FIG. 3.

FIG. 4.

FIG. 5.
BUOYANT FLOATS FOR DOCKING AND TOWING SEACRAFT

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ABSTRACT OF THE DISCLOSURE

A float for docking and towing seacraft comprising a pair of elongated hollow bodies maintained in spaced relation by a fore strong cross beam and an aft strong cross beam, each secured at its outer ends to said hollow bodies in catamaran fashion to form a rigid unit; the unit being flipped to vertical position by introducing ballast water into the hollow bodies in which position the seacraft may engage the fore strong cross beam, after which the unit is swung upwardly about the fore strong beam as a fulcrum to horizontal floating position by removing ballast water with the underside of the seacraft resting on supporting members secured to the hollow bodies.

This invention relates to buoyant floats for docking and towing buoyant seacraft or like things in deep or shallow water and is especially adapted for docking and towing a seacraft in an area which may be subjected to high winds and heavy seas. The float may also be used for salvage operations.

Background of the invention and the prior art

When seacraft such as a submarine is to be towed, particularly a research submarine, it has been the practice to tow it behind a small tender, or to transport such a submarine on the deck of a larger tender and then, by means of a shipboard crane, to lift the submarine from the deck and set it over the side of the tender into the sea at the site of operation. If small tenders are used, it is necessary to tow the submarine to the site of operation. Because of unstable properties of small research submarines, towing by small tender could proceed only at slow speed, perhaps not faster than four knots per hour. Hence, high speed transfer cannot be attained by towing the submarine with a small tender. When a large tender is used, and the submarine is set out from the deck by crane equipment, it has been the practice to transfer the craft from the deck of the tender to the sea with the crew on board. If a small tender is used, the crew has to board the research submarine while it is floating in the sea and since the submarine may be floating in an agitated sea, the crew may have to board her under most adverse conditions.

Summary of the invention

In accordance with this invention, a docking and towing float is provided which can be used to tow the submarine to the site of operation by fast speed tender, large or small, and the crew or operating personnel may board or leave the submarine floats at the surface of the sea. In order to provide favorable tow conditions and easy boarding or leaving the submarine by the crew or operating personnel, there is provided a float comprising two elongated hollow buoyancy bodies maintained in spaced substantially parallel relation by two main strong cross beams fore and aft of the pair of buoyancy bodies. One of these main cross beams is connected at its outer ends to the hollow bodies in the fore ends of the bodies and another main cross beam is connected at its outer ends to the hollow bodies at their aft ends, thus the pair of oppositely disposed bodies are connected in the fashion of a catamaran. A plurality of spaced elastomeric cross members positioned between the main cross beams are secured to the two buoyant bodies. The submarine may rest on these elastomeric cross members when the two hollow bodies are in a floating position on the surface of the sea in a manner that part of the submarine weight is supported by the buoyancy of the float and the remainder of the weight is balanced by the buoyancy of the submarine itself. Means are provided for introducing ballast into the hollow elongated bodies and for removing the ballast, which may, if desired, be the ambient seawater. By controlling the amount of ballast in the hollow bodies, they may be caused, as a unit, to assume a vertical position, in which case they are substantially submerged to facilitate the docking operation. Or, they may be caused as a unit, to assume a horizontal position, in which case they are floating on the surface of the sea with their long axes substantially horizontal, and with the submarine resting on the elastomeric cross members. The float provided by the invention is so contrived that it can be caused to move to a submerged, vertical position in the sea prior to docking the submarine on the float by introducing ballast into the hollow bodies. The submarine may then approach and contact the forward main cross beam. The submarine may then be docked on the float and with the underbelly of the submarine resting on the grid provided by the elastic cross members, by removing ballast in such sequence as to rotate the float about the fore strong main cross beam as a fulcrum, or pivot, so that the hollow bodies ultimately assume a horizontal position on the sea surface. In docking the submarine to the float, the submarine is smoothly contacted and partially lifted by the elastic cross members. When sufficient ballast water is removed, the float is floating in substantially horizontal position on the sea surface. The submarine may then be docked on the submerged ends of the submarine resting on the elastic members. In this position the system (float and submarine docked thereto) is ready for towing as a unit. Also, platform or deck means may be provided on the float from which operating personnel may board the submarine without danger of flooding the submarine through a topside open hatch, even under adverse weather conditions. And means are provided for lashing the submarine to the float, if desired.

Although the features which are believed to be characteristic of the invention are pointed out in the annexed claims, the invention itself as to its objects and advantages and the manner in which it may be carried out may be better understood by reference to the following more detailed description, considered in connection with the accompanying drawings forming a part hereof, in which:

FIG. 1 is a view in perspective and partly diagrammatic illustrating the support and towing float in submerged vertical position with a submarine to be secured thereto floating on the surface of the sea and approaching the float;

FIG. 2 is a view in perspective and partly diagrammatic illustrating the submarine secured to the float and resting on the float and at standstill for boarding the submarine;

FIG. 3 is a side view in elevation and partly diagrammatic to illustrate the docking operation.

FIG. 4 is a side view in elevation and partly diagrammatic to illustrate the submarine and float in horizontal position after docking and ready for towing;
FIG. 5 is a plan view of FIG. 4; FIG. 6 is a side view in elevation, illustrating one of the elongate hollow bodies, illustrating the float submerged in vertical position and containing ballast; FIG. 7 is a side view in elevation similar to FIG. 6, having some ballast removed and showing the float in inclined position; FIG. 8 is a side view in elevation similar to FIGS. 6 and 7, having more ballast removed and showing the float in horizontal position floating on the surface of the sea; FIGS. 9 and 10 are views on lines 9—9 and 10—10, respectively, of FIG. 8; FIG. 11 is a side view in section of a modified form of float and in submerged vertical position; and FIG. 12 is a diagrammatic and schematic perspective view illustrating the piping and electrical system for operation of the float.

Referring now to the drawings, in which like reference characters designate like parts throughout the several views, FIG. 1 illustrates a submarine 10 floating on the surface 11 of the sea; the submarine approaching the float (indicated generally by reference character 12) to the position and made fast thereto, the full lines representing the parts which are exposed above the surface of the water. FIG. 2 represents the submarine after it is docked and made fast to the float 12; the float now lying substantially horizontally and floating on the surface of the water and the unit 23 (submarine and float) ready to be towed by a suitable towing craft, such as a power driven sea-raft or tender (not shown) by means of the towline 14, secured to the power craft and to the float 12 by bridle 15, 15a.

The float comprises a pair of elongate hollow bodies 16, 16a which are maintained in spaced parallel relation by means of strong main cross beams 17 and 18, in the fashion of a catamaran. For convenience of description, the hollow bodies 16, 16a are herein sometimes referred to as enclosed hulls. The fore strong beam 17 is securely connected at one of its outer ends 19 to body 16, and at its other outer end 19a to body 16a, a short distance from the bases of the generally cone shaped portions 20, 20a which, together with hollow bodies 25, 25a form the twin bows 21, 21a of the float. The aft strong beam 18 is likewise connected at one end 23 to body 16 and at its other end 22a to body 16a near the stern end of the float. The hollow bodies 16, 16a, herein referred to as hulls, are preferably of general cylindrical shape and are constructed for and as described in further detail hereinafter. The hulls are referred to herein as starboard hull 16 and as port hull 16a.

It will be understood that the port hull 16a of the float is the same as the starboard hull 16; it being noted that similar parts are designated by the same reference numeral with a sub-a added to the numerals referring to the port hull 16a.

Inasmuch as the two enclosed hulls 16, 16a are of like construction, it is deemed sufficient to describe in detail only the starboard hull 16 as typical; it being understood that hull 16a is similarly constructed. The bow end comprises a cone 24 (see FIG. 6) upon which is mounted a hollow buoyancy body 25, this being conformed to merge with the cone 24 so that the fore end of the hull 16 has a contoured ship-shaped-bow 26. The portion 25 provides a closed air chamber 27. The closed air chamber 27 provides reserve buoyancy in the event of towing the floating unit 23 against waves, thus avoiding the danger of the unit 23 which could produce undesirable dynamic trimming. The cone chamber 28, at its aft end, communicates with the hollow elongate cylinder portion 30. A bulkhead 31 is mounted in the fore end portion of the cylinder 30, thus sealing off the chamber space 28 from the main chamber space 29 of the enclosed hull.

Aft the bulkhead 31 and toward the stern end 32 is mounted a partial bulk head or baffle 33. The partial bulkhead 33 is inclined rearwardly from the topside segment of the cylindrical hull portion 30 (see FIG. 6) and terminates in a horizontal edge 34 which lies short of the bottomside segment of the hull (see FIGS. 6 and 9). Thus the bulkhead 33 closes a large portion of the circle of the cylinder but leaving a small portion 35 bounded by the bulkhead edge 34 and the bottomside segment 35 of the hull, and the bulkhead provides, as described later on, a pocket space 36 abaft the partial bulkhead. The aft end portion of the hull cylindrical portion 30 is provided with a through-hull port 38 which is deeper at its stern end and the trough inclines upwardly in forward direction and merges into the cylindrical wall portion of the hull a little forward of the inclined partial bulkhead 33. This trough shaped wall 38 provides a drainage pocket 39 and also serves as a guidance fin.

An air pressure conduit 40 extends through the wall of body 25 through the wall of cone 24 and through the forward bulkhead 31 and thence through the partial bulkhead 33 and communicates with the air pocket space 36. The outer end of the compressed air line at 42 is suitably but removable connected to a flexible air pressure line 43 which extends to the power driven tow craft or tender (not shown), it being secured to the cable tow line 14 at spaced intervals by the clamps 44, the other end of which extends to the tender (not shown).

A vent pipe 46 extends from outside and through the wall portion 25 and passes through bulkhead 31 to provide communication between the chamber 29 of the hull with the ambient atmosphere, it being noted that the vent pipe 46 has a rearwardly extending outer end 47. The vent pipe is provided with a solenoid controlled valve 48 operative to open and close the vent pipe 46. The vent pipe is also provided with a one-way or check valve 45 which permits fluid (air) to flow in a direction out of chamber 29 but prevents flow in the other direction into chamber 29. If desired, the valve 48 may be located within the buoyancy body 25, where it is protected from the sea or weather. The vent pipe 46 is cross connected to air pressure conduit 40 by conduit 49 at a place intermediate the solenoid valve 48 and check valve 45.

An electric conductor cable 41 connected to the solenoid valve 48 at the port end 58a of the electric conductor cable 41 to the tender so that the opening and closing of valve 48 may be controlled from the tender.

One or more openable and closeable solenoid controlled valves or sea-coks 50 are mounted at the bottom and in the aft portion near the stern end of the cylindrical enclosure 30 to provide communication between the chamber 29 and the ambient sea 51.

An electric conductor cable 49 extends from the tender (not shown) through the flexible pressure conduit 43, and conduit 40 to the solenoid valve 50 so that the opening and closing of the valve to open the chamber 29 to the ambient sea, or to close it, may be carried out and controlled from the tender.

A hollow tube 52 having a bent shape is mounted in the stern end of cylinder 30. One end 53 of the tube extending through the bottom wall 38 of the hull and communicates with the ambient sea. The other leg 54 of the U-shaped tube extends into the trough 39 and terminates short of the bottom of the trough. The U-portion 55 of the tube terminates short of the topside wall of the cylindrical hull (see FIGS. 6, 7, 9, 10). A check valve 56 is provided in the leg of the U-shaped tube 54 which permits passage of fluid (air or water) in only one direction through the tube 52, namely, from trough 39 to the ambient sea through leg 53.

A cross connection air pressure conduit 57, which may pass through the fore strong beam, is connected to one end 58 to conduit 40 in starboard hull 16 and at its other end 58a in port hull 16a to conduit 40a. This cross connection, while not necessary in all instances, is de-
sirable in view of the fact that there are two flexible air pressure lines; one connected to the starboard hull and one to the port hull. It could happen that one flexible air pressure line could become clogged, for instance, when one flexible hose is bent or twisted. In such case, the hulls and both hulls might not be properly drained, resulting in overturning the float, or result in not keeping the float on an even keel. By providing cross connection conduit 57, the air pressure is evenly distributed to both hulls and both hulls are symmetrically drained of ballast water during a docking operation.

Air ductility of elastomer cross members might not be properly drained, resulting in overturning the float, or result in not keeping the float on an even keel. By providing cross connection conduit 57, the air pressure is evenly distributed to both hulls and both hulls are symmetrically drained of ballast water during a docking operation.

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upwardly about the strong beam pivot toward horizontal floating position on the surface of the sea. It will be noted that during the expulsion of ballast water from the hulls, the vent tubes 46 and 46a are closed by means of solenoid valve 48, 48a.

Near to completion of de-ballasting, the last portion of ballast water is drained from the through and all may be removed, if desired, except that indicated by arrow 81. In some instances, it may be desirable to arrange the electrical hook-up in such manner that the sea-cocks 50 and 50a be maintained in closed position during the entire upswinging operation of the float. When water is being expelled and the sea-cocks are closed, then the ballast water is expelled only through the tubes 52, 52a.

While the float is being de-ballasted and is swinging upwardly about its strong beam pivot 17, to horizontal floating position on the surface of the sea, the elastomeric cross members 64 successively from fore to aft come into engagement with the bottom or belly 92 of the submarine 10 in an orderly, smooth operating sequence, until the submarine is resting on the elastomeric grid 64a; provided by the cross members 64 (see FIG. 4). Sufficiently ample, it moved so that the submarine is carried partly by its own buoyancy and the balance by the buoyancy provided by the de-ballasted hulls 16, 16a, with the hulls in trim condition.

The submarine now having been docked, the switch contact handle 86 (FIG. 12) is rotated to clockwise to station 1. This interrupts all electric circuits and all solenoid valves are closed. The float and submarine is now ready for towing as a unit. If it is necessary or desirable, it may be lashed to the float by rope 63, 63a. The float and docked submarine may now be towed by the tow cable 14 secured at the tender. When docked, the submarine may be boarded from the platforms 60, 60a or personnel may disembark therefrom.

To disengage the docked submarine from the float, the "flooding" operation is then carried out by rotating the handle switch 86 clockwise to station II, on the switch panel 85, as described in the foregoing.

A modified form of enclosed hull 116 is illustrated in FIG. 11, which is simpler in construction. This form of hull connected as a pair in the fashion of a catamaran, as described in the foregoing, may be used in instances where the more sophisticated form is not required. A typical hull 116 of the pair of hulls is connected in the fashion of a catamaran as the more sophisticated form described in the foregoing and the float is provided with an elastomeric grid, such as grid 64x (see FIG. 4). The hull 116 comprises a cylindrical body portion connected to a cone portion 124 on which is mounted a buoyancy body portion 125. A bulkhead 131 is mounted intermediate the bow end 126 and the base end of the cone portion 124. This separates the enclosed hull into a sealed air chamber space 127, 128 and a ballast chamber 129; the air chamber 127, 128 will maintain a free board 170 when the float is in submerged vertical position. To float this float to submerged vertical position from horizontal floating position, the sea-cock 150 is opened and water enters into ballast chamber 129 from the sea. The terminal end 130 of the compressed air conduit 140 is positioned a distance 137 from the closed stern end of the hull. When water enters through valve 150, the compressed air line 140 is kept closed, so the air in space 129 is compressed sufficiently to permit sufficient ballast water 180 to occupy the ballast chamber 129 to float the vessel in vertical submerged position. In FIG. 11. This leaves a buoyancy space containing compressed air from the interface 139 between the water and air, to the bulkhead 131. To carry out a docking operation, that is, to de-ballast and rotate the hull 116 to horizontal position, solenoid sea-cock 150 is opened, this being connected by electric cable 149 to a suitable source of power and switch means on the tender. This introduces compressed air into ballast chamber 129 and expels ballast water 180 into the sea through valve 150. When sufficient ballast water is expelled to swing the hull to horizontal floating position on the sea during the docking operation, valve 150 is closed, the compressed air valve is then closed, and the hulls, as a unit, are ready for towing. It will be understood, of course, that two hulls similar to hull 116 are connected together by strong cross beams in catamaran fashion, as described in the foregoing, to provide a complete float to be towed by cable 114. Such a system requires less air for de-ballasting by virtue of the compressed air in chamber 129 and otherwise simplifies construction, although it will be manifest that the structure shown in detail in the other figures will be more desirable and preferred because of the additional advantageous features.

The float has been described in connection with its use as a docking and towing float for a submarine, but in the light of the foregoing description, it will be realized that the float is not limited to docking and towing of small submarines to open sea, but it may be designed as to size and contrivable for salvage and rescue work for larger or other surface and submarines vehicles or craft, for example, it may be used for rescue-towing of naval craft up to the size of small destroyers, preferably in the event of damage stability cases.

The terms and expressions which have been employed herein are used as terms of description and not of limitation, and the use of such terms shall not imply a restriction to the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the invention.

What is claimed is:

A floating float for docking and towing seacraft comprising at least two elongated hollow bodies, each having a bow end and a stern end, a rigid, fore strong beam connected at its outer ends to said bodies near the bow ends of said bodies, a rigid, aft strong beam connected at its outer ends to said bodies near the stern ends of said bodies, said beams and bodies being connected in catamaran fashion and forming a rigid unit which floats when placed in a body of water, a bulkhead located in the forward end portion of each of said hollow bodies, providing a buoyancy chamber in the bow ends of each said body and a ballast chamber inside each of said bulkheads, sea-cock valves through which ballast water may be introduced into and expelled from said ballast chamber, said buoyancy chambers being connected to said unit to float with a freeboard observable above the level of the body of water, in the use of such floaters contain sufficient water to sink the stern ends of said hollow bodies, said sea-cocks being located in the stern ends of said bodies, means for introducing compressed air into said ballast chambers for expelling ballast water from said ballast chambers including a conduit connectable to a source of compressed air, said conduit extending from outside said bodies to a location in the stern end portion of said ballast chambers, means connected to said sea-cock valves controllable from outside said hollow bodies for opening and closing said sea-cock valves, and means connected to said conduit controllable from outside said bodies for causing compressed air to pass through said compressed air conduits into said ballast chambers for expelling ballast water therefrom, a grid connected with said bodies and extending across the space between said bodies, said grid in position as illustrated, said strong beam below the water level and said bow ends extending above the water level of the body of water with sufficient free board to be observable, when ballast water is introduced into said ballast chambers, said fore strong beam serving as a pivot about which said unit may be swung when the seacraft is in contact therewith and floating on the body of water, said elongated hollow
3,448,712 bodies swinging upwardly about the fore beam as a pivot to substantially horizontal position with the grid contacting the under side of the seafloor when ballast water is expelled from said ballast chambers.

2. A docking and towing float comprising a pair of elongated hollow bodies and positioned in one of said hulls and aft main beams, sea-cock valves located in the stern of said ballast chambers and conducted with the grid. Ballast water may be introduced into and expelled from said ballast chambers, an inclined partial bulkhead baffle in each of said ballast chambers aft of said main bulkheads providing a pocket abaat each of said baffles and a passageway beneath each baffle for ballast water to pass therethrough in a direction toward said bow ends and in a direction toward said stern ends, a compressed air conduit in each of said ballast chambers terminating in said pockets and extending to outside of said ballast chambers and connectable to a source of compressed air, control means connected to said sea-cock valves controllable from outside said hulls for openings and closing said sea-cock valves, and control means connected to said compressed air conduits controllable from outside said hulls for causing compressed air to pass through said compressed air conduits into said pockets for expelling ballast water from said ballast chambers.

3. A float as defined in claim 2, in which said cross members between said fore and aft main beams are elastomeric and form a grid upon which an object to be towed may be supported.

4. A float as defined in claim 3, including a vent pipe in each of said hulls terminating in said ballast chambers abaat said main bulkheads and extending to outside of said hulls.

5. A float as defined in claim 4, in which an openable and closeable vent valve is connected in each of said vent pipes.

6. A float as defined in claim 5, which includes control means connected to said vent valves controllable from outside said hulls for opening and closing said vent valves.

7. A float as defined in claim 6, in which a check valve is provided in each of said vent pipes permitting flow through said vent pipes and valves in a direction away from said ballast chambers but not in a direction toward said ballast chambers.

8. A float as defined in claim 7, in which each hull at its stern end portions has a guidance fin on its bottom wall providing a trough in the stern end of each ballast chamber.

9. A float as defined in claim 8, which includes a curved drainage pipe in each of the stern end portions of said ballast chambers, each of said curved pipes having two legs and a check valve connected thereto, one of said legs extending through the bottom wall of the trough and the other of said legs terminating within its ballast chamber near its bottom wall, said check valves in said drainage pipes permitting fluid flow through said pipes only in a direction from the ballast chambers.

10. A float as defined in claim 9, which includes a cross over conduit is connected at one of its ends to the air pressure conduit in one of said hulls and at the other of its ends to the air pressure conduit in the other of said hulls, each end of said cross over conduit being connected to the vent pipe between the check valve and the openable and closeable vent valve.

11. A float according to claim 7, which includes a guidance fin at the stern end portions of each of said hulls on the bottom side providing a drainage trough in each of said ballast chambers, a curved drainage pipe in the stern portions of each of said ballast chambers, each of said curved pipes having two legs and a check valve connected therein, one of said legs extending through the bottom wall of the trough and the other of said legs terminating within its ballast chamber near the bottom wall of its trough, said valves in said drainage pipes permitting flow through said drainage pipes only in a direction from said ballast chambers.

12. A float for docking and towing a seafloor in the open sea or other waters, which comprises two elongated hollow bodies, hereinafter referred to as hulls, each having a bow end and a stern end; a strong, rigid, fore cross beam connected at its outer ends to said hulls near the bows of said hulls; a strong, rigid, aft cross beam connected at its outer ends to said hulls near the stern of said hulls; said hulls and strong cross beams being connectable in catamaran fashion and forming a rigid unit; the bow ends of said hulls each comprising a cone shaped hollow body having a hollow buoyant body mounted atop the cone shaped body and connected to said hull; a ship shaped bow; a main bulkhead in each of said hulls near the ends of said hulls providing an enclosed buoyancy air chamber in each of said hulls at their bow ends and a ballast chamber in each of said hulls abaat said main bulkheads, cross members secured to each of said elongated hollow bodies and positioned between said fore and aft main beams, sea-cock valves located in the stern of each of said ballast chambers through which ballast water may be introduced into and expelled from said ballast chambers, an inclined partial bulkhead baffle in each of said ballast chambers abaat said main bulkheads providing a pocket abaat each of said baffles and a passageway beneath each baffle for ballast water to pass therethrough in a direction toward said bow ends and in a direction toward said stern ends, a compressed air conduit in each of said ballast chambers terminating in said pockets and extending to outside of said ballast chambers and connectable to a source of compressed air, control means connected to said sea-cock valves controllable from outside said hulls for openings and closing said sea-cock valves, and control means connected to said compressed air conduits controllable from outside said hulls for causing compressed air to pass through said compressed air conduits into said pockets for expelling ballast water from said ballast chambers.

13. A float according to claim 7, which includes a guidance fin at the stern end portions of each of said ballast chambers, a curved drainage pipe in the stern portions of each of said ballast chambers, each of said curved pipes having two legs and a check valve connected therein, one of said legs extending through the bottom wall of the trough and the other of said legs terminating within its ballast chamber near the bottom wall of its trough, said valves in said drainage pipes permitting flow through said drainage pipes only in a direction from said ballast chambers.
in engagement with the bottom of the seacraft, by introducing compressed air into said ballast chambers and expelling ballast water from said ballast chambers.

13. A float according to claim 12, in which a boarding platform is mounted atop at least one of said hulls.

14. A float according to claim 12, including means secured to the float for lashing thereto a submarine resting on said grid.

15. A float according to claim 12, which includes lights for facilitating the docking of a submarine to said float in obscure weather conditions.