual manner. A second and not less important effect is that the customary side pressure being diverted to the bottom is converted into added effective buoyancy of hull. These qualities not only adapt my invention to use in the heavier warships typified in the drawings, but quite as well to torpedo-boats, torpedo-boat destroyers, rapid liners, and yachts, in which latter class of narrow-beamed vessels it is obvious that the adjunct of a centerboard may be employed to more readily adapt the relatively shallow draft of this system of construction to the heavier heeling effect of a large sail area.

Having thus described the structure and operative functions of my invention, what I claim is—

1. Combined in a hull structure, a keel proper having a central, superior longitudinal channel and longitudinal enlargements along its sides; and a web-keelson centrally attached thereto; the construction being such that both the said web-keelson and keel enlargements are adapted for attachment to the contiguous parts of the hull structure, substantially as described.

2. Combined in a hull structure, a trough-shaped horizontal, longitudinally-continuous flange-keelson; and a vertical web-keelson inferiorly attached thereto, substantially as described.

3. Combined in a hull structure, a horizontal keel proper; a vertical web-keelson attached centrally and perpendicularly thereto; and a horizontal trough-shaped flange-keelson attached to said web-keelson and parallelizing said keel proper, substantially as described.

4. Combined in a hull structure, a trough-shaped horizontal flange-keelson; a vertical web-keelson inferiorly attached thereto; and a horizontal keel proper inferiorly attached to said web-keelson; all of said members being longitudinally continuous, substantially as described.

5. Combined in a hull structure, bottom-sheathing plates, a keel proper; means for attaching said sheathing-plates to said keel; a continuous web-keelson centrally attached to said keel; a flange-keelson; port and starboard longitudinal web-plates; port and starboard transverse keel-bulkhead plates; and means for attaching said keel-bulkhead plates to said keel web-keelson, flange-keelson and vertical web-plates, substantially as described.

6. Combined in a hull structure, a keel proper; a web-keelson and vertical port and starboard web-plates all attached to the keel proper; and a flange-keelson; rectangular keel-compartments being longitudinally defined by the foregoing members, and transversely defined by bulkheads between said members, substantially as described.

7. Combined in a hull structure, a keel proper; a web-keelson centrally and perpendicularly attached thereto; a horizontal flange-keelson (having vertical longitudinal flanges at its sides) attached to said web-keelson and parallelizing said keel; longitudinally-continuous port and starboard web-plates; and means for attaching the flanges of said flange-keelson to said port and starboard web-plates, substantially as described.

8. Combined in a hull structure, a keel proper; a web-keelson centrally and perpendicularly attached thereto; a flange-keelson (having flanges at its sides) centrally attached to said web-keelson and parallelizing said keel; longitudinal port and starboard web-plates; transverse keelson-bulkheads; a hold-floor superiorly secured to said keelson-bulkheads and to said port and starboard web-plates; means for securing the flanges of said flange-keelson to said port and starboard web-plates and to said keelson-bulkheads; transverse keel-bulkheads; and means, respectively, for securing said keel-bulkheads to said port and starboard web-plates, flange-keelson, web-keelson and keel, substantially as described.

9. Combined in a hull structure, a longitudinally-channeled keel proper, having longitudinal enlargements along its edges; longitudinal web-plates; transverse keel-bulkhead plates; and means for attaching said web-plates and keel-bulkhead plates, respectively, to each other, and to said enlargements of the keel, substantially as described.

10. Combined in a hull structure, a horizontal keel proper, having longitudinal enlargements along its edges; a vertical web-keelson centrally and perpendicularly attached thereto; a horizontal flange-keelson (having longitudinal flanges at its sides) attached to said web-keelson and parallelizing the superior faces of said keel; vertical port and starboard web-plates adapted to rest continuously along the top of said keel enlargements; means for attaching the flanges of said flange-keelson to said web-plates; and means for attaching said web-plates to said keel enlargements, substantially as described.

11. Combined in a hull structure, a keel proper; a web-keelson and continuous port and starboard vertical web-plates, all attached to said keel; a flange-keelson; keelson-bulkheads; and transverse keel-bulkheads; the construction being such that compartments are thereby longitudinally and transversely defined, substantially as described.

12. Combined in a hull structure, bottom-sheathing plates, a horizontal keel proper; port and starboard vertical web-plates; means for attaching said sheathing-plates to said web-plates; a web-keelson, centrally and vertically attached to said keel; port and starboard transverse keel-bulkhead plates; a flange-keelson attached to said web-keelson; and means, respectively, for attaching said keel-bulkhead plates to said keel, web-keelson, flange-keelson and vertical web-plates, substantially as described.

13. Combined in a hull structure, bottom-sheathing plates, a horizontal keel proper; means for attaching said sheathing-plates to said keel; a vertical web-keelson (centrally and perpendicularly attached to said keel); port and starboard transverse keel-bulkheads; means for attaching said keel-bulkheads to said keel; a flange-keelson; continuous port and starboard web-plates; transverse keelson-bulkheads; hold-floor plates; and means, respectively, for attaching said keelson-bulkheads to said flange-keelson, port and starboard web-plates and hold-floor plates, substantially as described.

14. Combined in a hull structure, a keel proper; a web-keelson; longitudinally-continuous keel-angles for attaching said web-keelson to said keel; continuous port and starboard web-plates; longitudinally-continuous bed-angles for attaching said web-plates to said keel; a flange-keelson; longitudinally-continuous corner-angles for attaching said flange-keelson to said web-keelson; means for attaching the flanges of said flange-keelson to said web-plates; hold-floor plates transversely closing over the tops of said web-plates; and longitudinally-continuous framing-angles for attaching said hold-floor plates to said continuous web-plates, substantially as described.

15. Combined in a hull structure, bottom-sheathing; a horizontal keel proper; a vertical web-keelson centrally attached thereto; a horizontal flange-keelson attached to said web-keelson; hold-floor plates; continuous port and starboard web-plates attached, respectively, to said keel, flange-keelson and hold-floor plates; port and starboard keel-bulkheads; superposed keelson-bulkheads; transverse side bulkheads attached, respectively, to said bottom-sheathing, port and starboard web-plates, and said hold-floor plates; said members being so related that the keel, web-keelson, flange-keelson and web-plates all act as longitudinally-continuous defining members to all of the rectangular keel, keelson and side bulkheads which they interrupt in series, substantially as described.

16. Combined in a hull structure, a keel having longitudinal enlargements along its side edges; bottom-sheathing plates; means for attaching said sheathing-plates to the central body and side enlargements of said keel; a vertical web-keelson centrally attached to said keel; a horizontal flange-keelson attached to said web-keelson (having integral longitudinal flanges along the sides thereof); longitudinally-continuous web-plates extending from the top faces of said keel enlargements to the sustained hold-floor plates; means for attaching said web-plates to said longitudinal keel enlargements and flange-keelson flanges; hold-floor plates extending horizontally across said web-plates; and means for attaching said web-plates to said hold-floor plates, substantially as described.

17. Combined in a hull structure, a horizontal keel, a web-keelson, and port and starboard web-plates all vertically attached to said keel; a flange-keelson attached to said web-keelson and parallelizing said keel; rectangular keel-bulkheads; means, respectively, for attaching said keel-bulkheads to said keel, web-plates, flange-keelson and web-keelson; superposed keelson-bulkheads;

means, respectively, for attaching said keelson-bulkheads to said flange-keelson and web-plates; side bulkheads; bottom-sheathing; side keelsons attached to said bottom-sheathing; means, respectively, for attaching said side bulkheads to said bottom-sheathing, side keelsons and web-plates; hold-floor plates closing over the tops of said side keelsons, side bulkheads, web-plates and superposed keelson-bulkheads; and means, respectively, for securing said hold-floor plates to said side keelsons, side bulkheads and superposed keelson-bulkheads, substantially as described.

18. Combined in a hull structure, a keel, a vertical web-keelson and port and starboard vertical web-plates parallelizing said web-keelson, all perpendicularly attached to said keel; a horizontal flange-keelson parallelizing said keel; rectangular keel-bulkheads lying between the foregoing members so as to transversely define the keel-compartments; hold-floor plates closing over the tops of said vertical web-plates; superposed keelson-bulkheads transversely defining the central compartments; and a bottom-sheathing, substantially as described.

19. Combined in a hull structure, a floor-rib, comprising vertical floor-rib plates; bottom-sheathing attached to the bottom of said floor-rib plates; and hold-floor plates attached to the tops of said floor-rib plates, in such manner that said sheathing-plates and hold-floor plates become, respectively, the flange-plates to said floor-rib plates, integrating the same so as to render the structure sectionally equivalent to a box-girder of similar depth and parts, substantially as described.

20. Combined in a hull structure, paired vertical floor-rib plates; bottom-sheathing; calk-angles uniting said floor-rib plates to said bottom-sheathing; longitudinal keelsons; calking-plates; keelson-angles uniting said keelsons to said calking-plates; and rib-angles uniting said keelsons and said floor-rib plates to each other and to said keelson-angles, substantially as described.

21. In a hull structure, a keelson comprising a central web-plate, combined with a calking-plate secured to the said web-plate, and sheathing secured to said calking-plate, substantially as described.

22. In a hull structure, a keelson comprising a central web-plate, combined with a calking-plate secured perpendicularly to the bottom of said web-plate; bottom-sheathing secured to said calking-plate; hold-floor plates; means for attaching said web-plate to said calking-plate, and means for attaching said hold-floor plates to said web-plate, substantially as described.

23. In a hull structure, a keelson comprising a vertical, central web-plate, combined with a longitudinally-continuous calking-plate; keelson-angles secured to said calking-plate; hold-floor plates; floor-angles for securing said hold-floor plates to said web-plates; a floor-rib intersected by said web-plate; and rib-angles uniting said floor-rib to said web-plate, substantially as described.

24. In a hull structure, a floor-rib; a deck-beam; and a gusset interjectionally combined therewith to form an angular juncture, substantially as described.

25. In a hull structure, duplex floor-ribs; duplex deck-beams; and flanged duplex gussets; combined interjectionally to form angular junctures therewith, substantially as described.

26. Combined in a hull structure, floor-ribs; deck-beams; gussets interjectionally joining said floor-ribs and deck-beams; and water-line armor-plates overlying the gussets at the junctures, substantially as described.

27. Combined in a hull structure, floor-ribs; deck-beams; gussets interjectionally joining said floor-ribs and deck-beams; backing-plates; overlying water-line armor-plates; and rivet connections, substantially as described.

28. Combined in a hull structure, floor-ribs; deck-beams; means for directly and interjectionally connecting said floor-ribs and deck-beams; and water-line armor-plates overlying the junctures, substantially as described.

29. Combined in a hull structure, floor-ribs; deck-beams; angular gussets for directly and interjectionally connecting said floor-ribs and deck-beams; and water-line armor-plates overlying their junctures, substantially as described.

30. Combined in a hull structure, hold-floor plates; floor-ribs; gussets attached to said floor-ribs, a longitudinally-continuous backing-plate attached to and uniting said gussets in series; water-line bulkheads attached to said hold-floor plates and secured transversely to and between the webs of said gussets; and means for securing said water-line bulkheads to said backing-plate, substantially as described.

31. Combined in a hull structure, hold-floor plates; floor-ribs; gussets attached to said floor-ribs; a longitudinally-continuous backing-plate attached to and uniting said gussets in series; water-line bulkheads attached to said hold-floor plates and secured transversely to and between the webs of said gussets; means for securing said water-line bulkheads to said backing-plate; and deck-beams attached to said gussets substantially as described.

32. Combined in a hull structure, hold-floor plates; floor-ribs; gussets, each comprising a vertical web having top and bottom extension-flanges plane therewith and side flanges perpendicular thereto; a longitudinally-continuous backing-plate attached to said perpendicular side flanges of said gussets and uniting said gussets in series; water-line bulkheads attached to said hold-floor plates and secured transversely to and between the vertical webs of said gussets; means for securing said water-line bulkheads to said backing-plate; floor-ribs attached to the bottom extension-flanges of said gussets; and deck-

beams attached to the top extension-flanges of said gussets, substantially as described.

33. Combined in a hull structure, hold-floor plates; floor-ribs; gussets attached to said floor-ribs; a longitudinally-continuous backing-plate attached to and uniting said gussets in series; water-line bulkheads attached to said hold-floor plates and secured transversely to and between the webs of said gussets; means for securing said water-line bulkheads to said backing-plate; deck-beams attached to said gussets; and water-line armor-plates angularly overlying said backing-plate, substantially as described.

34. Combined in a hull structure, floor-ribs; gussets attached to said floor-ribs; a longitudinally-continuous backing-plate attached to and uniting said gussets in series; deck-beams attached to said gussets; bottom-sheathing attached to said floor-ribs and said backing-plate; water-line armor-plates attached to said backing-plate; and deck-armor attached to said backing-plate and deck-beams, substantially as described.

35. Combined in a hull structure, floor-ribs; gussets attached to said floor-ribs; a longitudinally-continuous backing-plate attached to and uniting said gussets in series; deck-beams attached to said gussets; water-line bulkheads attached to and between said gussets and to said backing-plate; bottom-sheathing attached to said floor-ribs and said backing-plate; water-line armor-plates attached to said backing-plate; and deck-armor attached to said backing-plate and deck-beams, substantially as described.

36. Combined in a hull structure, floor-ribs; gussets attached to said floor-ribs; a longitudinally-continuous backing-plate attached to and uniting said gussets in series; deck-beams attached to said gussets; hold-floor plates attached to said floor-ribs; water-line bulkheads secured to said hold-floor plates, and attached to and between said gussets and to said backing-plate; bottom-sheathing attached to said floor-ribs and to said backing-plate; water-line armor-plates attached to said backing-plate; and deck-armor attached to said backing-plate and deck-beams, substantially as described.

37. In a hull structure, a deck-beam consisting of duplex parallel bulb-angles in close proximity to each other, with their bulbs facing reversely; combined with deck-sheathing; and means for attaching said deck-beam to said sheathing, substantially as described.

38. In a hull structure, a deck-beam consisting of duplex parallel bulb-angles having their bulbs facing reversely (adapted to be attached to the deck-sheathing at such determinate distance apart as shall render their combined effect substantially equivalent to that of a box-girder of similar depth and weight); combined with deck-sheathing and means for attaching said deck-beam to said sheathing, substantially as described.

39. In a hull structure, a deck-stringer comprising duplex side channels and top and bottom plates uniting said channels; combined with supported overlying deck-beams, substantially as described.

40. Combined in a hull structure, a deck-stringer comprising duplex side channels, and bottom and top plates; means for attaching said bottom plates to the flanges of said channels; means for attaching said top plates to the flanges of said channels; and supported overlying deck-beams, substantially as described.

41. Combined in a hull structure, supported deck-beams, and deck-stringers, each consisting of duplex vertical side channels situated with their flanges facing reversely; bottom plates; means for attaching said bottom plates to said channels; top plates for closing the stringers; and means for attaching said top plates to said channels, substantially as described.

42. Combined in a hull structure, supported deck-beams and deck-stringers each consisting of duplex vertical side channels situated with their flanges facing reversely; bottom plates; means for attaching said bottom plates to said side channels; top plates for closing the stringers; means for attaching said top plates to said side channels; and means for attaching said stringers to said deck-beams, substantially as described.

43. Combined in a hull construction, a deck-framing consisting of transverse duplex deck-beams; and longitudinal deck-stringers (running substantially perpendicularly to the axes thereof) secured to, supporting and uniting said duplex deck-beams in series, substantially as described.

44. Combined in a hull construction, a deck structure consisting of transverse duplex deck-beams; deck-sheathing superiorly attached to said transverse duplex deck-beams; and longitudinal deck-stringers inferiorly attached to and uniting said deck-beams in series, substantially as described.

45. Combined in a hull structure, deck-sheathing; transverse duplex deck-beams consisting of reversely-facing bulb-angles; and longitudinal stringers running perpendicularly to the direction of said deck-beams and attached to and uniting the same in series, substantially as described.

46. Combined in a hull structure, duplex transverse-supported deck-beams; longitudinal deck-stringers uniting said deck-beams; and vertical columns united to said stringers and deck-beams, substantially as described.

47. Combined in a hull structure, an inwardly-inclined side keelson; columns resting axially upon the top of said keelson; deck-stringers supported by said columns, and deck-beams supported in series by said deck-stringers, substantially as described.

48. Combined in a hull structure, an inwardly-inclined side keelson; columns resting upon the top of the keelson and attached

axially thereat to the same; deck-stringers supported by and within the capitals of said columns; means for uniting said deck-stringers to the capitals of said columns; means for uniting said deck-stringers to the deck-beams in series; and means for securing said capitals to the deck-beams, substantially as described.

49. Combined in a hull structure, a supporting-column (consisting of channels longitudinally united by an I-beam); butt-angles united to the tops of said channels; side angles attached to the flanges of said channels; a deck-stringer inclosed between said side angles and attached to said butt-angles; and cap-angles superiorly attached to said deck-stringer substantially as described.

50. Combined in a hull structure, deck-beams; supporting-columns; butt-angles attached to the tops of said columns; and side angles attached to the upper end sides of said columns to form the capitals thereof; a deck-stringer inclosed within said side angles and attached to said butt-angles; cap-angles superiorly attached to and uniting said stringer to the deck-beams; and means for attaching said side angles to said deck-beams, substantially as described.

51. Combined in a hull structure, bottom sheathing; a longitudinally-continuous calking-plate attached thereto; a keelson superiorly attached to said calking-plate; supporting-columns superiorly attached to said keelson; deck-stringers supported by and attached to said supporting-columns; deck-beams supported by and attached to said stringers; and deck-sheathing attached to said deck-beams, substantially as described.

52. Combined in a hull structure, floor-ribs; keelsons longitudinally intersecting said floor-ribs; and deck-supporting columns superiorly attached to said floor-ribs and keelsons at their intersections, substantially as described.

53. Combined in a hull structure, a floor-rib (consisting of paired axially-vertical floor-rib plates); bottom-sheathing closing under the bottoms, and hold-floor plates closing over the tops of said floor-rib plates; and means for securing said floor-rib plates to the hold-floor and to the bottom-sheathing, substantially as described.

54. Combined in a hull structure, a rib and bottom construction comprising a floor-rib (composed of duplex vertical floor-rib plates, bottom-sheathing securedly closing under the bottoms, and hold-floor plates securedly closing over the tops of said floor-rib plates); a side keelson longitudinally intersecting said floor-rib plates; and means for securing said floor-rib plates to said side keelson, substantially as described.

55. Combined in a hull structure, a keel; side bulkheads attached to said keel; web-plates and side keelsons laterally attached to and interrupting said side bulkheads; transverse floor-ribs outwardly attached to and interrupted by said side keelsons; sister keelsons inwardly attached to and interrupting said floor-ribs; floor-ribs outwardly attached to and interrupted by said sister keelsons; stringer-keelsons inwardly attached to and interrupting said floor-ribs; floor-ribs outwardly attached to and interrupted by said stringer-keelsons; and water-line bulkhead-plates outwardly attached to and closing over and between the beam ends of said floor-ribs, substantially as described.

56. Combined in a hull structure, a keel proper having port and starboard keel-bulkheads united in series thereupon; a web-keelson attached perpendicularly to said keel proper; a flange-keelson attached horizontally upon said web-keelson; superposed bulkheads attached upon said flange-keelson and united in series vertically plane with said keel-bulkheads; side bulkheads vertically plane with said superposed bulkheads; and floor-ribs whose axes are vertically plane with said side bulkheads; the construction being such that compartments are formed within the skin adjacent to said side bulkheads, substantially as described.

57. Combined in a hull structure, a central keel proper, having port and starboard keel-bulkheads united in series thereupon; a web-keelson attached perpendicularly to said keel; a flange-keelson attached horizontally upon said web-keelson; superposed bulkheads attached upon said flange-keelson and united in series vertically plane with said keel-bulkheads; web-plates laterally attached to and closing said keel-bulkheads and superposed bulkheads; and hold-floor plates closing over the tops of said superposed bulkheads and web-plates, substantially as described.

58. Combined in a hull structure, a central keel proper, having port and starboard keel-bulkheads united in series thereupon; a web-keelson attached perpendicularly to said keel; a flange-keelson attached horizontally upon said web-keelson; superposed bulkheads attached upon said flange-keelson and united in series vertically plane with said keel-bulkheads; web-plates laterally attached to and closing said keel-bulkheads and superposed bulkheads; hold-floor plates closing over the tops of said superposed bulkheads and web-plates; side bulkheads vertically plane with said superposed bulkheads; and floor-ribs, whose axes lie in the same vertical plane therewith, attached adjacently to said side bulkheads, substantially as described.

59. Combined in a hull structure, a central keel proper, having port and starboard keel-bulkheads united in series thereupon; a web-keelson attached perpendicularly to said keel; a flange-keelson attached horizontally upon said web-keelson; superposed bulkheads attached upon said flange-keelson and united in series vertically plane with said keel-bulkheads; web-plates laterally attached to and closing said keel-bulkheads and superposed bulkheads; hold-floor plates closing over the

tops of said superposed bulkheads and web-plates; side bulkheads vertically plane with said superposed bulkheads; floor-ribs attached adjacently to said side bulkheads, having axes in the same vertical plane therewith; hold-floor plates attached to and closing over the tops of said bulkheads and floor-ribs; and bottom-sheathing attached to and closing over the bottoms of said side bulkheads and floor-ribs, substantially as described.

60. Combined in a hull structure, a central keel proper, having port and starboard keel-bulkheads united in series thereupon; a web-keelson attached perpendicularly to said keel; a flange-keelson attached horizontally upon said web-keelson; superposed bulkheads attached upon said flange-keelson, and united in series vertically plane with said keel-bulkheads; longitudinal web-plates laterally attached to and closing said keel-bulkheads and superposed bulkheads; side bulkheads vertically plane with said superposed bulkheads; side keelsons laterally attached to and closing said side bulkheads; floor-ribs interrupted by and laterally attached to said side keelsons; hold-floor plates attached to and closing over the tops of said superposed bulkheads, side bulkheads, side keelsons and floor-ribs; and bottom-sheathing covering the keel and attached to and closing under the bottoms of said side bulkheads, side keelsons and floor-ribs, substantially as described.

61. Combined in a hull structure, an upwardly and outwardly inclined bottom; upwardly and inwardly inclined sea-decks; and means, including backing-plates and water-line armor-plates of superficial parabolic contour, for continuously attaching said bottom along its beam edges to said sea-deck, substantially as-set forth.

62. Combined in a hull structure, a bottom inclining upwardly and outwardly in either direction from the keel; sea-decks inclining upwardly and inwardly from the beam edges of said bottom; and means, including backing-plates and water-line armor-plates of superficial parabolic contour, for attaching said bottom and sea-decks to each other without the intervention of sides or freeboards, substantially as set forth.

63. Combined in a hull structure, a bottom inclining upwardly and outwardly in either direction from the keel; sea-decks inclining upwardly and inwardly from the beam edges of said bottom; a central deck intermediately attached to and between said sea-decks; and means, including backing-plates and water-line armor-plates of superficial parabolic contour, for attaching said bottom and sea-decks to each other without the intervention of sides or freeboards, substantially as set forth.

In testimony whereof I hereunto set my hand.

CHARLES H. HOWLAND-SHERMAN.

Witnesses:
EDWIN S. CLARKSON,
H. E. MANNING.