June 26, 1945. R. F. SMITH 2,379,259

ART OF SHIPBUILDING

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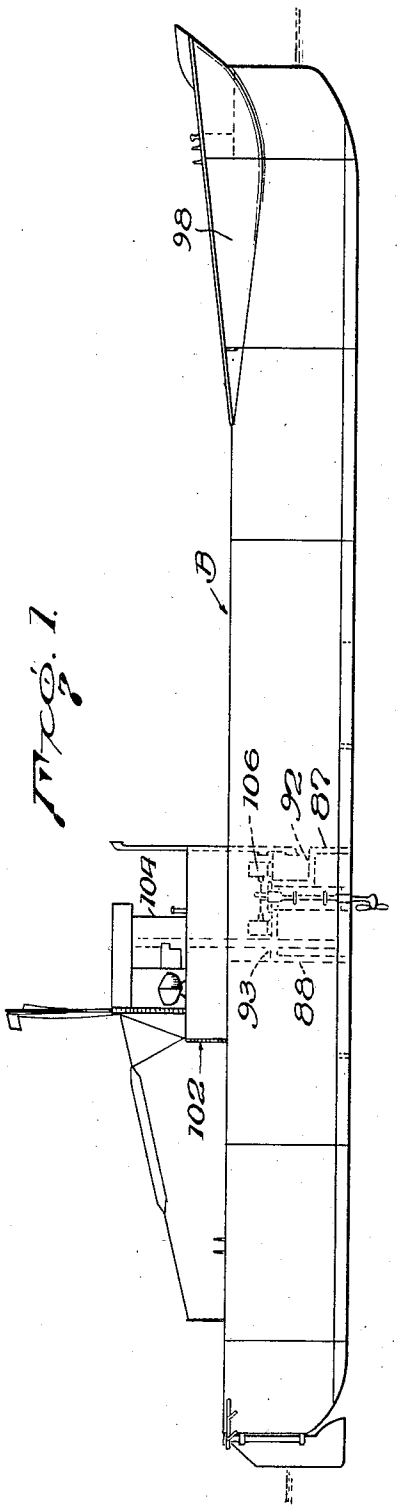


Fig. 1.

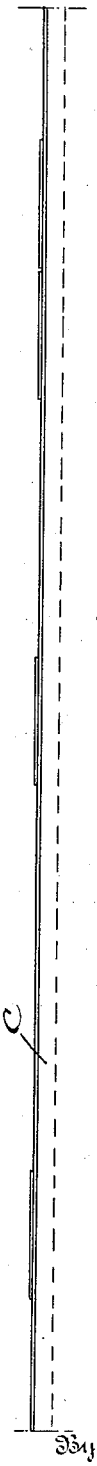


Fig. 3a.

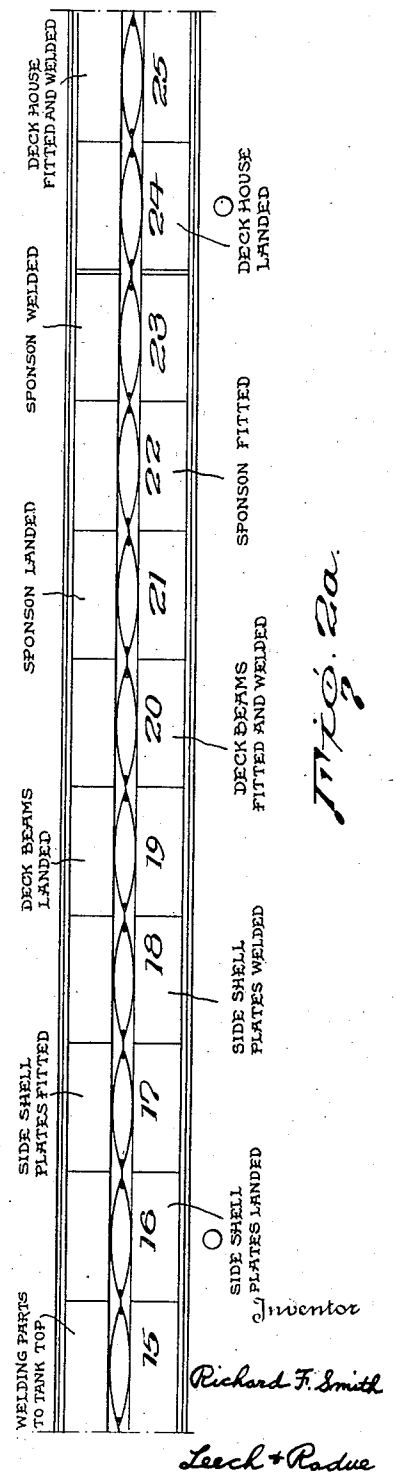


Fig. 2a.

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June 26, 1945. R. F. SMITH 2,379,259

ART OF SHIPBUILDING

Filed Oct. 23, 1941 6 Sheets-Sheet 2

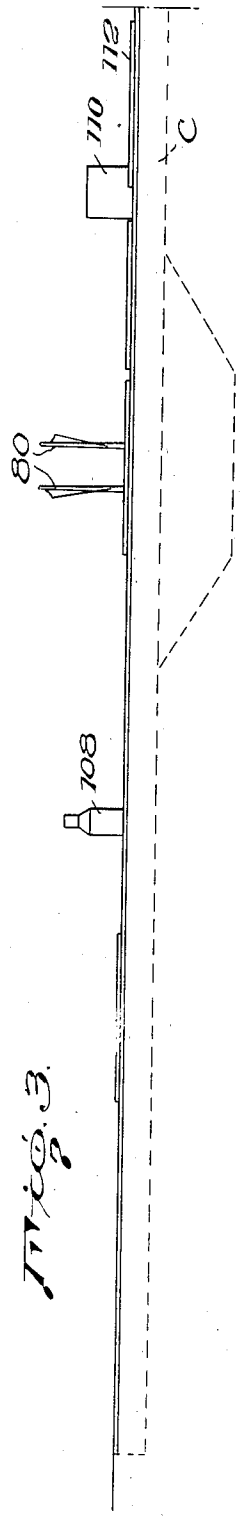


Fig. 3.

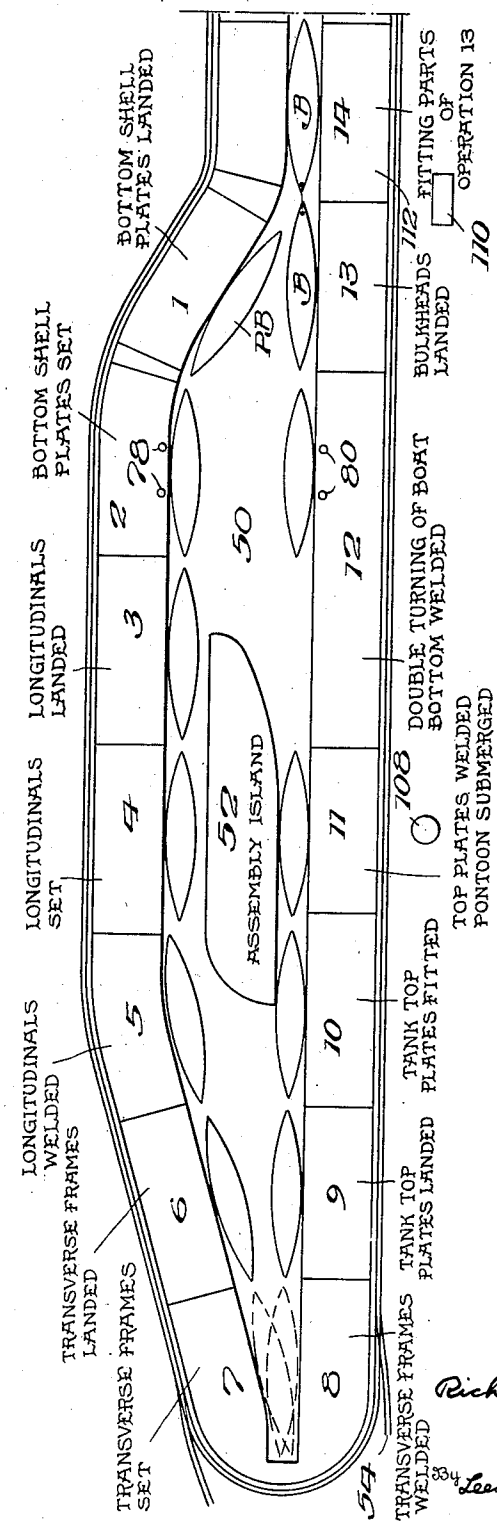


Fig. 2.

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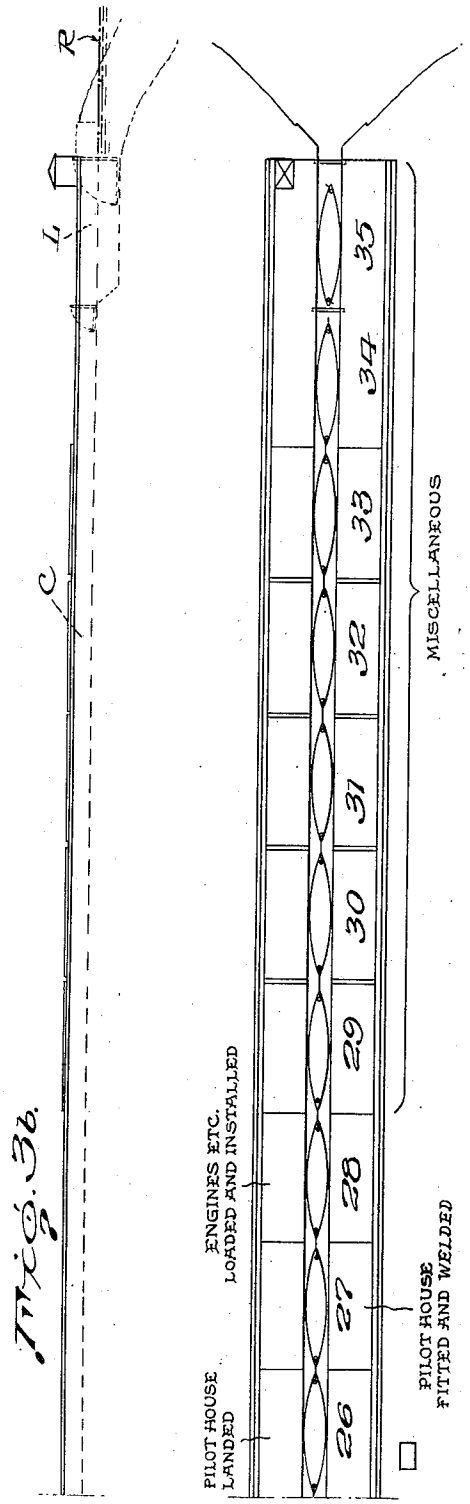


Fig. 3a.

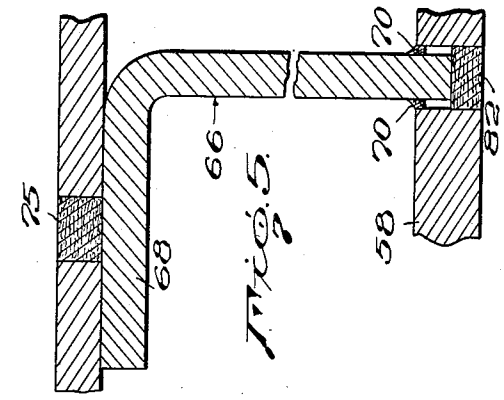


Fig. 5.

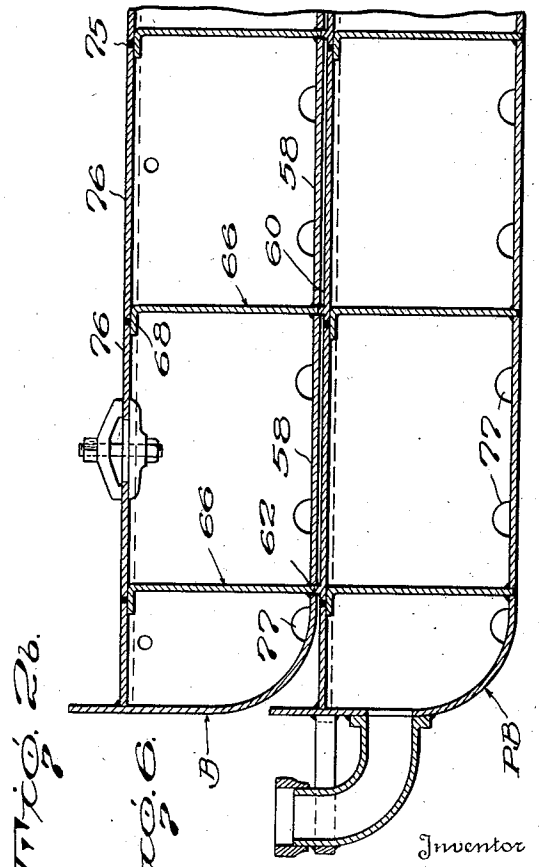


Fig. 2a.

Fig. 6.

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June 26, 1945. R. F. SMITH 2,379,259

ART OF SHIPBUILDING

Filed Oct. 23, 1941 6 Sheets-Sheet 4

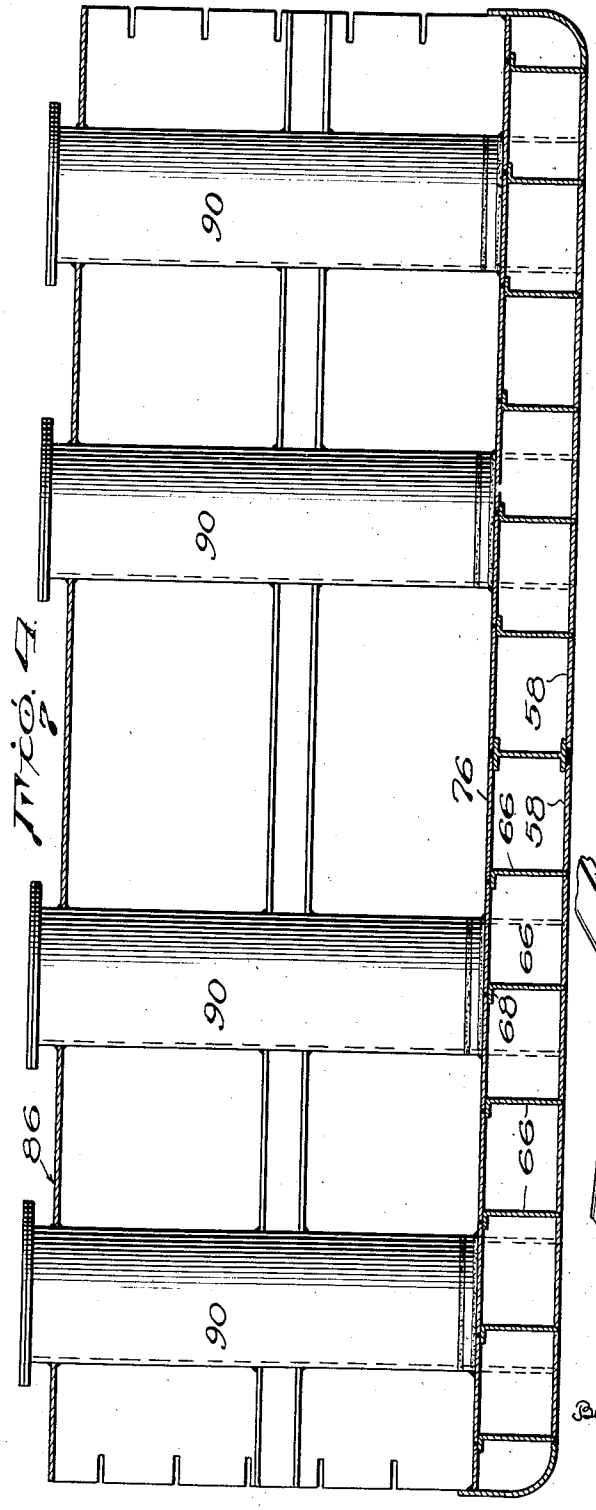


Fig. 4.

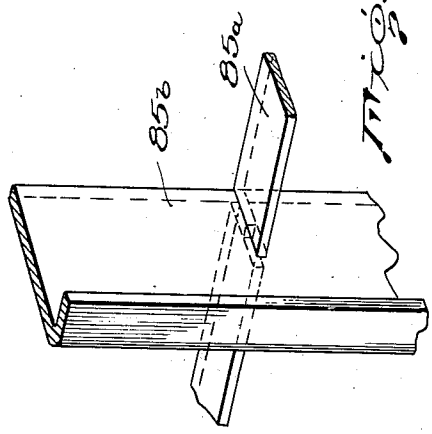


Fig. 9.

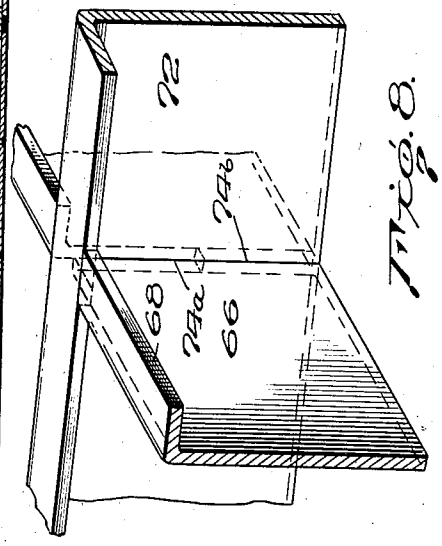


Fig. 8.

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June 26, 1945. R. F. SMITH 2,379,259

ART OF SHIPBUILDING

Filed Oct. 23, 1941 6 Sheets-Sheet 5

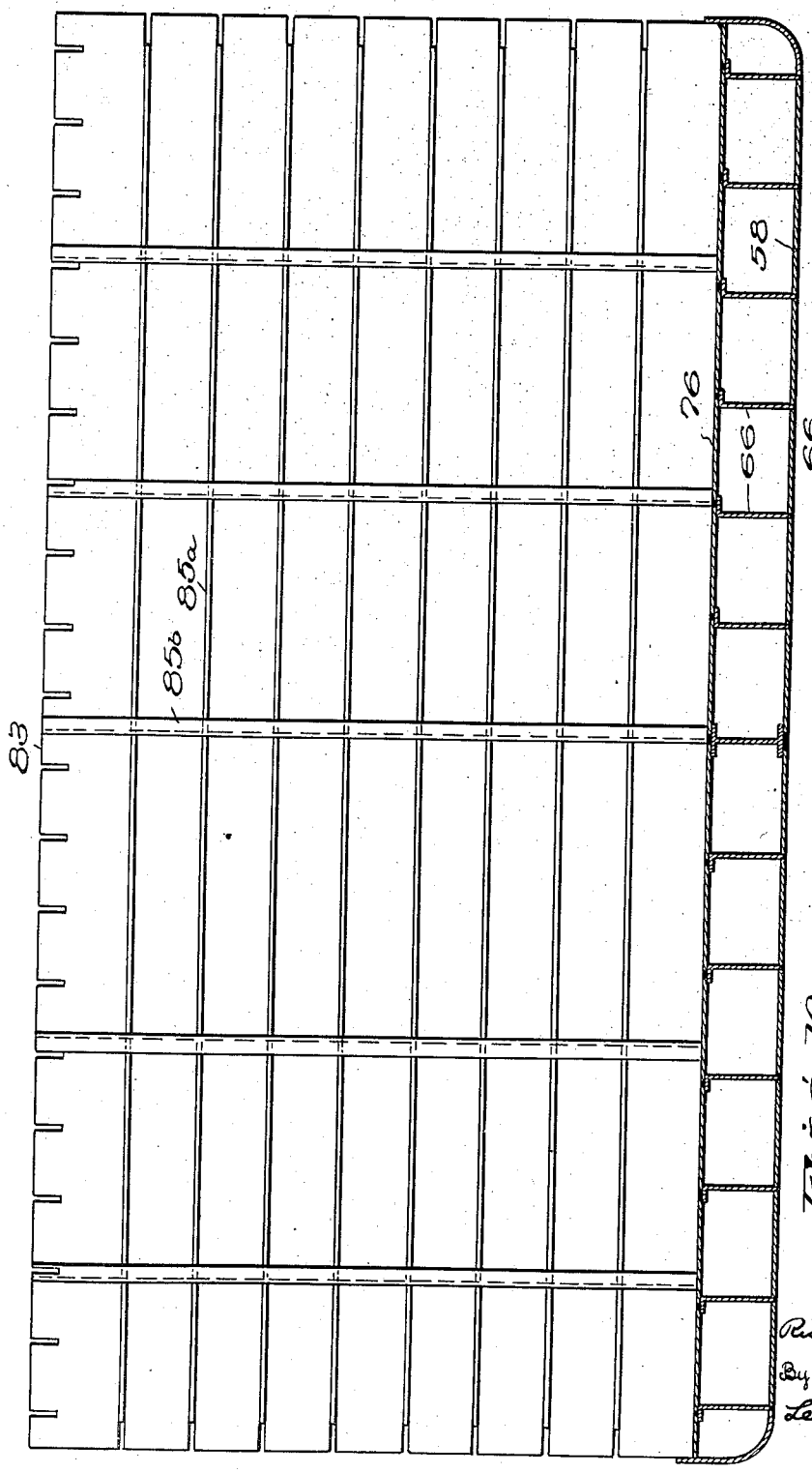


Fig. 10.

Fig. 9.

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ART OF SHIPBUILDING

Filed Oct. 23, 1941 6 Sheets-Sheet 6

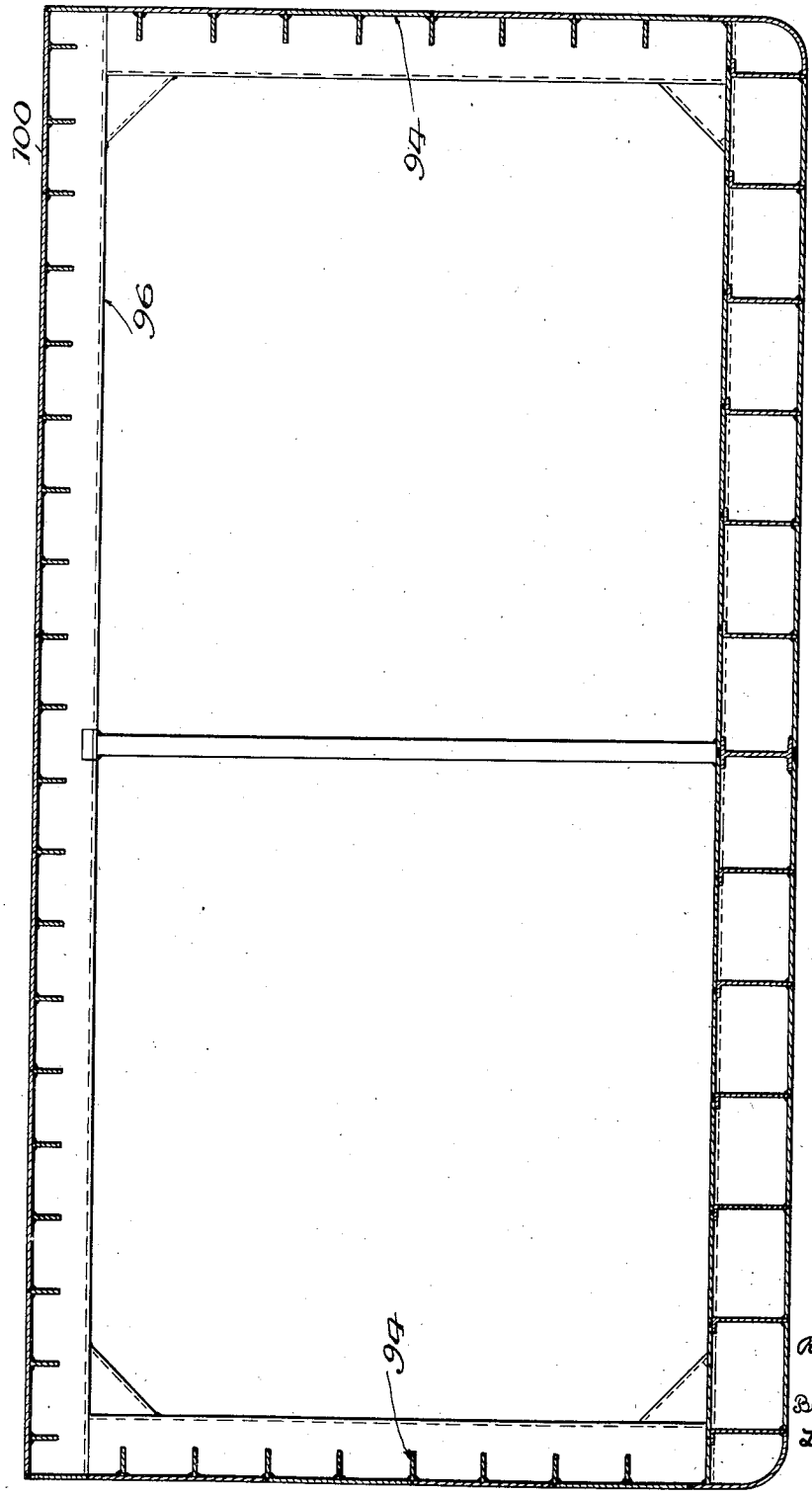


Fig. 11.

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Patented June 26, 1945 2,379,259

UNITED STATES PATENT OFFICE

2,379,259

ART OF SHIPBUILDING

Richard F. Smith, Savannah, Ga.

Application October 23, 1941, Serial No. 416,249

3 Claims. (Cl. 114—79)

This invention is directed to basic improvements in the art of shipbuilding, and particularly to a novel canal or marine system for building ships and to a method of constructing welded type ships with the aid of that system.

The problems of ship construction differ so widely from those relating to the production in large quantity of small land vehicles, or airplanes, that it has previously been considered wholly impractical to adapt to marine work the developments of more recent years in connection with the continuous assembly of automobiles, for example. Recently there has been a nearly unprecedented demand for shipping tonnage, and to meet it, standard ship designs of simplified construction, such as that afforded by welding, have been brought forward. A further aspect of this situation is the dearth of skilled ship fitters and other necessary mechanics.

All of these implied general objects have been attained in the present invention by the elimination of the relatively slow, complicated and expensive procedure of building ships on ways. Instead, it is proposed to use a canal to carry a series of hulls from station to station along its sides where construction is progressively accomplished with a minimum of confusion. Initially, the hull inner bottoms are fabricated on a set of pontoons which are advanced along the sides of a loop portion of the canal until each becomes independently floatable, at which time the respective pontoons are removed by partial sinking and then returned to the starting point of the operations. The floating inner bottoms are next connected together so that they may be intermittently advanced in unison to successive stations immediately adjacent on either or both sides of an extended portion of the canal. Finally, the completed ships are discharged serially from the canal into open water for commencement of useful service.

An important object of this invention is to provide a method of ship construction which will avoid the unpredictable and abnormal strains incident to laying a ship on ways, by giving fluid support to the under water surface of the hull as soon as it is completed.

A further significant object resides in the provision of an improved method of welded hull assembly which increases the amount of down welding, with a corresponding reduction in slower more laborious side welding. This improved method is characterized by the use of spacer bars on the upper surface of the construction pontoons to align the bottom shell plates and longitudinals for interior welding and leave a continuous groove for automatic exterior welding together of these structural members. The availability of the hull bottom for the latter welding operation is attained by sealing it and turning it bottom side up after removal of the pontoon.

While the principal purposes and features of the invention have been indicated, other novel features of improvement contributing to conservation of time, ease of operation, and uniform excellence of the completed ships will be perceived and understood from the following detailed description of the application of the canal or pontoon system to the production of a definite type of welded ship, taken in conection with the accompanying drawings, in which

Fig. 1 shows in side elevation a type of cargo ship to be constructed;

Figs. 2, 2*a*, and 2*b* are plan views of the construction canal, and the appurtenant stations at which successive operations are to be performed;

Figs. 3, 3*a*, and 3*b* are corresponding side elevations of the canal, showing its profile in dotted lines;

Fig. 4 is an enlarged transverse section of a partially completed ship taken at one of its bulkheads;

Fig. 5 is an enlarged vertical section showing the details of the welding of the longitudinals to the bottom shell plates and the tank top plates;

Fig. 6 is a partial transverse section showing a completed hull inner bottom on a construction pontoon;

Fig. 7 is a fragmentary transverse section on the same plane as Fig. 6 and showing the relation of shell bottom plates, longitudinals, and spacer bars;

Figs. 8 and 9 are detail isometric views showing the interlocked form of hull construction which is used for the inner bottom and bulkheads respectively;

Fig. 10 is an enlarged transverse section of a typical bulkhead construction; and

Fig. 11 is a further and enlarged transverse section illustrating the side plate assemblies and deck construction.

Referring to the drawings, the boat B illustrated in Fig. 1 has an overall length of 240 feet between perpendiculars and a beam of 38 feet, which dimensions will determine the principal ones of the canal C of Figs. 2, 2*a*, 2*b* and 3, 3*a*, 3*b*.

Along the canal C, there are thirty-five assembly stations bearing corresponding operation numbers. Each station is 250 feet long or a whole multiple thereof and has 100 feet of width away from the waterway. The canal C is an excavated ditch only three feet deep, and approximately one and five-eighths miles long, with the exception of the basin, 23 feet in depth to permit turning operation 12, and the lock L closing the river end. It is 41 feet wide, just sufficient to take the boats contemplated and give only a small margin on either side.

Where the canal C empties into river R, the lock L controls the water levels.

At the opposite inland end the canal has a loop **50** formed by one side to accommodate operations 1–7, and, as a continuation of its straight extended portion, operations 8–13. An assembly island **52** within the loop **50** is formed and disposed to allow free passage between operations 11 and 1, for purposes to be explained.

Along the two outer edges of the station areas, and approximately 110 feet from the canal runs a standard gauge track **54**, to permit direct receipt of rail-born material at the station where it will be used, and to afford a way for three locomotive cranes (not shown) on each side of the canal for unloading, landing and assembling the material at the various stations.

In addition to having all materials rail delivered to the station of use, and prefabrication where required, the boats B may be connected together in any suitable manner, as indicated, and progressed in unison at periodic intervals. Since the operations are apportioned to the normal eight-hour workshift, all connected boats from operations 8–35 may be moved economically by a windlass (not shown) at the lock end of the canal C. Another windlass may be employed at the extreme land end to move the boats or pontoons from operations 1–7. It is not until operation 13 adjacent the extended part of canal C, is reached, however, that the boats under construction can be directly connected and require no uncoupling until completion. The economies in time and effort resulting from movement of the work to the segregated material will be very obvious.

Initial operations

At the outset of construction, one of the boats would have to be built on a ways, up to its inner bottom and slightly higher side shell plating. This would then be launched into the canal and taken to station at operation 1, to serve as a pontoon, designated PB, on which the first actual canal-constructed pontoon would be put together on the upper surface of the first pontoon, as described hereinafter. This second pontoon boat, PB, would then be floated off at operation 11, turned and finished at operation 12; turned back and brought to operation 2 as the second of the construction pontoons.

On these first two construction pontoons, PB, two more would then be built, and the operation repeated until eleven were available. The twelfth hull, thus started, would be the first to continue down the canal for completion and launching into the river.

Individual station operations

Operation 1.—With the receiving pontoon, PB, in place, the single operation at the initial station is the landing of the bottom shell plates **58** on the pontoon.

Operation 2.—The deck **60** of pontoon PB, which is in reality its tank top, or inner bottom, has a plurality of small, flat longitudinal bars **62**, ½ by ¼ inch, fastened thereto with exact spacing of three feet between their edges to form a uniform jig the length of the pontoon to receive the three feet wide bottom shell plates **58**. When these plates **58** are put in place, there will remain a small open trough or groove **64** (Fig. 7) one-quarter inch in depth, by reason of the one-half inch thickness of said plates **58**.

Operation 3.—At this station, the set of longitudinals **66** (Fig. 4) are landed on the bottom shell plates **58**. In this particular embodiment, the longitudinals **66** takes the form of a ⅜ inch flanged plate 24 inches in height, with a 3½ inch flange **68** at the top (Fig. 5).

Operation 4.—At this next station, the longitudinals **66** are set in the grooves **64** between shell plates **58** and on top of the flat longitudinal spacer bars **62**, so as to leave a small space of approximately $\frac{1}{16}$ inch at each side within said groove.

Operation 5.—The previously landed longitudinals **66** are next welded to the bottom plates **58** along the fore and aft shell plate seams with a sealing bead **70** along each side (Fig. 5). This form of sealing is entirely sufficient to make the bottom shell watertight.

Operation 6.—A plurality of transverse frames **72** identical in size with the longitudinals **66**, that is, ⅜ inch by 24 inches with a 3½ inch flange at the top, and spaced about 10 feet between centers, are landed across the longitudinals which have a half cutout **74***a* to match an identical half cutout **74***b* in the transverse frames **72**, best shown in Fig. 8. This manner of interfitting forms a lock and allows the bottom of the transverse frames **72** to come flush with the bottom shell, at the same time bringing the top of the transverse frames flush with the inner bottom.

The interlocking welded construction previously described, forms no part of this invention, having been already disclosed in applicant's Patent No. 1,806,508.

Operation 7.—As the transverse frames **72** are here fitted into place and set, they are tack-welded so as to be ready for final welding to the bottom shell plates **58** and the longitudinals **66**.

Operation 8.—At this station, the transverse frames **72** are completely welded to the bottom shell structure and the longitudinals **66**.

Operation 9.—The tank top plates **76** are landed preliminarily on the relatively wide flanges **68** of the longitudinals **58** and transverse frames **72**.

Operation 10.—The tank top or inner bottom plates **76** are spread and fitted to provide a ½ inch longitudinal opening between them, which is necessitated by the original opening of this width left between the bottom shell plates **58** to receive the spacer bars **62** on the deck of the receiving pontoon PB. This longitudinal opening affords space for free automatic welding of the plates **76** to the flanges **68** of the longitudinals **66**, and also allows the burning of holes in the transversals or frames **72** to permit of their plug-welding to said plates. In Fig. 5 a typical automatically produced weld **75** between flange **68** and spaced plates **76**, is clearly shown.

Operation 11.—The tank top plates **76** are automatically welded to the longitudinals **66** and plug-welded to the transversals **72**, as described above. At the same time, the support of the pontoon PB is being progressively removed by pumping into its inner bottom the relatively

small amount of water necessary to submerge it. Limber holes 77 are formed to aid water circulation, indicated at Figure 6. When the submerging operation is complete, the boat B under construction will float off the pontoon PB and maintain its own buoyancy through its watertight inner bottom. After being thus floated off, this boat is removed to the next station.

After release, the sunken pontoon PB is raised by pumping from the inner bottom the amount of water necessary to restore its buoyancy; and is then taken back through the neck of the loop 50 in the canal C to the station where Operation 1 is performed, for a repetition of its prescribed travel through the first eleven stations.

Operation 12.—The canal C at this double unit length station has a depth sufficient to permit turning the inner bottom under construction bottom side up in a lateral direction. This may be accomplished by suitable means such as steel cables and masts on opposite sides of the canal, indicated generally as 78 and 80. When such means are employed, the inversion is effected by having two cables run over the inner bottom and fastened to the upper edge of the shell plating on the opposite side, and by having two additional cables from the other side of the canal passing across the top of the inner bottom to pull in opposition to the first two.

Meantime, water has been pumped into the inner bottom until it is half full, resulting in a rolling axis that tends to stabilize and render much easier the required movement throughout the whole of the turning operation.

It will be understood that the purpose of this inversion is to provide free access for a rapid automatic welding of the outer sides of bottom plates 58 which were previously sealed for watertightness only, and not for strength, by the small fillet welds 70 attaching them to the longitudinals 66 and transversals 72, as more fully described in connection with Operation 5. The groove space provided by removal of the spacer bars 62 is filled and adjacent bottom shell plates 58 are welded to each other and to the interposed longitudinals 66 or transversals 72 by a single large weld 82, best illustrated in Fig. 5. The relatively deep insertion of the framing elements 66 and 72 below the upper or inner surface of plates 58 prevents blowing out of the edges of those plates during these automatic welding operations.

With the welding of the inner bottom shell thus completed, the boat is then turned back to its normal position while still in the deep water portion of the canal. The boat is now a normal floating hull, with every square foot of its underwater surface carrying a normal load throughout the remaining operation of hull construction, machinery placing, and complete outfitting. It is one of the outstanding advantages of this invention that all abnormal strains which inevitably attend the construction and launching on shipways are avoided.

Operation 13.—Referring to Figs. 4 and 10, five bulkheads 83 are landed, and also one special assembly 86 embracing two bulkheads, 87 and 88, and four propeller shaft tubes 90, as well as two platforms, 92 and 93. Fig. 9 shows in more detail the interlocked stiffening members 85*a* and 85*b* welded to the intermediate portions of the bulkhead 83. From this operation onward, other small items can be added at the various stations, as may be found most advantageous and convenient.

Operation 14.—All connections with the material landed in operation 13 are here fitted to the inner bottom or its tank top.

Operation 15.—The connections made in operation 12 are welded to the inner bottom at this station.

Operation 16.—At this point, side shell plating in three sub-assembled sections indicated generally as 94 in Fig. 11, for port and starboard, are landed from both sides of the canal.

Operation 17.—The operation at this station is a special one in that the side shell plating frames, and longitudinals are sub-assembled and completely welded in three sections for the entire length of the boat, while the hull on which they are to be placed, is at the station for operation 15. As the hull moves forward to operation 16, the sub-assembled side shell sections 94 are carried back to the same station for landing.

At the same time, another set of three sections of side shell plating 94 is under assembly at the station of operation 18, to be moved back to operation 17, allowing a repetition of the same operation for the succeeding boat. The complete assembly operation, therefore, takes sixteen hours, or two shifts, to complete.

In the meantime, operation 17 workmen on board the boat are fitting the side shell plates 94 landed during the preceding operation 16.

Operation 18.—While the sub-assembly work is going forward quite independently on both sides of the canal, the welders are aboard at this station and are free to operate without danger of injuring any other workmen, which can so often happen when the operations of welders and fitters are mixed in the ordinary method of ship construction. This minimizing of accident hazard applies to all of the other welding operations on the boats, since fitters and welders are never working together at the same time, with the one possible exception of the tack-welders, who must cooperate with the mechanics while they are fitting up the work.

Operation 19.—The deck beams 96 of Fig. 11 are assembled on their platforms on both sides of the canal, one side for fitting and one side for landing.

Operation 20.—While at this station, the deck beams 96 are fitted and welded to the side shell frame connections and to the tops of possible stanchions.

Operation 21.—At this station, the sponsons 98, one of which is shown in Fig. 1, are assembled and landed and the deck plating 100 (Fig. 11) also is landed.

Operation 22.—The sponsons 98 and deck plating 100 just referred to are fitted.

Operation 23.—Sponsons 98 and deck plating 100 are welded in place.

Operation 24.—An upper deck house assembly 102 (Fig. 1) is landed.

Operation 25.—The upper deck house assembly 102 is fitted and welded to the main deck plating 100.

Operation 26.—A pilot house and platform 104 are assembled and landed at this station.

Operation 27.—The pilot house 104 is here fitted and welded.

Operation 28.—The engines 106 indicated in Fig. 1 and similar miscellaneous equipment are landed and installed.

Operations 29 to 35.—The remaining seven stations which have been provided are available for painting and for unforeseen operations such as the installation of plumbing, degaussing system, pipe fitting, or other miscellaneous opera-

tions which may not have been completed during the passage from operation 13. Launching through lock L follows these operations.

It will, of course, be understood that suitable store houses are provided at operation stations along the assembly line for all materials which require protection from the elements. In addition to that previously mentioned, other mechanical equipment for handling materials and constructing assemblies most efficiently will be used, as exemplified by the steam boilers 108 and acetylene generators 110.

Where sub-assemblies and landing operations are involved, suitable wood platforms 112 are erected, as shown in Figs. 2 and 3.

As an illustration of the revolutionary nature of the foregoing improvements, in the art of shipbuilding, it is pointed out that the specific application of the principles thereof, as described herein, will result in the launching of a boat of 450 tons of steel each day on a single shift working schedule, with the possibility, by employing three shifts, of tripling this production without increase in the canal or any of the working equipment.

The term "loop" appearing in the specification is used in its broadest sense to define an enclosure for a liquid supporting medium of at least double width, or, such as to provide two joined paths, about which the construction pontoons PB can be circulated and pass in opposite directions.

Since it will be apparent that the system and method of this invention can be adapted to a great variety of ship constructions, it is intended that its scope shall not be limited to the illustrative embodiment, except as may be required by the language of the appended claims. Those skilled in this art will readily recognize the separate utility of various sub-combinations included in the present inventive disclosure, and for that reason, certain of the following claims have been directed to such features.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of constructing a welded hull comprising, providing a floating pontoon structure having a plurality of spacer bars secured in predetermined relation to its upper surface; setting a plurality of bottom shell plates, of greater thickness than the height of the spacer bars, between said bars; setting a plurality of framing elements on the tops of the spacer bars and between adjacent shell plates; welding the framing elements to adjacent pairs of shell plates at the upper portions of the latter; sealing the hull; removing the pontoon structure by progressively sinking it when the hull is capable of floating; turning the bottom of the sealed hull uppermost while it is floating; and then automatically welding the bottom shell plates and framing elements together in the space provided by removal of the spacer bars.

2. The improvement in the art of shipbuilding on a canal having a widened portion at one end defining a loop with its periphery and connected with an extended portion of only slightly greater width than the ships being constructed comprising; floating a plurality of pontoons along the loop; assembling and constructing a hull bottom on each pontoon starting at one side of the connected end of the loop; submerging each pontoon at the end of the loop on the other side of the canal to float its completed hull bottom; refloating each pontoon and returning it to the starting position; and advancing a series of floating hull bottoms intermittently and in unison to successive construction stations arranged along opposite sides of the extended portion of said canal.

3. The improvement in the art of shipbuilding on a canal having an extended portion of only slightly greater width than the ships being constructed comprising; floating a plurality of pontoons along the canal; assembling and constructing a hull bottom on each pontoon starting at one end of the canal; sinking each pontoon to float the completed hull bottom when complete; refloating each pontoon and returning it to the starting position; and serially completing the respective ships while advancing a plurality of floating hull bottoms to successive construction stations arranged along opposite sides of the remaining portion of said canal.

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