C. LAURENTI.

SUBMARINE OR SUBMERSIBLE BOAT.

APPLICATION FILED AUG. 14, 1907.

985,911. **Patented Mar. 7, 1911.**

3 SHEETS—SHEET 1.

Fig. 1

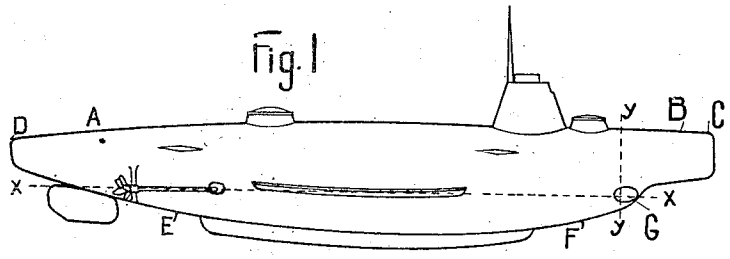


Fig. 7

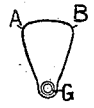


Fig. 4

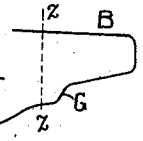


Fig. 6

Fig. 8

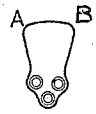


Fig. 5

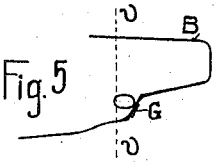


Fig. 2

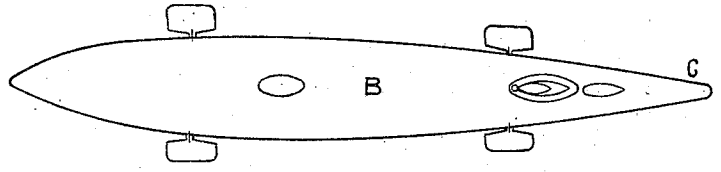
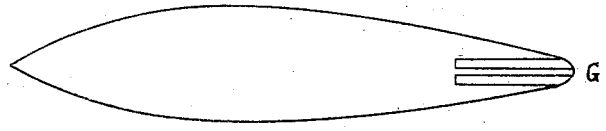


Fig. 3



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3 SHEETS—SHEET 2.

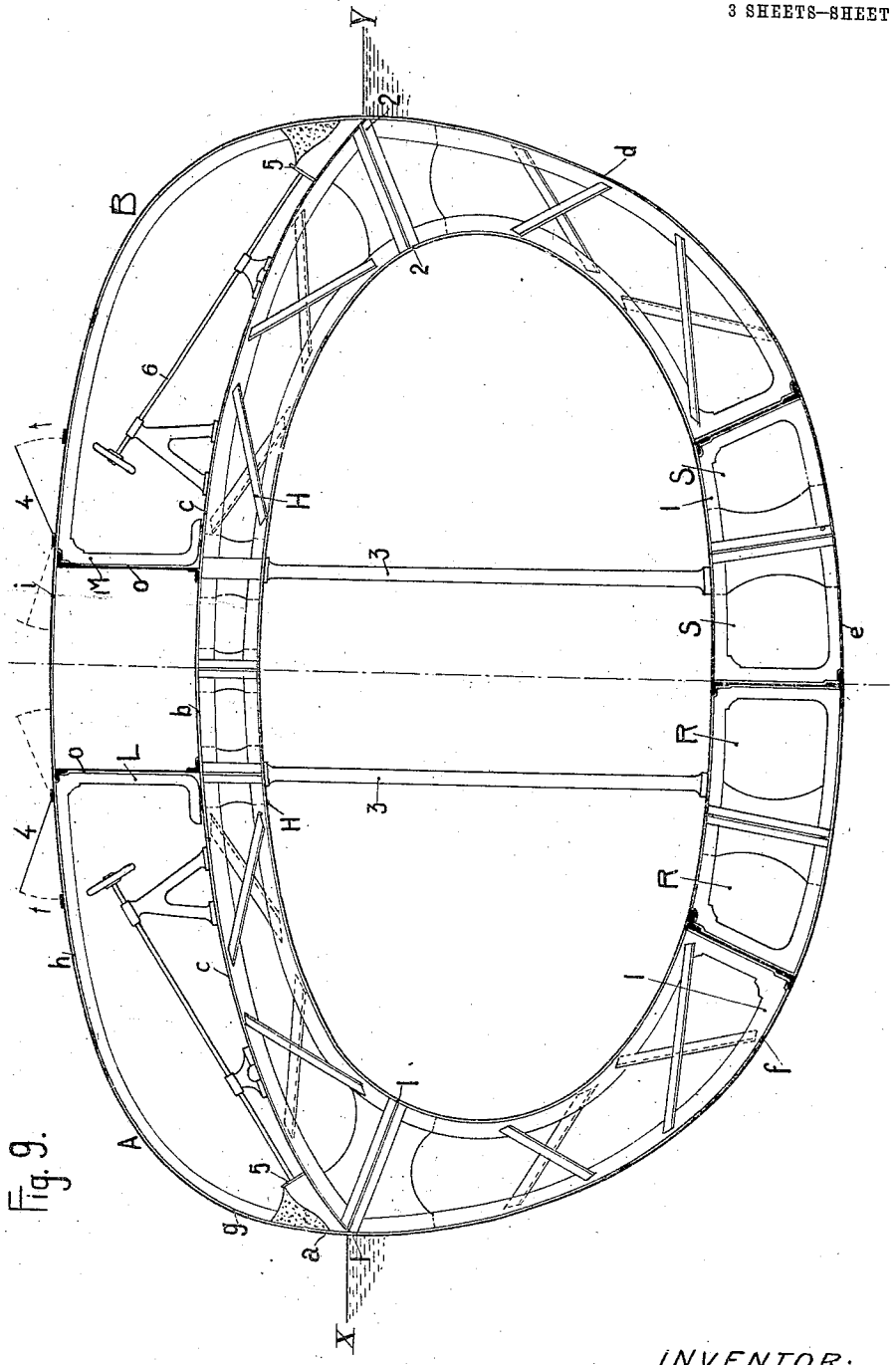

Fig. 9.

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3 SHEETS—SHEET 3.

Fig. 10

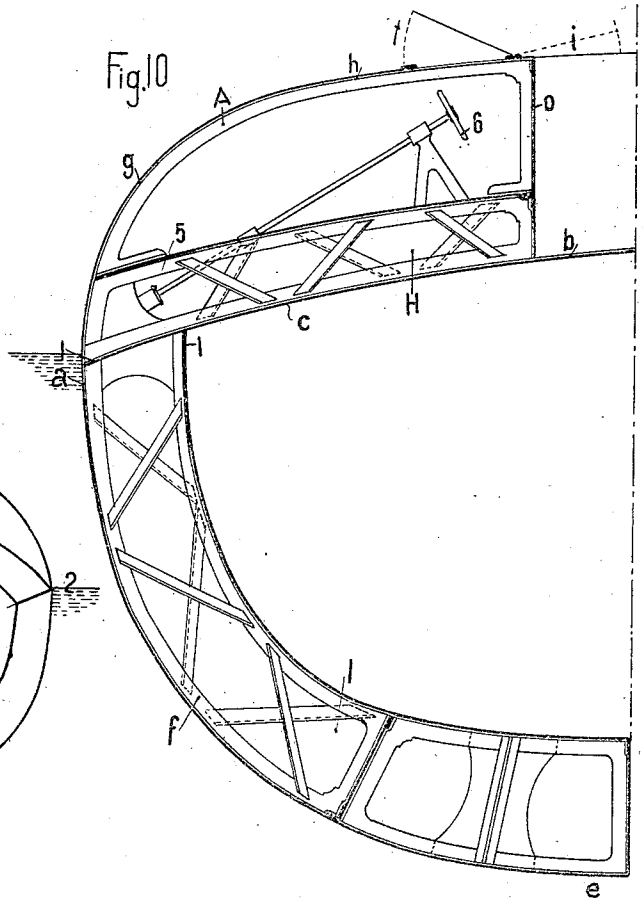


Fig. 11

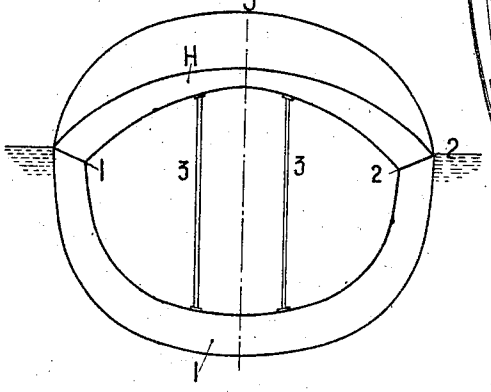


Fig. 12

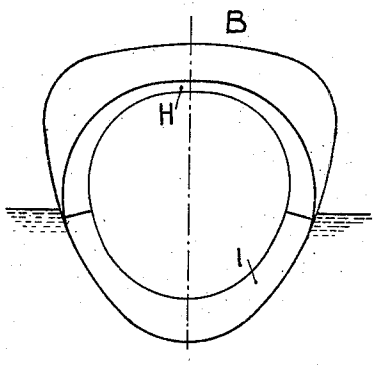
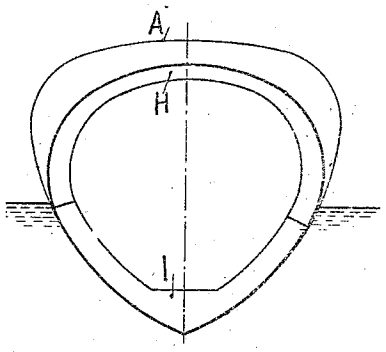


Fig. 13.



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SUBMARINE OR SUBMERSIBLE BOAT.

985,911. Specification of Letters Patent. Patented Mar. 7, 1911.

Application filed August 14, 1907. Serial No. 388,445.

To all whom it may concern:

Be it known that I, CESARE LAURENTI, of Spezia, Italy, have invented certain new and useful Improvements in Submarine or Submersible Boats, of which the following is a full, clear, and exact specification.

In submarine or submersible boats the principal requirements that must be fulfilled in order to insure their acting properly, are: (*a*) That they shall oppose the smallest possible resistance to motion. (*b*) That they present the highest possible reserve of buoyancy while on surface navigation. (*c*) That they keep the center of buoyancy high while the boat is fully submerged.

The types of submarine or submersible boats in existence do not generally fulfil these requirements, without causing other inconveniences. These submarines or submersibles have the portions of their hulls which are designed to resist the high pressure of submersion round or oval in cross section, which makes their hull oppose a considerable resistance to motion especially on surface navigation. In order to lessen this resistance, it has been common to provide these circular shaped hulls with a super-structure, which is either for the free circulation of water or is filled or covered in the upper portion with some light material, such as cork, wood or the like, which serves both to give a certain power of buoyancy to the boat when on surface navigation and to keep the center of buoyancy as high as possible, while traveling under water. This expedient of a super-structure however, has an unfavorable effect on the lines of the hull and has a disturbing influence on the operations of sinking and coming to the surface.

The subject of this invention is a kind of hull for submarine or submersible boats, by means of which the desired requirements are fulfilled without creating other disadvantages.

This invention at the same time presents further improvements, by means of which greater advantages in the working of the submarine or submersible boats are secured.

The accompanying drawings illustrate the invention.

Figure 1 is a lateral elevation of the hull of a submarine or submersible boat in accordance with the invention. Fig. 2 is a view from above. Fig. 3 a section along the line *x*—*x* of Fig. 1. Figs. 4 and 5 show two different forms of the end of Fig. 1. Figs. 6, 7 and 8 are the corresponding sections along the lines *y*—*y*, *z*—*z*, and *v*—*v* of Figs. 1, 4 and 5. Fig. 9 represents a main cross section of Fig. 1 on a larger scale. Fig. 10 a variant of Fig. 9. Fig. 11 is a diagrammatic view of the part of the hull which opposes resistance to the pressure of the water in correspondence with the main cross section. Figs. 12 and 13 represent diagrammatically two sections, one of them in the vicinity of the bow and the second near the stern.

The upper or decked part A, B, forms a flat deck which has an almost straight longitudinal profile as far as the commencement A of the stern, Fig. 1, where the part curves slightly in order to approach the water line. The bow C and the stern D run straight and vertically downward, and the under part of the hull E, F, has the profile of a continuous curve. If, however, the boat is to be fitted with torpedo tubes, then the profile exhibits a shouldered or offset portion G at the end of which are situated the mouths of the torpedo-tubes.

Figs. 1, 3 and 6 show the arrangement of a boat with two torpedo tubes. Figs. 4 and 7 the arrangement for a single tube. Figs. 5 and 8 the arrangement for three tubes.

The chief advantages of the peculiar shape of the ends of the boat just described is that, as can be seen especially in Fig. 3, there is no portion of the boat's hull between the mouths of the launching tubes, so that, contrary to what happens in the known types, there does not take place any increase or diminution of pressure at the mouths of the tubes during lateral movements of the boat, which phenomena are probable when the boat turns for the purpose of taking aim for firing the torpedoes. In existing and known types of submarines or submersibles the part of the hull projecting over and between the mouths of the torpedo-tubes produces an increase of pressure of water on the side toward which the boat is turning while a suction takes place on the opposite side, both of which phenomena greatly disturb the safe exit and the proper after run of the torpedoes.

The structure of the boat which is intended to offer resistance to the pressure of the water when the boat is sunken, is dia-

grammatically represented in Fig. 11, and on a larger scale in Figs. 9 and 10, in correspondence with the principal cross section of the boat. It consists of a metallic framework composed of two elastic arches H, I. The ends of these arches are strongly connected at the points 1, 1, 2, 2, so as to form a rigid resistant system, which can be further strengthened by cross stays 3. The cross vertical stays 3 take up either the pressure or the strain, according to the deformations to which the hull is subjected. Around the periphery of the arches H, I are fixed the sheets which form the covering *a*, *b*, *c*. These sheets can be applied either to the upper convex surface of the arch H (as shown in Fig. 9) or to the concave part of the same arch H, as shown in Fig. 10. In this latter case the superior arch H reaches with its ends the outside of the boat, so that the latter is less contracted and the inside of the hull remains more roomy and can be better utilized. Above the described strong part of the hull are arranged coffer-dams, which are bounded on the lower side by the covering *b*, *c*, and on the upper side by a second light covering *g*, *h*, *i*, this latter forming the upper deck of the boat A, B. Between the sheets *a*, *b*, *c*, and the deck *g*, *h*, *i*, run two longitudinal beams L, M, to which are laterally fixed sheets *o*, *o*, so that the walls *b*, *o*, *i*, *o*, form a central air chamber which is isolated from the adjacent chambers included within the plates *a c o h g*. The side coffer-dams formed by the plates *a*, *c*, *o*, *h*, *g* are provided at their upper part with hatches 4, 4, and with valves 5 at their lowest part. These valves 5 can be operated by hand by means of the rods 6.

When the boat has been made ready to sink then the hatches 4, 4, and valves 5 are opened, but there is no communication between the central cofferdam *b o i o* and the side cofferdams. The line of flotation of the boat in her normal surface trim is (Figs. 9 and 10) in X, Y, viz.: lower than the upper part of arch H, and sheets *c b c*. When the valves 5 are opened the two upper side chambers fill automatically as the boat sinks and are automatically emptied as the boat returns to the surface. The valves 5 are sufficient in number to effect this result. The hatches 4 permit the escape of air as the water enters upon submerging and the return of the air as the water leaves upon emerging. This automatic filling and emptying of the super-structure results in the condition that the super-structure does not afford any substantial or material reserve of buoyancy when the boat is sinking, since when the ballast tanks are filled the water runs in substantially as fast as the boat sinks, so that submergence is not materially delayed. On the other hand upon emerging the water runs out substantially as fast as the blowing of the ballast tanks would ordinarily bring it to the surface, so that the super-structure does not add any material dead weight or displacement to the boat in emerging. In other words, the super-structure in its preferred form is a negligible factor or nearly so in the operation of emerging and submerging. When in surface running condition, however, the buoyancy of the hull of the boat is sufficient to carry the super-structure well out of water. In a heavy seaway in surface running condition the super-structure adds a certain amount of buoyancy even though its valves 5 are open, provided hatches 4 are closed, since a certain amount of air is thus imprisoned in the super-structure and in a heavy sea adds to the buoyancy of the boat in this condition. If it is desired to add further to the factor of buoyancy of the boat the valves 4 and 5 are closed, so that the super-structure is watertight. Under these circumstances a large positive factor of buoyancy is added to the boat, as much in ordinary practice as 50 or 60 per cent. At the same time this factor of buoyancy may be at once neutralized by opening the valves 4 and 5, whereupon as before stated the boat submerges and emerges practically as rapidly as though the super-structure were not present. It will be understood that the super-structure may be divided longitudinally as shown in the drawing, but that it should not be divided transversely. It is practically necessary that the water within the super-structure be given opportunity to flow substantially freely from end to end.

It will clearly appear how it is possible with a proper calculation of the volume of coffer-dams to make the reserve of flotation of the boat while engaged in surface navigation as great as that of any ordinary ship. The central coffer-dam *b*, *o*, *i*, *o*, remains always free from the water, and is used for the following purposes. 1. To make the diminution of the surface of buoyancy gradual with the sinking of the boat; viz.: to produce the gradual reduction of the metacentric height, and thus facilitate the longitudinal setting of the boat during the period of submergence. 2. To raise the center of buoyancy of the boat so as to assure to the same a greater metacentric height during submersion, without necessitating any super-structures which would unfavorably influence the simplicity of the boat's lines and increase its resistance to motion. 3. To assist in strengthening the upper part of the hull of the submarine or submersible boat by making the resistance of the longitudinal beams L, M, as well as that of the deck covering *g*, *h*, *i*, *l*, *m*, and the arches which support the deck covering work together in support of the above mentioned deck. The lowest part of the boat contains at R, S,

(Figs. 9 10) the ordinary tanks for admitting and discharging the water ballast during the submerging or emerging operations.

What I claim is:—

1. In a submarine or submersible boat, a hull having an arched upper side, and having an upper hollow coffer-dam formed by trussed arches inseparably connected with the superior part of the hull itself, and which cofferdam forms a continuous part of the hull and coöperates to give to said hull a greater strength against pressure while submerged.

2. In a submarine or submersible boat, a series of transverse frames adapted to resist the pressure of the water and composed each of two elastic arches connected at their ends by rigid joints and constituting the entire periphery of the frame, a cofferdam supported by these frames and forming the upper part of the hull, said coffer-dam being adapted to remain empty while the boat is traveling at the surface so as to give the boat a high reserve of buoyancy without interfering with the operations of submerging and emerging.

3. In a submarine or submersible boat having torpedo tubes, a hull the longitudinal profile of which exhibits a shoulder at least at one end, the mouths of said torpedo tubes being arranged horizontally alongside of each other and coinciding with the said shoulder so as to avoid having any part of the hull between the mouths of the torpedo tubes.

4. In a submarine or submersible boat, a hull in which is an upper coffer-dam, and a central smaller longitudinal coffer-dam inclosed in said upper coffer-dam, said central coffer-dam adapted to remain empty so as to keep the center of buoyancy as high as possible when the boat is traveling under water.

5. A submarine or submersible boat having a hull, ballast tanks in said hull, and a hollow superstructure above said hull, said hull and super-structure having openings to the exterior of such area as to freely admit water to said super-structure when the boat submerges and permit the same to freely escape when the boat emerges, said hull having such a measure of buoyancy that when said ballast tanks are empty and said openings are open, the hull will rise to such an extent as to bring substantially all of said super-structure above the surface of the water and cause it to free itself automatically of substantially all of the water in said superstructure, and said super-structure being constructed to permit a free flow of water therein substantially from end to end.

6. A submarine or submersible boat having a hull, ballast tanks in said hull, and a hollow super-structure above said hull, said hull and super-structure having openings to the exterior of such area as to freely admit water to said super-structure when the boat submerges and permit the same to freely escape when the boat emerges, said hull having such a measure of buoyancy that when said ballast tanks are empty and said openings are open, the hull will rise to such an extent as to bring substantially all of said super-structure above the surface of the water and cause it to free itself automatically of substantially all of the water in said super-structure, and said super-structure being constructed to permit a free flow of water therein substantially from end to end, and means for closing the openings in said super-structure.

7. A submarine or submersible boat having a hull, ballast tanks in said hull, and a hollow super-structure above said hull, said hull and super-structure having openings to the exterior of such area as to freely admit water to said super-structure when the boat submerges and permit the same to freely escape when the boat emerges, said hull having such a measure of buoyancy that when said ballast tanks are empty and said openings are open, the hull will rise to such an extent as to bring substantially all of said superstructure above the surface of the water and cause it to free itself automatically of substantially all of the water in said superstructure, and said super-structure being constructed to permit a free flow of water therein substantially from end to end, and said hull and superstructure being rounded on their upper sides.

8. A submarine or submersible boat having a hull, ballast tanks in said hull, and a hollow super-structure above said hull, said hull and superstructure having openings to the exterior of such area as to freely admit water to said super-structure when the boat submerges and permit the same to freely escape when the boat emerges, said hull having such a measure of buoyancy that when said ballast tanks are empty and said openings are open, the hull will rise to such an extent as to bring substantially all of said super-structure above the surface of the water and cause it to free itself automatically of substantially all of the water in said super-structure, and said super-structure being constructed to permit a free flow of water therein substantially from end to end, and said openings being located substantially at the bottom of said super-structure.

9. A submarine or submersible boat having a hull, ballast tanks in said hull, and a hollow super-structure above said hull, said hull and super-structure having openings to the exterior of such area as to freely admit water to said super-structure when the boat submerges and permit the same to freely escape when the boat emerges, said hull having such a measure of buoyancy that

when said ballast tanks are empty and said openings are open, the hull will rise to such an extent as to bring substantially all of said superstructure above the surface of the water and cause it to free itself automatically of substantially all of the water in said super-structure, and said super-structure being constructed to permit a free flow of water therein substantially from end to end, and said super-structure being divided longitudinally to form a central water-tight cofferdam.

10. A submarine or submersible boat having a hull, ballast tanks in said hull, and a hollow super-structure above said hull, said hull and super-structure having openings to the exterior of such area as to freely admit water to said superstructure when the boat submerges and permit the same to freely escape when the boat emerges, said hull having such a measure of buoyancy that when said ballast tanks are empty and said openings are open, the hull will rise to such an extent as to bring substantially all of said super-structure above the surface of the water and cause it to free itself automatically of substantially all of the water in said super-structure, and said super-structure being constructed to permit a free flow of water therein substantially from end to end and said super-structure having air vent openings at the top thereof.

11. A submarine or submersible boat having a normal surface running water line and having ballast tanks of a capacity to submerge the boat when filled, and to emerge it to said water line when emptied, and having a hollow super-structure on its upper side, and openings in said super-structure approximately at said water line, said openings being of such area that when said tanks are filled the exterior water enters said super-structure so rapidly that the latter adds no reserve of buoyancy sufficient to materially retard submergence and said super-structure being constructed to permit the free flow of water therein substantially from end to end.

12. A submarine or submersible boat having a normal surface running water line and having ballast tanks of a capacity to submerge the boat when filled, and to emerge it to said water line when emptied, and having a hollow super-structure on its upper side, and openings in said super-structure approximately at said water line, said openings being of such area that when said tanks are emptied when the boat is submerged the water escapes from said super-structure so rapidly that the contained water adds no dead weight or displacement sufficient to materially retard emergence and said super-structure being constructed to permit the free flow of water therein substantially from end to end.

13. A submarine or submersible boat having a normal surface running water line and having ballast tanks of a capacity to submerge the boat when filled, and to emerge it to said water line when emptied, and having a hollow super-structure on its upper side, and openings in said super-structure approximately at said water line, said openings being of such area that when said tanks are filled the exterior water enters said super-structure so rapidly that the latter adds no reserve of buoyancy sufficient to materially retard submergence, and said openings being of such area that when said tanks are emptied when the boat is submerged the water escapes from said super-structure so rapidly that the contained water adds no dead weight or displacement sufficient to materially retard emergence and said super-structure being constructed to permit a free flow of water therein substantially from end to end.

14. A submarine or submersible boat having a normal surface running water line, and having ballast tanks of a capacity to submerge the boat when filled, and to emerge it to said water line when emptied, and having a hollow super-structure on its upper side, and openings in said super-structure approximately at said water line, said openings being of such area that when said tanks are filled the exterior water enters said super-structure so rapidly that the latter adds no reserve of buoyancy sufficient to materially retard submergence and said super-structure being constructed to permit the free flow of water therein substantially from end to end, and means for closing said openings.

15. A submarine or submersible boat having a normal surface running water line, and having ballast tanks of a capacity to submerge the boat when filled, and to emerge it to said water line when emptied, and having a hollow super-structure on its upper side, and openings in said super-structure approximately at said water line, said openings being of such area that when said tanks are emptied when the boat is submerged the water escapes from said super-structure so rapidly that the contained water adds no dead weight or displacement sufficient to materially retard emergence, and means for closing said openings.

16. A submarine or submersible boat having a normal surface running water line, and having ballast tanks of a capacity to submerge the boat when filled, and to emerge it to said water line when emptied, and having a hollow super-structure on its upper side, and openings in said super-structure approximately at said water line, said openings being of such area that when said tanks are filled the exterior water enters said super-structure so rapidly that the lat-

ter adds no reserve of buoyancy sufficient to materially retard submergence, and said openings being of such area that when said tanks are emptied when the boat is submerged the water escapes from said super-structure so rapidly that the contained water adds no dead weight or displacement sufficient to materially retard emergence and said super-structure being constructed to permit a free flow of water therein substantially from end to end, and means for closing said openings.

17. A submarine or submersible boat having a normal surface running water line, and having ballast tanks of a capacity to submerge the boat when filled, and to emerge it to said water line when emptied, and having a hollow super-structure on its upper side, and openings in said super-structure approximately at said water line, said openings being of such area that when said tanks are filled the exterior water enters said super-structure so rapidly that the latter adds no reserve of buoyancy sufficient to materially retard submergence, and said openings being of such area that when said tanks are emptied when the boat is submerged the water escapes from said super-structure so rapidly that the contained water adds no dead weight or displacement sufficient to materially retard emergence and said super-structure being constructed to permit a free flow of water therein substantially from end to end, the hull of said boat being rounded on its upper side and said super-structure being also rounded.

18. A submarine or submersible boat having ballast tanks of a capacity to submerge the boat when filled, and to emerge it to said water line when emptied, and having a hollow super-structure on its upper side, and openings in said super-structure, said openings being of such area that when said tanks are filled the exterior water enters said super-structure so rapidly that the latter adds no reserve of buoyancy sufficient to materially retard submergence, and said openings being of such area that when said tanks are emptied when the boat is submerged the water escapes from said super-structure so rapidly that the contained water adds no dead weight or displacement sufficient to materially retard emergence and said super-structure being constructed to permit a free flow of water therein substantially from end to end, said super-structure having its lower portions approximately at the water line when the boat is in surface running condition.

19. A submarine or submersible boat having a normal surface running water line and having a hollow super-structure above said water line and openings into said super-structure at least partially above said water line, said openings being adapted to admit water automatically into the interior of said super-structure when the boat submerges and to discharge water automatically and substantially completely from the interior of said super-structure when the buoyancy of the hull brings the boat to such surface running water line, said super-structure being constructed to permit the free flow of water therein substantially from end to end.

20. A submarine or submersible boat having a normal surface running water line and having a hollow super-structure above said water line, openings into said super-structure at least partially above said water line, said openings being adapted to admit water automatically into the interior of said super-structure when the boat submerges and to discharge water automatically and substantially completely from the interior of said super-structure when the buoyancy of the hull brings the boat to such surface running water line, said super-structure being constructed to permit the free flow of water therein substantially from end to end, and means for closing said openings.

21. A submarine or submersible boat having a normal surface running water line and having a hollow super-structure above said water line, openings into said super-structure at least partially above said water line, said openings being adapted to admit water automatically into the interior of said super-structure when the boat submerges and to discharge water automatically and substantially completely from the interior of said super-structure when the buoyancy of the hull brings the boat to such surface running water line, said super-structure being constructed to permit the free flow of water therein substantially from end to end, and means for closing said openings and air vents in the top of said super-structure.

22. A submarine or submersible boat having a normal surface running water line, and having a hollow super-structure above said water line, openings into said super-structure at least partially above said water line, said openings being adapted to admit water automatically into the interior of said super-structure when the boat submerges and to discharge water automatically from the interior of said super-structure when the boat emerges, and the hull of said boat having a flattened arched top and said super-structure sloping gradually to the sides and meeting the same near said water line.

23. In a submarine or submersible boat, a main hull, a super-structure above said main hull, and a trussed arch forming a part of the framework of said main hull and located within said super-structure.

24. In a submarine or submersible boat, a main hull, a super-structure above said main hull, and a trussed arch forming a part of the framework of said main hull

and located within said super-structure, the sheeting of the deck of the main hull being connected to the under side of said arch.

25. A submarine or submersible boat having a hull, and a superstructure above said hull, said superstructure having openings to the exterior through which water may enter freely into the interior of the superstructure, and discharge automatically and substantially completely therefrom, and said boat having a normal surface-running water line, and having ballast tanks of a capacity to submerge the boat when filled and to emerge it to said water line when emptied, and said openings being approximately at said water line in surface-running, and said hull when in surface-running trim having a substantial reserve buoyancy, whereby a material portion of the hull of the boat extends above the water line when the boat is in cruising trim, so that the longitudinal stability of the boat is increased.

26. A submarine or submersible boat having a hull, and a superstructure above said hull, said superstructure having openings to the exterior through which water may enter freely into the interior of the superstructure, and discharge automatically and substantially completely therefrom, and said boat having a normal surface-running water line, and having ballast tanks of a capacity to submerge the boat when filled and to emerge it to said water line when emptied, and said openings being approximately at said water line in surface-running and said hull when in surface-running trim having a portion extending upwardly above such water line into such superstructure, whereby the longitudinal stability of the boat is increased.

27. A submarine or submersible boat having a hull, and a superstructure above said hull, said superstructure having openings to the exterior through which water may enter freely into the interior of the superstructure, and discharge automatically and substantially completely therefrom, and said boat having a normal surface-running water line, and having ballast tanks of a capacity to submerge the boat when filled and to emerge it to said water line when emptied, and said openings being approximately at said water line in surface-running and said hull when in surface-running trim having a portion extending upwardly above such water line into such superstructure, whereby the longitudinal stability of the boat is increased, and said portion being of arched form, whereby water drainage from the superstructure is facilitated.

28. A submarine or submersible boat having a hull, and a superstructure above said hull, said superstructure having openings to the exterior through which water may enter freely into the interior of the superstructure, and discharge automatically and substantially completely therefrom, and said boat having a normal surface-running water line, and having ballast tanks of a capacity to submerge the boat when filled and to emerge it to said water line when emptied, and said openings being approximately at said water line in surface-running and said hull when in surface-running trim having a portion extending upwardly above such water line into such superstructure and said superstructure being rounded, whereby the longitudinal stability of the boat is increased.

29. A submarine or submersible boat having a hull, and a superstructure above said hull, said superstructure having openings to the exterior through which water may enter freely into the interior of the superstructure, and discharge automatically and substantially completely therefrom, and said boat having a normal surface-running water line, and having ballast tanks of a capacity to submerge the boat when filled and to emerge it to said water line when emptied, and said openings being approximately at said water line in surface-running and said hull when in surface-running trim having a portion extending upwardly above such water line into such superstructure, and said superstructure being rounded, whereby the longitudinal stability of the boat is increased, and said portion being of arched form, whereby water drainage from the superstructure is facilitated.

In witness whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

CESARE LAURENTI.

Witnesses:
G. AIMI,
A. FERRAR.