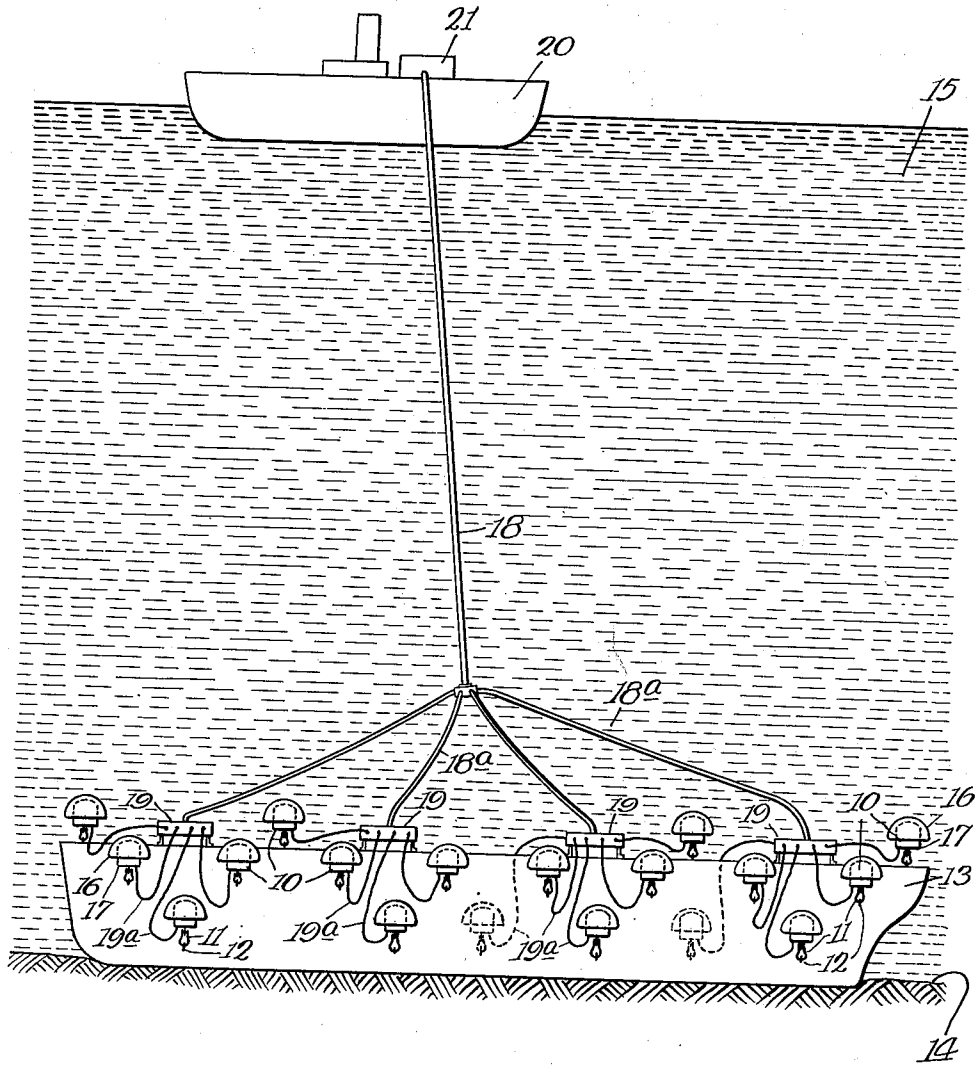
Sept. 3, 1940. A. BARNA 2,213,375

LIFTING BUOY

Filed Nov. 26, 1937 3 Sheets-Sheet 1

Fig. 1



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Sept. 3, 1940. A. BARNA 2,213,375

LIFTING BUOY

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Fig. 2

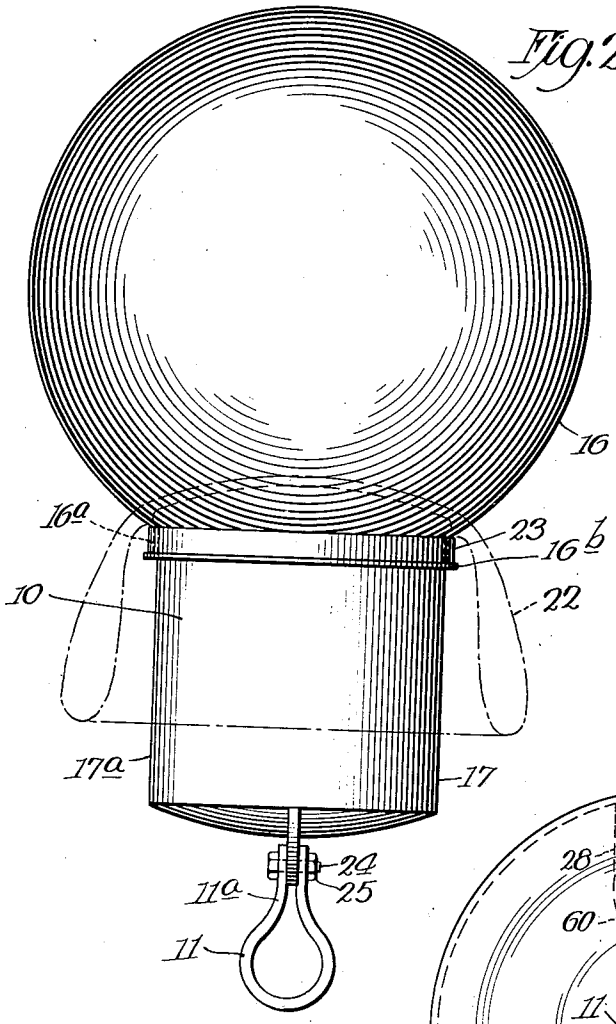


Fig. 3

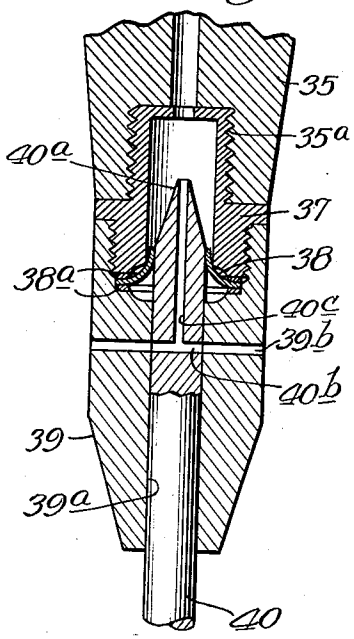
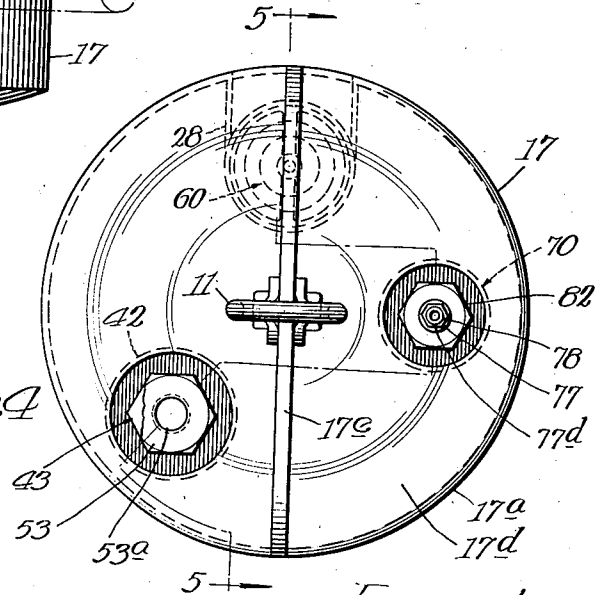


Fig. 4



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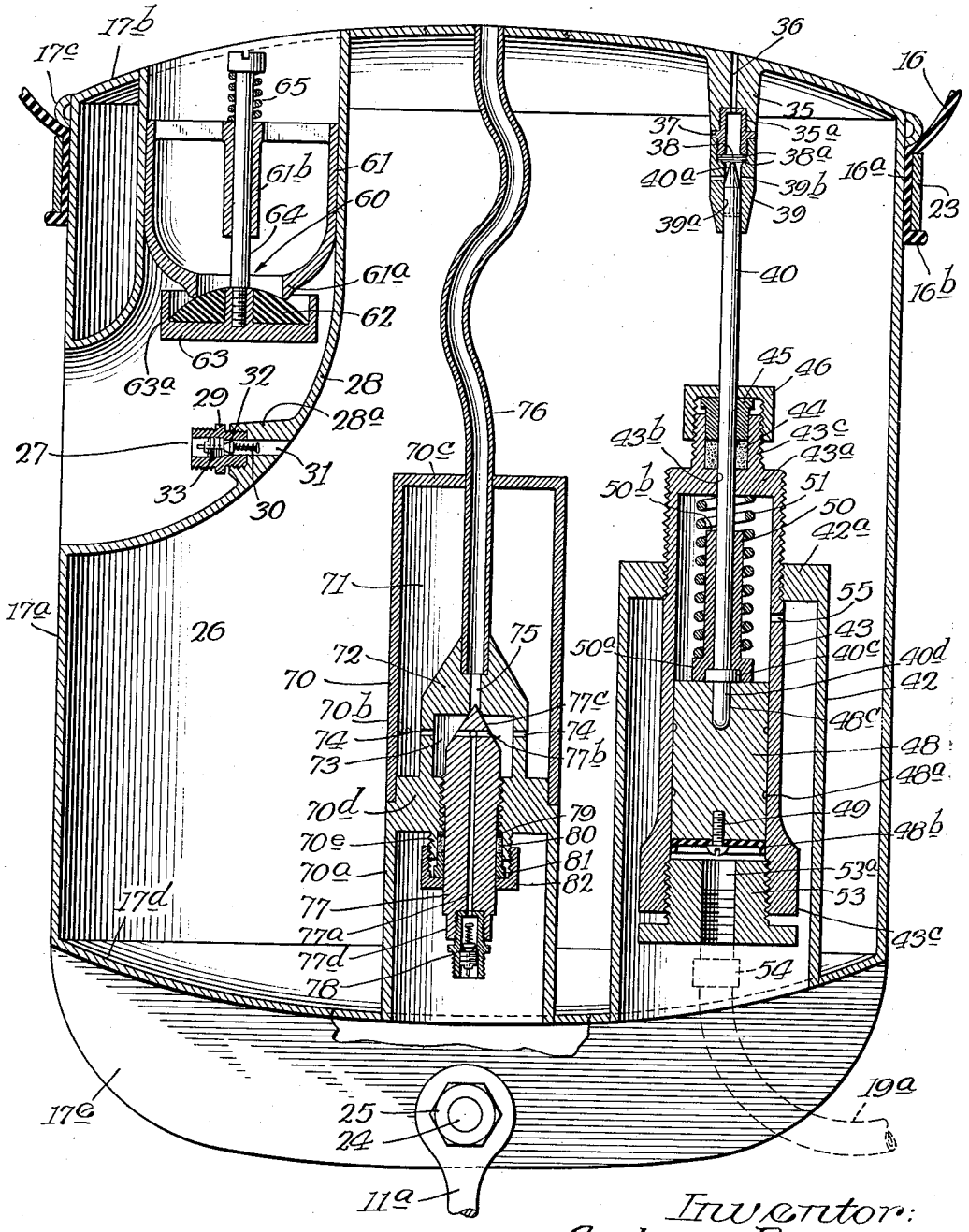
Filed Nov. 26, 1937 3 Sheets-Sheet 3

Fig. 5



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Patented Sept. 3, 1940

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UNITED STATES PATENT OFFICE

2,213,375

LIFTING BUOY

Andrew Barna, South Chicago, Ill.

Application November 26, 1937, Serial No. 176,432

6 Claims. (Cl. 114—49)

This invention relates to improvements in lifting devices, herein termed "lifting buoys" which are intended for use in elevating to the surface of the water vessels and the like which have been sunk and which lie at the bottom of the sea, or on the bottoms of rivers, harbors and lakes, or other bodies of water.

Lifting devices have heretofore been used for this purpose but, so far as is known, they have comprised collapsible containers adapted to be attached to a sunken vessel and to be thereafter inflated by compressed air or the like supplied thereto through hose connections leading from an air compressor carried by a boat or scow on the surface of the water. This practice has made it necessary to employ an air compressor of large capacity on the boat or scow and to use a boat or scow of considerable size in order to carry on the necessary operations at the surface of the water. A large amount of equipment has therefore been required in order to use lifting devices of this prior type and their use has further been unsatisfactory because a leak in one of the collapsible containers or in the hose connection leading thereto has been likely to render the whole system inoperative where a plurality of lifting devices are attached to the sunken vessel and inflated by the same air compressor.

The principal object of the present invention is to overcome the above mentioned difficulties and others by providing an improved lifting buoy having embodied therein means for storing a quantity of compressed air or other fluid which may be released to inflate a collapsible container after the lifting buoy has been attached to the sunken vessel. These improved lifting buoys may therefore be charged with compressed air or the like on shore, or elsewhere, before being taken to the place where they are to be carried down by a diver and attached to the sunken vesesl. The apparatus which must be in position at the surface of the water above the sunken vessel is thus comparatively limited. A further object of the invention is to provide an improved lifting buoy adapted to be attached to a sunken vessel and comprising an inflatable member capable of being inflated by a supply of compressed fluid carried by the lifting buoy, in combination with means for releasing the compressed fluid supply through a connection leading to the surface of the water when it is desired to bring into operation the buoyant action of the device. Still another object is to provide a lifting device of the type referred to comprising a collapsible container and a plurality of separate chambers for storing compressed air in different compartments under the same pressures so that the compressed air from one chamber may be used to effect a partial inflation of the collapsible container to lessen its weight due to its buoyancy while it is being attached to the vessel, after which the compressed air from another chamber may be employed to effect a further inflation of the container when everything is in readiness for bringing about the elevation of the sunken vessel. A further object is to provide a lifting buoy comprising a collapsible container and a drum attached thereto for storing fluid under pressure, in combination with improved means for causing the fluid in the drum to inflate the collapsible container when desired. Another object is to provide a lifting buoy comprising a collapsible container adapted to be inflated after being attached to a sunken vessel in combination with means for automatically relieving the pressure in the container as the lifting buoy and the vessel move upwardly through the water. Other objects relate to various features of construction and arrangement of the apparatus which will appear more fully hereinafter.

The nature of the invention will be understood from the following specification taken with the accompanying drawings in which one embodiment of the invention is illustrated. In the drawings,

Figure 1 shows a somewhat diagrammatic vertical section through a body of water illustrating a sunken vessel resting on the bottom and having attached thereto a plurality of lifting buoys embodying the present invention and adapted to be controlled from a boat or scow which is located at the surface;

Fig. 2 shows a side elevation of one form of the improved lifting buoy, illustrating by dotted lines the position of the wall of the collapsible container after it has been deflated and bent downwardly about the metal drum in which the compressed air or other fluid is stored;

Fig. 3 is a detailed vertical section similar to that of a portion of Fig. 5 showing the inlet valve of the collapsible container after the valve disk or diaphragm has been punctured to permit the compressed fluid in the drum to pass into the collapsible container;

Fig. 4 shows an enlarged bottom plan view of the lifting buoy illustrated in Figs. 2 and 5; and

Fig. 5 shows an enlarged vertical section taken on the irregular line 5—5 of Fig. 4.

One method of use of the invention is shown in Fig. 1 where a plurality of the improved lifting buoys 10 are attached by straps 11 to hooks or other objects 12 fastened around the upper edge, along the sides, over the top, and distributed on the inside of the hull of a sunken vessel 13 which is to be lifted from the bottom 14 of a body of water 15. In this view, the collapsible containers 16 of the lifting buoys 10 are deflated and are folded downwardly about the outer surfaces of the metal drums 17 which are adapted to be filled with compressed air or other fluid before being put in place on the sunken vessel 13 by a diver. After all of the lifting buoys 10 have been attached to the vessel, the compressed fluid in the drums 17 is adapted to be released simultaneously through valve mechanism which is controlled through hose connections leading from a common hose or conduit 18 which extends downwardly from a boat or scow 20 located at the surface of the water. In the arrangement illustrated, branch conduits 18a lead from the conduit 18 to a series of headers or casings 19 mounted on the vessel and hose connections 19a extend from these headers to the lifting buoys 10. The boat or scow 20 has an air compressor 21 mounted thereon or a tank containing a supply of compressed air or the like and the pipe or conduit 18 leads from this source of compressed fluid supply to the branch conduits or hose connections 18 by which the valve mechanism of the various lifting buoys 10 is controlled. It is thus possible to actuate the valve mechanism of all of the lifting buoys simultaneously by controlling means carried by the boat or scow 20 so that all of the collapsible containers 16 will be simultaneously inflated to bring about the elevation of the vessel 13 to the surface of the water due to the buoyant action of the lifting device 10.

As shown in Figs. 2, 4 and 5, the collapsible container 16 of each lifting buoy 10 is substantially spherical in form except on one side where it is attached to the metal drum 17. The collapsible container 16 is formed preferably of rubber or of a composition of rubber and reinforcing fabric so that it is strong and durable while being of sufficient flexibility to permit it to be folded downwardly around the walls of the drum 17 as shown by the dotted line 22 in Fig. 2. The collapsible container or globe 16 is provided on one side with an annular flange 16a which surrounds and closely fits one end of the annular wall 17e of the metal drum. This drum is provided at its upper end with an integral head 17b and a rib or shoulder 17c is attached to or formed on the annular wall 17a adjacent this head. The flange 16a of the collapsible container fits the annular wall 17a just below the rib 17c and is secured in place by a strap 23 which extends around this flange and around the drum. The ends of this strap may be welded or otherwise secured together after it has been drawn taut around the flange 16a and this flange is provided along its lower edge with an annular outwardly projecting shoulder 16b which is adapted to engage the lower edge of the strap 23 to hold the collapsible container or globe securely in place. At its lower end, the drum 17 has a head 17d which is formed integrally with the annular wall 17a or secured thereto by welding or the like. This head 17d is united with a flange or rib 17e which extends diametrically across the lower end of the drum and which has a centrally located aperture therein adapted to be engaged by a bolt 24 which engages the arms 11a of one of the straps 11 by which the drum 17 is attached to the vessel 13. The arms 11a of this trap extend on opposite sides of the rib 17e and a nut 25 engages the threaded end of the bolt to secure it in place.

The drum 17 has an internal chamber 26 adapted to contain the supply of compressed air or other fluid by which the collapsible container or globe 16 is to be inflated after the drum 17 has been attached to the vessel. This chamber is adapted to be filled with compressed fluid to the desired pressure through an inlet valve 27 which may be located in any wall of the drum, but which, in this embodiment, is shown as being mounted in the wall of an exhaust conduit 28 which communicates with the collapsible container 16 through the upper head 17b and which is constructed in the form of an elbow so that it opens outwardly through the cylindrical wall 17a of the drum. A boss 28a is formed on the wall of this exhaust conduit 28 opposite its outlet and a valve plug 29 is threaded into an internally threaded recess formed in this boss with the valve stem 30 projecting into the inlet opening 31 which is formed through the boss. A coil spring mounted on the valve stem normally forces the cone-shaped valve 32 against its seat on the member 33 which is threaded into the plug 29, as in the usual construction of air valves. The plug 29 is adapted to be connected with a coupling on the end of a tube leading from an air compressor or source of compressed air from which a supply of compressed air or the like may be forced into the chamber 26 of the drum. This is preferably done on shore or at some point removed from the place where the vessel is to be raised and when the drum has thus been filled, the lifting buoy 10, of which it forms a part, may be taken to the place where it is to be used and then attached by a diver to a part of the vessel which is to be elevated.

When all of the lifting buoys 10 have been connected to the vessel 13, the compressed air or other fluid in the chamber 26 of the drums 17 of these devices is released so that all of the globe-like collapsible containers 16 are simultaneously inflated to the necessary extent to cause them to effect the elevation of the vessel to the surface by reason of the buoyant action of the water thereon. The means for releasing the compressed fluid in the chamber 26 of each device is shown patricularly in Fig. 5 where the upper head 17b of the drum is shown as being provided with an inwardly extending boss 35 having a passage 36 leading therethrough to communicate with the interior of the collapsible container 16. This boss is provided with an enlarged internally threaded recess 35a in which there is mounted a threaded plug 37. The lower end of this plug forms a valve seat against which is mounted a circular valve disk or diaphragm 38 formed of comparatively thin metal, such as copper, having sufficient strength to withstand the pressure in the chamber 26 while at the same time being capable of being punctured when it is desired to permit the compressed fluid in this chamber to flow into the collapsible container 16. The valve disk or diaphragm 38 has a fiber washer 38a on each side thereof to serve as packing and this valve disk and fiber washers are held in place by a tubular guide member or cap 39 which is internally threaded at its upper end to engage the lower threaded extremity of the plug 37. The lower portion of this cap mem-

ber 39 has a smooth inner bore 39a which is closely fitted by the punch or plunger 40 having a pointed end 40a which is adapted to puncture the valve disk or diaphragm 38 when the operator wishes to permit the compressed fluid in the chamber 26 to flow into the collapsible container. In order to facilitate this flow of fluid after the diaphragm has been punctured, the cap member 39 is provided with radially extending passages 39b which communicate with the central bore 39a and which, when the plunger 40 is in its upper position, as shown in Fig. 3, communicate with the radial passages 40b in the plunger 40. This plunger is provided with an axial passage 40c communicating with the radial passages 40b so that the compressed fluid can flow through the connected passages into the chamber of the plug 37 and thence into the passage 36 which leads to the interior of the collapsible container.

In order that the punch or plunger 40 may be actuated by a workman on the boat or scow 20 at the surface of the water, fluid pressure actuated means are provided for moving the plunger 40 from the position shown in Fig. 5 to the position shown in Fig. 3, this means being controlled by compressed air or the like supplied through the conduit 18 and the branch conduits 18a, previously referred to. As shown in Fig. 5, this actuating mechanism comprises a tubular casing 42 which is mounted within the drum 17 with its lower end opening through the head 17d to which it is welded or otherwise integrally united. The casing 42 forms a chamber adapted to receive a removable cylinder 43 which is externally threaded at its upper end for detachable engagement with the internally threaded aperture which is formed in the upper end wall 42a of the casing. This cylinder 43 is provided at its upper end with an integral end wall 43a having a central aperture 43b therein which is closely fitted and slidably engaged by the punch or plunger 40. This end wall 43a has an integral annular flange 43c projecting therefrom to form a packing chamber around the plunger 40. This packing chamber is filled with packing material 44 and a packing gland 45 surrounds the plunger 40 and fits in the upper end of this packing chamber so that when the packing nut 46 is threaded onto the externally threaded flange 43c, the packing material 44 is compressed to form a fluid-tight joint about the relatively movable plunger 40.

The plunger 40 is adapted to be moved upwardly to puncture the valve disk 38 by a cylindrical piston 48 which is mounted to reciprocate in the cylinder 43. This piston is provided with annular grooves 48a in its outer wall and a disk 48b, of leather or the like, is secured to the lower end thereof by a screw 49 in order to form a fluid-tight connection with the wall of the cylinder. The piston is provided at its upper end with a recess 48c which is closely fitted by the lower extremity 40d of the plunger 40. This plunger has a collar 40e secured thereto to fit against the upper end of the piston 48 and a tubular guide member or sleeve 50 is provided with a bore which fits the plunger 40 and the collar 40e with its end engaging the upper end of the piston 48. A coil spring 51 surrounds the guide member 50 with its upper end engaging the end wall 43a of the cylinder and with its lower end engaging the enlarged portion 50a of the guide member which surrounds the collar 40e. The upper end 50b of the guide member is spaced from the end wall 43a of the cylinder a distance corresponding to that through which the plunger 40 is permitted to move when it is actuated by the piston 48, thus preventing the pointed end 40a of the plunger from moving upwardly beyond the position shown in Fig. 3 where the passages 40b register with the passages 39b. This upward movement of the plunger 40 and the piston 48 is effected by compressed air or the like admitted to the lower end of the cylinder 43 beneath the piston. For this purpose, the lower end of the cylinder 43 is internally threaded and is engaged by a plug 53 having a passage 53a therethrough which is threadedly engaged by a nipple 54 to which one of the hose connections 19a is connected. When compressed air or other fluid is admitted through the hose connection 19a, under the control of the operator on the boat or scow 20, the piston 48 moves upwardly and causes the plunger 40 to puncture the valve disk 38 thereby admitting compressed air or the like from the chamber 26 into the collapsible container 16.

In order to permit the escape of any fluid contained in the cylinder 43, between the head 43a and the piston 48, when the piston moves upwardly, and also to equalize the pressures on opposite sides of the piston 48 before the hose 19a is connected to the cylinder, a vent opening or port 55 is provided in the side of the cylinder, as shown in Fig. 5. When the piston 48 is actuated by compressed air supplied through one of the hoses 19a, the water or air in the upper part of the cylinder will flow out through this port 55 so that there will be no back pressure acting on the piston. Before the hose 19a is connected to the plug 53 in the end of the cylinder, the lower end of the piston 48 is subjected to the pressure of the water at the depth at which the lifting device is located, and if this pressure were not equalized it would force the plunger 40 upwardly and puncture the valve diaphragm before the operator is ready for that to occur, but the vent 55 permits the same water pressure to be applied to the upper end of the piston 48 so that difficulty is prevented. When the hose 19a is connected, the compressed air supplied therethrough must have a pressure sufficient to overcome that of the water acting upon the upper end of the piston 48.

In order to replace the valve disk 38 for a succeeding use of the device after one of these valve disks has been punctured, it is necessary to remove the cylinder 43 and the parts carried thereby together with the plunger 40 and the cap member 39. To permit this to be done, the lower end of the cylinder 43 is provided with a portion 43c of hexagonal cross section which is adapted to be engaged by a socket wrench inserted into the casing 42. The cylinder 43 may then be screwed out of its engagement with the end wall 42a of the casing and be thus removed bodily along with the plunger 40. Access may then be had to the cap member 39 which is similarly provided with an external surface of hexagonal cross section so that it may be engaged by a socket wrench to permit it to be unscrewed. The cap member 39 preferably has a lighter engagement with the plug 37 than the engagement of this plug with the boss 35 so that upon unscrewing the cap member 39, the plug 37 will not be removed with it. After the cap member 39 has been removed, new fiber washers 38a and a new valve disk 38 are put in place in the cap member where they are held by friction while the cap member is being restored to the position shown in Fig. 5, which may be done before putting the cylinder 43 and the plunger 40 back in place. It will be under-

stood that after compressed air has been applied through one of the hose connections 19a to cause the plunger 40 to puncture the valve disk 38, the piston 48 and the plunger 40 will be restored to the position shown in Fig. 5 by the action of the spring 51.

After the plungers 40 of all of the lifting buoys 10 have been actuated in the manner described above to puncture the valve disks 38, the collapsible containers 16 will be inflated by internal pressure, depending upon the pressure of the charge initially placed in the chambers 26 of the drums. The pressure of this initial charge in the drum and that of the collapsible container 16 when it is first inflated will depend upon the depth at which the lifting device is to be used, the pressure being increased as the depth of the water increases. For example, if the collapsible container is four feet in diameter and is to be used at a depth of three hundred feet, it is desirable to use a drum 17 about thirteen inches in diameter and about four feet high, and under those circumstances there would be about three hundred and thirty cubic feet of air in the chamber 26 at a pressure of thirteen hundred pounds. When this pressure is released at a depth of three hundred feet, the collapsible container 16 would be inflated with a pressure of about one hundred thirty pounds per square inch.

For illustration of the method of calculating the sizes of the collapsible container and drum to be used under given conditions, let it be assumed that the lifting buoy is to be attached to the vessel at a depth of three hundred feet and that each lifting buoy is to have a buoyant force of two thousand pounds. To find the capacity of the collapsible container, this buoyant force is divided by the weight of a cubic foot of water (to be displaced), giving 32 cubic feet as the capacity, if the container is to be used at the surface. This corresponds roughly to the capacity of a globe having a diameter of four feet. Since water has a pressure of 0.434 pound per foot of depth, the water pressure to be overcome at a depth of three hundred feet by the pressure in the container is obtained by multiplying these figures (300 x 0.434) which gives 130.20 pounds per square inch. The pressure of the atmosphere under standard atmospheric conditions at sea level being 14.7 pounds per square inch, the number of atmospheres of pressure at a depth of three hundred feet is obtained by dividing 130.20 by 14.7 and adding one atmosphere, acting on the surface, giving a total of 9.8571 atmospheres. To find the number of cubic feet of air required to give a pressure of 130.20 pounds per square inch at the depth mentioned, the figure 9.8571 is multiplied by 32 giving 315.427 cubic feet of air required in the collapsible container. If it be assumed that the drum 17 is to be thirteen inches in diameter and four feet high, which is a convenient size to use with a collapsible container 16 having a diameter of about four feet, the capacity of the drum would be 3.687 cubic feet. In order to fill the collapsible container from this drum with air at a pressure of 130.20 pounds per square inch, the air in the drum would have to be compressed to an amount determined by dividing the cubic feet required in the collapsible container by the capacity of the drum, subtracting one atmosphere from the result, and multiplying by the atmospheric pressure, 14.7 pounds per square inch, giving 1242.901 pounds per square inch as the pressure of the air in the chamber 26 of the drum. This calculation does not take account of the fact that the space within the drum 17 is partially occupied by the members 28, 40, 42, 43, 70, and 76, and the pressure in the drum should therefore be higher than the figure just calculated. In addition, it is desirable to use an excess of pressure in the collapsible container when it is first inflated so that it exerts a jarring action on the vessel tending to release it from the bed on which it rests. This is caused by having an excess amount of air compressed in the drum 17 so that it inflates the collapsible container with an excess of air which tends to open the automatic valve 60 because the pressure in the container 16 is then greater than the surrounding water pressure. For these reasons, the pressure should preferably be increased to sixteen hundred pounds per square inch in a drum of the size under consideration.

As the lifting devices rise to the surface with the vessel, it is necessary to release the pressure in the collapsible containers 16 in order to prevent them from bursting as the water pressure is reduced. This is accomplished by providing an automatic valve 60 in the exhaust conduit 28, previously referred to, which opens through the upper head 17b of the drum, as shown in Fig. 5. Each valve comprises a frame member or spider 61 secured to the wall of the conduit 28 and having an annular valve seat 61a engaged by a valve member 62 of rubber or the like having a curved upper surface to fit closely against the valve seat. This valve member 62 is carried by a cup-shaped member 63 which is threaded onto the lower end of a valve stem 64 and which has its annular flange 63a of such height that it will engage the curved lower part of the member 61 to limit the compression of the valve member 62 when the valve is closed by the water pressure acting upon it. This valve stem slides in a guide 61b carried by the spider 61 and a coil spring 65 is mounted between the head of this valve stem and the end of the guide 61b so that the spring normally maintains the valve in a closed position against the pressure of the air or other fluid which is contained in the collapsible container 16. The pressure of the water on the outside of the drum acts on the outside of the cup-shaped member 63 to assist in maintaining the valve in its closed position. As the lifting device rises to the surface, however, the water pressure on the outside of the valve will decrease so that there will be a gradual opening of the valve and a gradually relieved pressure within the collapsible container.

The lifting device is also preferably provided with means for effecting a partial inflation of the collapsible container 16 in order to render the entire device somewhat buoyant during the period that it is being taken down by the diver and attached to the vessel. For this purpose, the drum is provided with an auxiliary casing 70 which is closed at its upper end and which has its open lower end united with the lower head 17d of the drum around an aperture therein. This auxiliary casing is preferably formed in two sections 70a and 70b, for convenience in manufacture, the upper section 70b being closed at its upper end by an end wall 70c, and the upper end of the lower section being closed by a transverse wall 70d. A chamber 71 is thus formed between the two end walls 70c and 70d for the storage of a comparatively limited quantity of compressed air or the like which is to be used to effect the partial inflation of the collapsible container 16. The transverse wall 70d has a boss 72 carried on the upper side thereof and this boss

has formed therein a valve chamber 73 which communicates with the chamber 71 through ports 74. This valve chamber 73 has a passage 75 leading upwardly therefrom to communicate with a tube 76 which is secured in the upper end of the boss 72 and which is welded in an aperture formed in the upper end wall 70e of the auxiliary casing. This tube, which is preferably formed of metal having considerable ductility, extends through the chamber 26 and has its upper end secured in the upper end wall 17b of the drum so that it communicates with the chamber of the collapsible container 16. This tube 76 is of greater length than is necessary to extend from the boss 72 to the head 17b and has a plurality of curves therein so that it may extend or contract longitudinally without breaking in case there is relative movement of the heads 17b and 17d of the drum, which may occur, for example, when one of the lifting devices is dropped on the ground from a considerable height.

The transverse wall 70d has an internally threaded aperture which is detachably engaged by an externally threaded valve plug 77 having a central passage 77a leading therethrough and communicating at its upper end with transverse passages 77b which lead into the valve chamber 73. This valve plug 77 has a cone-shaped upper end 77c which is adapted to engage and close the lower end of the passage 75 when the valve plug is in its uppermost position. When in that position, the chamber 71 is adapted to be charged with compressed air or the like through an inlet valve 78 which is mounted in the lower end of the valve plug 77 to communicate with the passage 77a. This valve is similar to the valve 27 previously described and is normally closed so that it retains the charge of compressed air or the like in the chamber 71 after this chamber has been filled. When the workman wishes to permit the charge of compressed air in the chamber 71 to pass into the collapsible container 16, the valve plug 77 is unscrewed from the position shown in Fig. 5 in order to cause the tapered end 77c to move off of its seat at the end of the passage 75. This turning of the valve plug may be accomplished by applying a socket wrench to the hexagonal portion 77d which is formed on the outer end of the plug. Having thus unscrewed the valve plug, the collapsible container 16 will be partially inflated so that the lifting device may be more readily carried about by the diver who puts it in place on the sunken vessel.

In order to provide a fluid-tight joint around the valve plug 77, the transverse wall 70d is provided with an externally threaded annular flange 70e which forms a packing chamber around the valve plug. A washer 79 closes the upper end of this chamber which is partially filled with packing material 80. A packing gland 81 is adapted to fit into this packing chamber and to be moved upwardly by a cap member or nut 82 which threadedly engages the flange 70e, thereby compressing the packing material 80.

Although one form of the invention has been shown and described by way of illustration, it will be understood that it may be constructed in various other forms coming within the scope of the appended claims.

I claim:

1. The combination in a lifting device for vessels, of a collapsible container adapted to be attached to a sunken vessel, means attached to and movable with said container for partially inflating said container preliminary to attaching said device to said vessel, and additional means attached to and movable with said container for further inflating said container after it has been connected with said vessel.

2. The combination in a lifting device adapted to be attached to a sunken vessel, of a collapsible container, a drum attached to said container and having a chamber adapted to contain fluid under pressure, means including a valve disk for normally preventing the flow of said fluid from said chamber into said container, a detachable cap member for holding said valve disk in place, a plunger slidably engaging said cap member and adapted to puncture said disk, a casing extending into said drum and having an inner end wall provided with a threaded aperture, a cylinder threadedly engaging said aperture and having an end wall slidably engaged by said plunger, a piston mounted in said cylinder and operatively connected to said plunger, and means for admitting compressed fluid to said cylinder to operate said piston.

3. The combination in a lifting device adapted to be attached to a sunken vessel, of a collapsible container, a drum attached to said container and having a chamber adapted to contain fluid under pressure, means including a valve disk for normally preventing the flow of said fluid from said chamber into said container, a detachable cap member for holding said valve disk in place, a plunger slidably engaging said cap member and adapted to puncture said disk, a casing extending into said drum and having an inner end wall provided with a threaded aperture, a cylinder threadedly engaging said aperture and having an end wall slidably engaged by said plunger, a piston mounted in said cylinder and operatively connected to said plunger, and means for limiting the movement of said piston.

4. The combination in a lifting device adapted to be attached to a sunken vessel, of a collapsible container, a metal drum attached to said container and having a chamber for storing fluid under pressure, means for admitting said fluid to said container to inflate said container, an auxiliary casing extending into said drum and having an auxiliary chamber for containing fluid under pressure, said casing having an end wall, a valve member threadedly engaging said wall and having a passage therethrough, an inlet valve controlling said passage for permitting fluid under pressure to be passed into said chamber, and a conduit leading from said chamber to said container, the mouth of said conduit being normally closed by said valve member.

5. The combination in a lifting device adapted to be attached to a sunken vessel, of a collapsible container, a drum attached to said container and having a chamber adapted to contain a quantity of fluid under pressure for inflating said container, means comprising a valve member for normally preventing the flow of said fluid from said chamber into said container, a plunger for puncturing said valve member, a cylinder carried by said drum and having an aperture slidably engaged by said plunger, a piston mounted in said cylinder and connected to said plunger, and means for admitting compressed fluid to said cylinder, said cylinder having a vent open to the surrounding water pressure on the side of said piston opposite that engaged by said compressed fluid.

6. The combination in a lifting device adapted to be attached to a sunken vessel of a collapsible container adapted to be inflated, a drum attached

to said container and adapted to have said container collapse about it, said drum having two compartments each adapted to contain a quantity of fluid under pressure, a valve for controlling the flow of fluid from one of said compartments to said container to effect a partial inflation of said container, another valve for controlling the flow of fluid from the other of said compartments to said container to effect a further inflation of said container, and means operated from the surface of the water for controlling said last named valve.

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