

June 26, 1934.

S. LAKE

1,963,996

SUBMARINE SALVAGE AND RECOVERY APPARATUS

Filed Nov. 19, 1928

3 Sheets-Sheet 2

Fig. 4.

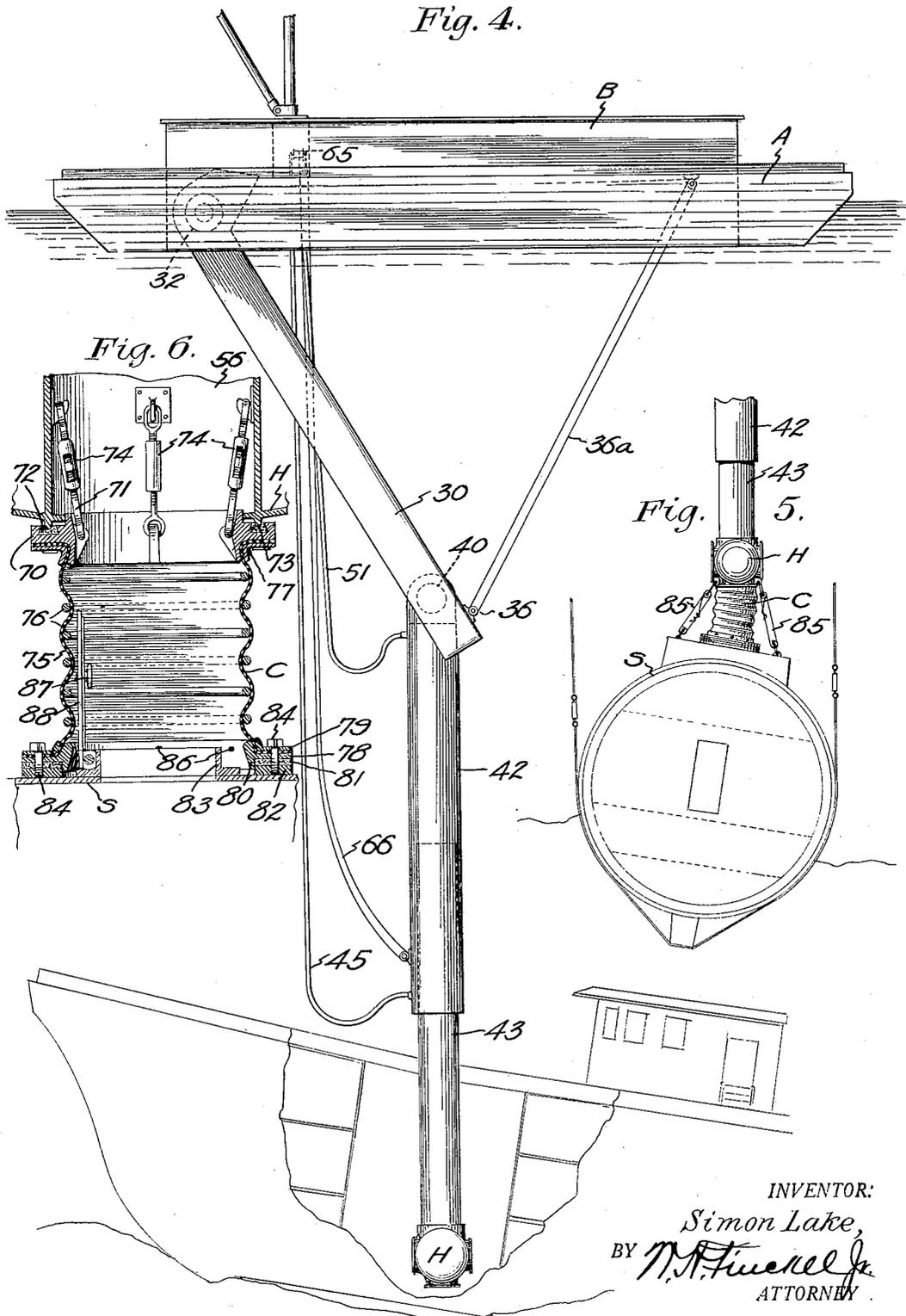


Fig. 6.

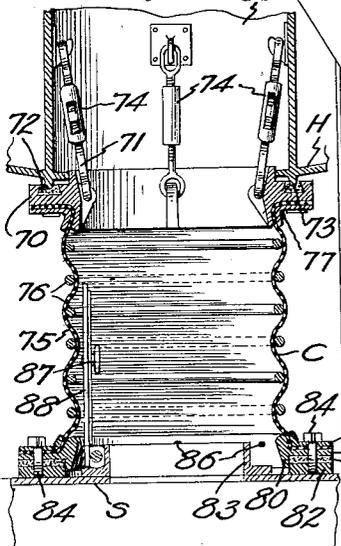
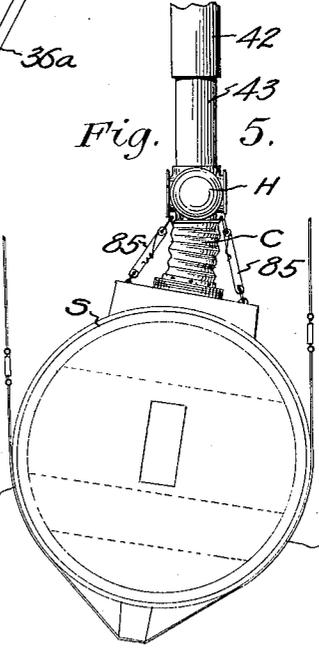


Fig. 5.



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Fig. 8.

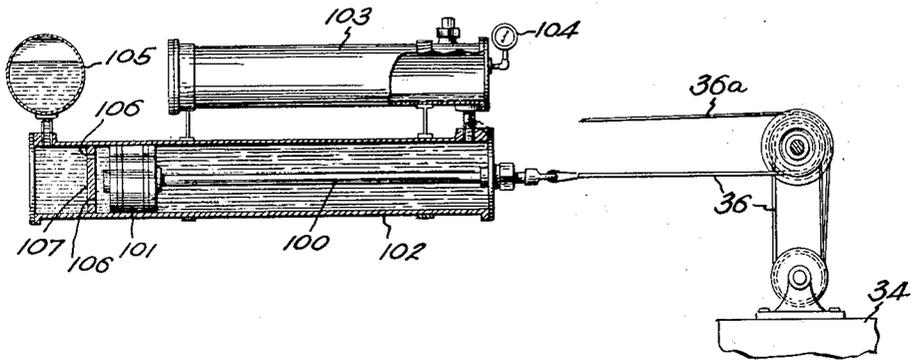
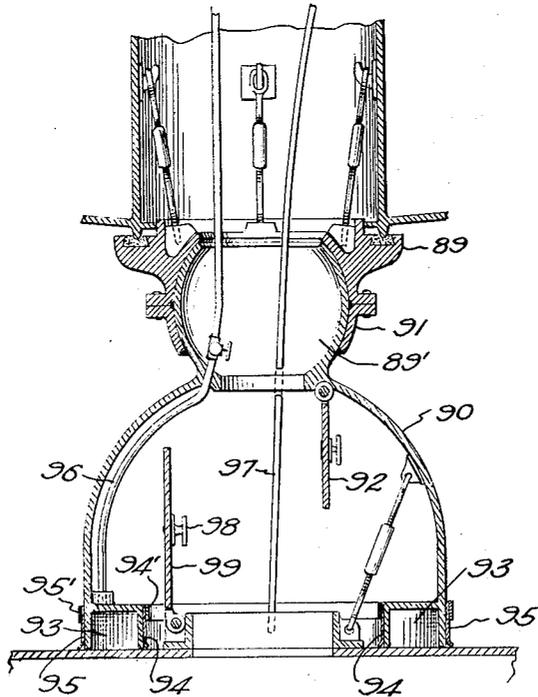


Fig. 7.



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UNITED STATES PATENT OFFICE

1,963,996

SUBMARINE SALVAGE AND RECOVERY APPARATUS

Simon Lake, Milford, Conn.

Application November 19, 1928, Serial No. 320,318

9 Claims. (Cl. 61—69)

This invention relates to submarine salvage and recovery apparatus, and embodies certain improvements on the devices of a similar nature disclosed in my Patents Nos. 867,984, granted October 15, 1907; 885,930, granted April 28, 1908; 1,356,773, granted October 26, 1920, and 1,379,928, granted May 31, 1921, whereby greater facility and safety in performing various deep-water operations, such as recovering sunken vessels or their cargoes, rescuing the crews imprisoned in sunken submarines, gathering shell-fish, sponges, etc. are attained.

These improvements are based upon actual operations performed with semi-submersible tubes built in accordance with the inventions disclosed in my patents above mentioned, and which showed where improvements could be made to further increase the efficiency of such apparatus in performing the various functions for which they are adapted.

In the accompanying drawings illustrating the invention, in the several figures of which like parts are similarly designated, Figure 1 is a deck-plan of a vessel, preferably a barge embodying the present invention, the top or roof of the deck-house being removed. Fig. 2 is a vertical longitudinal section of the vessel, taken on line 2—2 of Fig. 1. Fig. 3 is a similar view, taken on line 3—3 of Fig. 1. Fig. 4 illustrates the barge engaged in salvaging the cargo or inspecting the condition of a sunken vessel. Fig. 5 illustrates the manner in which communication may be established between the barge and a sunken submarine to rescue the crew therefrom. Fig. 6 is a construction detail of the connector between the barge-tube and the hatchway of the submarine. Fig. 7 illustrates a modification of the connector shown in Fig. 6. Fig. 8 is a detail sectional elevation of one of the hydraulic devices used to prevent the breaking of the hoisting lines.

Referring to Figs. 1, 2, 3 and 4, the hull A of the barge is shown as having a deck-house B, the floor 10 of which constitutes the deck of the vessel and covers a rectangular well 11 which is open at the bottom but is made air-and-water-tight by bulkheads 12, 13 at its ends, side-bulkheads 14, 15 and the floor 10 of the deck-house. The deck-house is divided by bulkheads 16, 17 into three compartments, of which the largest 18 provides the necessary space for the crew, machinery, supplies, etc., while the compartment 19 enclosed by the end and side walls 12, 14 and roof of the deck-house, in conjunction with the bulkheads 17, forms an air-tight compartment the floor of which is, however, provided with

openings, to be hereinafter referred to, leading into the well 11 above described. The middle compartment located between the bulkheads 16 and 17 provides an air-lock 20 enclosed by walls 21, 22, the latter having a door 23 whereby the air-lock may be sealed against the passage 24 leading to the side deck of the vessel. A door 25 in the bulkhead permits passing between the compartment 19 and air-lock 20, the organization being such that, when the door 23 is locked, a person may pass freely from either chamber (19 or 20) into the other, the air pressure being equalized with that in the main well 11 of the vessel.

One of the particular objects of the present invention is the provision of improved means whereby a diver may be permitted to descend to a considerable depth without being encumbered by armor, air-lines, etc., such means leading from the vessel's deck through the water and to a compartment wherein the diver may put on his armor. As a matter of fact these means provide apparatus whereby the diver is enabled to descend in a tubular device, provided with a diving compartment and containing air under practically normal pressure, until he reaches a point of submergence where he desires to leave the tube and emerge into the sea. He then increases the air pressure in the diving compartment to equal the water pressure on the exterior of the diving compartment, then opens the bottom door, dons his diving dress and steps out into the sea, as has been described in my prior patents.

The preferred construction of these means, as shown in the drawings, comprises a pair of hollow tubular arms 30, 31 which are pivoted, at one end, on trunnions 32, 33 in the side walls 14, 15, respectively, of the well. Their other ends are rigidly connected by an enclosed, box-like structure 34 forming a water ballast chamber which, when supplied with water will aid in causing this end to descend from its highest position, shown in Fig. 2, where it normally floats to any desired submerged position. The structure 34 is held up against a girder 35 extending athwartship of the hull by a block-and-cable mechanism 36, the cable 36a thereof leading to a winch 37 located in a chamber 38 between the bulkheads 16, 17 above referred to. It will therefore be understood, that, when the winch is operated to gradually unwind the cable 36a, the arms will pivot upon their trunnions 32, 33 to swing from the position shown in Fig. 2 to any desired lowered position down to the perpendicular. (See for example Figs. 3 and 4).

The connected swinging ends of the arms 30, 110

31 support, on suitable watertight hollow trunnions 40, 41, one end of a tube 42 which constitutes the principal element of the organization and is provided at its free end with an observation and diving head or compartment H which, in the present instance, is formed as a part of a secondary tube 43 adapted for telescopic sliding movement within the main tube 42, see Fig. 3. This movement may be controlled by a fluid under pressure, preferably oil. The space 44 between the tubes 42 and 43 receives the oil under pressure from a pipe or hose 45 leading from the pressure supply for the purpose of retracting the inner tube 43 into the outer tube 42, the pressure of the oil acting in the space 44 between a stationary packing-ring 47 carried by the outer tube and an annular piston 46 carried by the inner tube.

In order to project the inner tube 43 outward from the outer or main tube 42, the latter has secured to it at 48 one end of a guide-tube or cylinder 49 which is slightly smaller in diameter than the inside diameter of the inner tube 43 so as to provide room for a packing ring 50 secured to the cylinder 49. If, now, the oil is forced through a tube 51 under pressure into the space 52 between the adjacent surfaces of the outer tube 42 and cylinder 49, the inner tube, having at its end the piston 46, will be forced out, the pressure in the oil-pipe 45 being, of course, relieved.

From the above it will be understood that the position of the inner tube 43 relative to the outer tube 42 can be positively controlled by properly manipulating the control-valves (not shown) of the oil-supply tubes 45 and 51 respectively.

It will thus be seen that the arms 30, 31 and tube 42, with its telescoping inner tube 43 carrying head H form an articulated tubular member which may be adjusted at will.

The inner tube 43 carries at its outer end the observation or divers' compartment H previously referred to, which consists, substantially, of a working chamber 55 surrounded by water ballast compartments or tanks *h* and having an end outlet 56 provided with a removable door, and bottom and top outlets 57 and 58, respectively, also provided with doors. All of these doors may be provided with glazed ports or closures (not shown) which, when shut and sealed, will enable a person within the chamber 55 to make observations of the surroundings of the divers' compartment, whether on the sea-bottom, in the hull of a sunken vessel, or other locality. It will be noted, as previously pointed out, that the air pressure in the chamber 55 is the same as that in the vessel-well 11 by virtue of the clear open passage through the members 30, 31, 42, 43 and 49 between these two points. If, however, the chamber 55 is to be used as a diver's compartment, and the diver is to emerge therefrom to travel about under water, the air pressure in the compartment 55 must naturally be increased in accordance with the depth of submergence of the compartment. For this reason the inner tube 43 is provided near the entrance to the diver's chamber 55 with an air-lock bulkhead 60 in which a door 60' may be closed to separate the compartment 55 from the main portion of the inner tube and seal the same to confine the high-pressure air to the space in the diving compartment and in an air lock 61.

Any suitable piping (not shown) may be used to carry the high-pressure air into the diving compartment and air lock 61, such piping preferably passing through the inner tube 43 and through one of the trunnions 40 and 41 and its communication-arm 30 or 31 into the compression-cham-

ber 19 where a suitable air-pump with air receiver may be provided to supply the proper amount of air pressure to the pipe line.

Practice has demonstrated the fact that, when a diver is ready to ascend from any great depth, it is necessary, in order to guard him against what is termed the "bends" (a disease which is caused by a too rapid change in the air pressure and which often proves fatal) to employ a so-called "stage-decompression". Assuming that the bottom of the diving chamber is at a depth of 200 feet, the air pressure required to keep the water out of compartment 55 would be 86.6 lbs. per square inch, a pressure which should not be decreased to a point less than 43.3 lbs. for the first stage of decompression of the diver. By a proper arrangement of successive air locks *a*, formed by bulkheads provided with sealable doors *a'*, in the side arm 30 (see Figs. 1 and 2) the several decompression stages will be provided for at properly timed intervals and will be effective to avoid any mishaps or injury to the diver due to too rapid decompression.

In navigating on the surface, with the arms 30, 31 pulled up against the beam or girder 35, the tube 43 retracted within the outer tube 42, and the latter raised by a winch 65 and cable 66 so as to be completely housed within the well 11, the vessel may be towed, or be self-propelling, and thus conducted to its field of operation. If this operation should be the investigation and possible salvage of a sunken vessel, or its cargo, or both, the barge is located as closely as possible over the wreck, and soundings may be taken with a lead-line for determining the best position.

A diver and his assistant now pass through the air-lock 21 into the compartment 19 from which they may enter an inlet 30' or 31' to one or the other of side-arms 30, 31, respectively, or directly through the opening 58, into the diving compartment 55. If entrance is had through opening 58 the cover or door thereof is then closed and sealed. The air pressure in the compartment 55 is equal to that in the well 11 because communication between the two is open, as described. According to the depth in which the wreck is located, either one or both of the winches 37 and 65 may now be released to slowly unwind the cables which sustain the arms, tube and diving compartment. For instance, as illustrated in Fig. 4, the arms 30, 31 have not been lowered to their descent-limit, the tube 42 hangs in perpendicular position and the inner or diving-compartment carrying tube 43 is partly projected therefrom to bring the observation or diver's compartment H into position for investigation of the condition of the wreck, the air pressure in the diver's compartment or chamber 55 still being maintained as it was when the divers left the compartment 19.

If the divers should now decide to leave the compartment for the wreck's hull, they close the air-lock door 60', don their divers' suits and admit additional air under pressure into compartment 55. The pressure is slowly increased until it is equal to the pressure of the sea water against the lowermost doors of member H. This permits any of these doors to be opened without the possibility of water entering the compartment and the divers may leave the compartment 55 and more closely inspect their surroundings or do required work.

Returning to the diver's chamber after their work, they first close the outer door through which they left and returned and then start their ascent. They enter air-lock 61 and slowly re-

lease the air pressure from compartment 55 and air-lock 61 into the compartment formed by the tube 49 until it is preferably brought to about one-half of what it was. This constitutes the first stage of decompression. Additional stages of decompression can be had by passing through the additional air-locks formed by bulk-heads *a—a—a—a* in an obvious manner.

Suitable ladders (not shown) may be provided in the tubes and arms to enable the operators to ascend to and descend from the barge without changing the position of the diving compartment H within the wreck's hull.

The arrangement of the air-locks in the passageway formed by the tube and arms is particularly advantageous for the decompression of divers, in that while they are ascending the ladders they will be exercising in a manner appropriate to drive nitrogen out of their blood, thus making unnecessary the calisthenics usually performed by them for this purpose to prevent occurrence of "the bends" or caisson disease.

If it should be deemed advisable to salvage the sunken vessel and bring it to the surface, the procedure would be to attach slings or chains to or under the wreck, release the air pressure in the well 11 to permit the barge or vessel A to settle more deeply in the water, then fasten one end of the hoisting cable to the deck winch and then bring the other end, after passing it through a pulley attached to the sling under the sunken vessel, up to a hydraulic cushioning cylinder substantially in the manner illustrated in more detail in Fig. 8. After bringing all lines up to a uniform tension, air is pumped into the well 11, the result being a powerful lift. Yet such lift is inherently elastic and this is essential to prevent parting of the lines. As the seas roll by the barge, the air in the well will become slightly compressed or expanded, thus holding a steady or continuous yielding strain on the lines, as distinguished from that asserted by a salvage vessel of ordinary type which upon dropping in the trough of a sea thereafter takes up on the lifting lines or chains with a sudden jerk.

Experience has demonstrated the fact that the first pull to lift a wreck from its bed is always the hardest, because it has to overcome not only the weight of the wreck but also to break the suction created by the lifting movement and the stickiness of the mud. Therefore, after the wreck has once been lifted with my apparatus, even for a comparatively short distance only, the lifting cables or chains may be further hauled in aboard the surface vessel, generally without changing the air pressure in the well 11, to raise the wreck up under the hull, in which condition it may be transported into shallow water.

This operation will be more clearly understood by referring to Fig. 8. To prevent parting of the hoisting lines connected with the submersible tube, or when hoisting a sunken vessel in a heavy sea, I use single or multiple blocks with one end of the line 36 carried up and attached to a piston rod 100, the piston 101 of which is movable in a cylinder 102 filled with oil, a sufficient supply of such oil being stored in a tank 103 containing air under pressure which pressure may be indicated by a gage 104. The other end, 36*a*, of the line runs to a hoisting winch such as that indicated at 37. When, now, a sudden heavy pull is exerted on the line while its end 36*a* is held against yielding, the other end of the line 36 will pull the piston rod 100 outward, thereby forcing oil from the cylinder 102 into the tank 103 against the

pressure of air therein, the pressure in the tank being thus correspondingly increased. At the same time the piston movement will draw oil into the other end of the cylinder from a tank 105 through apertures 106 in a baffle plate 107, the oil in the tank 105 being preferably also under pressure and this pressure will then be correspondingly reduced. When, now, the extra or sudden hard strain or pull on the cable 36 has ceased, the pressure in the tank 103 will automatically return the piston 101 to normal position, such return movement being naturally slow as it is controlled by the size of the apertures 106.

Another instance of the utility of the present invention is in regard to the rescue of a crew imprisoned in a sunken submarine. One manner in which this can be accomplished is illustrated in Figs. 5 and 6. In this adaptation of the invention an accordion-like tubular member C is employed for connecting the deck-hatch of the sunken submarine with the divers' compartment H of the tube 43. The preferred construction of this connector C is clearly illustrated in detail in Fig. 6, and comprises at its upper end a flange 70 having a projecting lip 71 for locating it properly relatively to the lower opening 57 of the head H. A packing-ring 72 forms a tight joint with the outer end ring 73 of the head H, when the flange is tightly drawn upward, as for instance by turnbuckle links 74 in the manner shown. An accordion sleeve 75, preferably made of rubberized canvas and reinforced internally and externally by annular bands 76, is securely clamped in a water and air tight manner to the underside of the flange 70 through the medium of a suitable clamping ring 77.

The lower end of the canvas tube is similarly clamped to the upper face of a connector-flange 78 by a clamping ring 79 which is permanently secured to the flange 78 by rivets (not shown). A lip 80 projecting downwardly from the flange 78 serves as a locator for a packing ring 81 and also as a means for positioning the flange itself within a ring 82 secured around the hatchway 83 of the submarine hull S. This ring is provided with a series of tapped holes corresponding to a series of plain holes drilled in the lower-combination flange 78, 79, 81, and adapted to receive a series of bolts 84 whereby this flange can be readily and tightly secured to the ring 82 to form a water and air tight joint. Stays, such as tackle-lines 85 (see Fig. 5) may be employed for maintaining the diving compartment H in position relatively to the hatch 83 without undue strain on the connector C.

When the connector C has thus been placed, the air pressure may be slightly raised in the diving chamber 55 until all the water in the connector C has been forced out through small check valves 86, whereupon a valve 87 in the hatch cover 88 may be opened to permit air under pressure to enter from the connector C into the interior of the submarine until the air pressure in the diving compartment and in the compartment of the submarine connected with it are equalized. Thereafter cover 88 may be raised into the position shown in Fig. 6, to allow the crew to ascend into the diving chamber 55 and from there ascend, by the stage-decompression process above described, to the surface.

Another adaptation of the present invention is illustrated in broken lines in Fig. 3, in which both the arms 30, 31 and the tubes 42, 43 are

shown in partly lowered condition, the head H serving as an observation chamber for directing the navigation of the vessel as required in the recovery of shell-fish, sponges, etc. In such operations a special dredge is required, such as indicated at D, which is preferably pivotally attached to the compartment H and drags evenly over the bottom as the vessel proceeds, the lower door at 57 being left open so that the observer may gather the material collected by the dredge and store it temporarily within the chamber 55.

Fig. 7 shows a modification of the attachment shown in Figs. 5 and 6 to permit the connection of two submarine vessels, or the submersible tube and a sunken submarine vessel. In this modification 89 is a bearing member secured to the diver's exit door in the same manner as is casting 72 shown in Fig. 6. This bearing member forms the upper part of the socket portion of a ball-and-socket joint, the ball 89' of which is attached to a bell-shaped casting 90 and is held in place by the retaining member 91 which forms the lower part of the socket portion of the joint. A door 92 permits access from the diving compartment to the bell, and an annular passage 93 is provided surrounding the bottom of the bell for a purpose later appearing. 94 and 95 are flexible rubber packing rings which surround the passage 93 and are held in fixed relation to the walls thereof by retainers 94' and 95', respectively. A pipe 96 connects this annular passage with a pump (not shown) located in the diving compartment. An other pipe 97 connects with another pump (not shown) in the diving compartment.

To afford communication between two vessels the diving compartment with its pendant bell 90 is positioned over the hatchway of the sunken vessel and then allowed to come to rest on the plating surrounding the hatch. Water is now pumped out of the annular passage 93, by means of the pump connected with pipe 96, thus creating in the passage a partial vacuum which draws the rubber packing rings 94 and 95 tight against the deck and ties the ships together by the force of the pressure acting upon the area covered by the mouth of the bell. Door 92 may now be opened and any water in the bell pumped out through pipe 97. The valve 98 in hatch cover 99 is now opened to allow the air in the compartment of the sunken ship to equalize with the air in the diving compartment and thereafter the hatch cover may be raised and the crew of the sunken ship ascend to the surface from the diving compartment, as previously described in connection with Figs. 5 and 6.

In raising sunken vessels it may be found that the surface displacement of the surface craft is not sufficient to lift the submerged vessel. I therefore provide a coffer dam E, which, as shown in Fig. 2, is normally hoisted up into the well 11 but which, as shown in Fig. 3, may be lowered to increase the capacity of the well, so that on increasing the air pressure in the well 11 the water will be forced out at the bottom of the coffer dam, thus very materially augmenting the displacement of the vessel. This coffer dam may be made air-tight with respect to the walls of the well in any suitable manner.

In operating on ships sunk in shallow waters, or in laying foundations, or doing other kinds of submarine work this coffer dam may be lowered so that the men may conduct their work without the use of diving armor, the upper portion of their bodies being encased in the air contained

within the well, which thus virtually becomes a huge diving compartment itself.

It will be apparent that my apparatus is susceptible of a variety of uses in addition to those mentioned, and it is to be understood that the structures illustrated in Figs. 5, 6 and 7 are adapted for use not only with a vessel of the type shown and described, but may be used with any existing type of submarine or submersible boat having a diving or escape compartment from which access may be had with a sunken submarine or other vessel, and various changes and modifications in details of construction and arrangement of parts may be made within the spirit of the invention and the scope of the following claims.

What I claim is:—

1. In a submarine salvage and recovery apparatus, a surface vessel, a semi-submersible arm pivotally attached at one of its ends to said vessel, a submersible tube pivotally secured at one end to said semi-submersible arm, and means to raise and lower said semi-submersible arm and said submersible tube, said arm and tube capable of being housed, when raised, within the limits of the hull of said vessel.

2. In a submarine salvage and recovery apparatus, a surface vessel, a pair of similar semi-submersible arms attached at one end to said vessel, a submersible tube secured at one of its ends between said semi-submersible arms, and means to raise and lower said semi-submersible arms and said submersible tube, said tube, when raised, lying between said arms and in substantial lateral alignment therewith.

3. In a submarine salvage and recovery apparatus, a surface vessel provided with a well, a pair of similar semi-submersible arms pivotally attached at one end to said vessel within said well and having their other ends free, a submersible tube pivotally secured at one of its ends between said semi-submersible arms adjacent to their free ends, and means to raise and lower said semi-submersible arms and said submersible tube, said arms and tube, when raised, lying within said well in substantial alignment laterally.

4. In a submarine salvage and recovery apparatus, a surface vessel, a pair of semi-submersible arms pivotally attached at one end to said vessel, a submersible tube secured at one of its ends between said semi-submersible arms, an auxiliary extensible tube telescopically housed within said submersible tube, means to project and retract said extensible tube relatively to said submersible tube, and means to raise and lower said arms and said submersible tube.

5. In a submarine salvage and recovery apparatus, a surface vessel, a pair of semi-submersible arms attached at one end to said vessel, a submersible tube secured at one of its ends between said semi-submersible arms, an auxiliary extensible tube telescopically housed within said submersible tube and provided with an observation chamber at its outer end, pressure fluid means to project and retract said extensible tube relatively to said submersible tube, and mechanical means to raise and lower said arms and said submersible tube.

6. In a submarine salvage and recovery apparatus, a surface vessel provided with a well within its hull and opening through the bottom thereof, a deck forming a closure for the top of said well, an arm pivotally connected at one of its ends with said vessel and arranged within said well and having an inlet portion in communication

- with said deck, means providing an air-tight chamber surrounding said inlet portion, and a tube connected with said arm and carrying an observation chamber, said tube and arm providing a passageway between said observation chamber and said air-tight chamber, said air-tight chamber adapted to receive air at any desired pressure and communicate same to said observation chamber.
7. In a submarine salvage and recovery apparatus, a surface vessel provided with a well within its hull and opening through the bottom thereof, a deck forming a closure for the top of said well, an arm pivotally connected at one of its ends with said vessel and arranged within said well and having an inlet portion in communication with said deck, means providing an air tight chamber surrounding said inlet portion, a tube connected with said arm and carrying an observation chamber, said tube and arm providing a passageway between said observation chamber and said air-tight chamber, said air-tight chamber adapted to receive air at any desired pressure and communicate same to said observation chamber, and means providing an air-lock affording communication between said air-tight chamber and the atmosphere, whereby operatives may pass from said vessel to said air-tight chamber, arm, tube and observation chamber with the pressure in said air-tight chamber higher than atmospheric pressure.
8. In a submarine salvage and recovery apparatus, a surface vessel provided with a well within its hull, said vessel provided with means from which submerged apparatus may be supported from the surface of the water by said vessel, said well open to the surrounding body of water but normally closed to the surrounding atmosphere and adapted to receive air under pressure to vary the pressure therein and thereby vary the buoyancy of said vessel, whereby the ability of the vessel to support from the surface the weight of the submerged apparatus may be varied as desired, and means associated with and normally contained within said well and extensible therefrom for increasing its normal cubical capacity.
9. In a submarine salvage and recovery apparatus, a surface vessel provided with a well within its hull, said vessel provided with means from which submerged apparatus may be supported from the surface of the water by said vessel, said well open to the surrounding body of water but normally closed to the surrounding atmosphere and adapted to receive air under pressure to vary the pressure therein and thereby vary the buoyancy of said vessel, whereby the ability of the vessel to support from the surface the weight of the submerged apparatus may be varied as desired, and means comprising a coffer-dam associated with said well and extensible therefrom for increasing its normal cubical capacity.
- SIMON LAKE.

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