Oct. 30, 1956 H. W. DAVIS 2,768,601

APPARATUS AND METHOD FOR RAISING SUBMERGED VESSELS

Filed Oct. 19, 1951 2 Sheets-Sheet 1

Fig. 1.

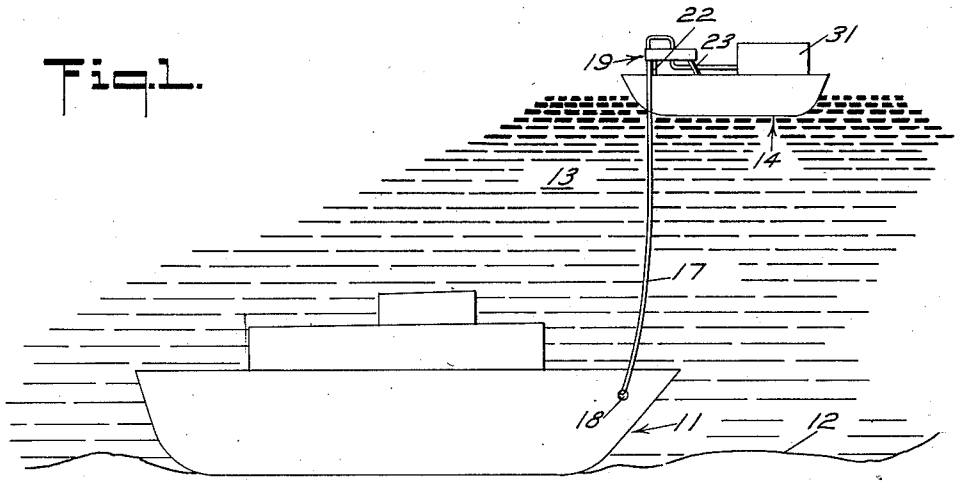
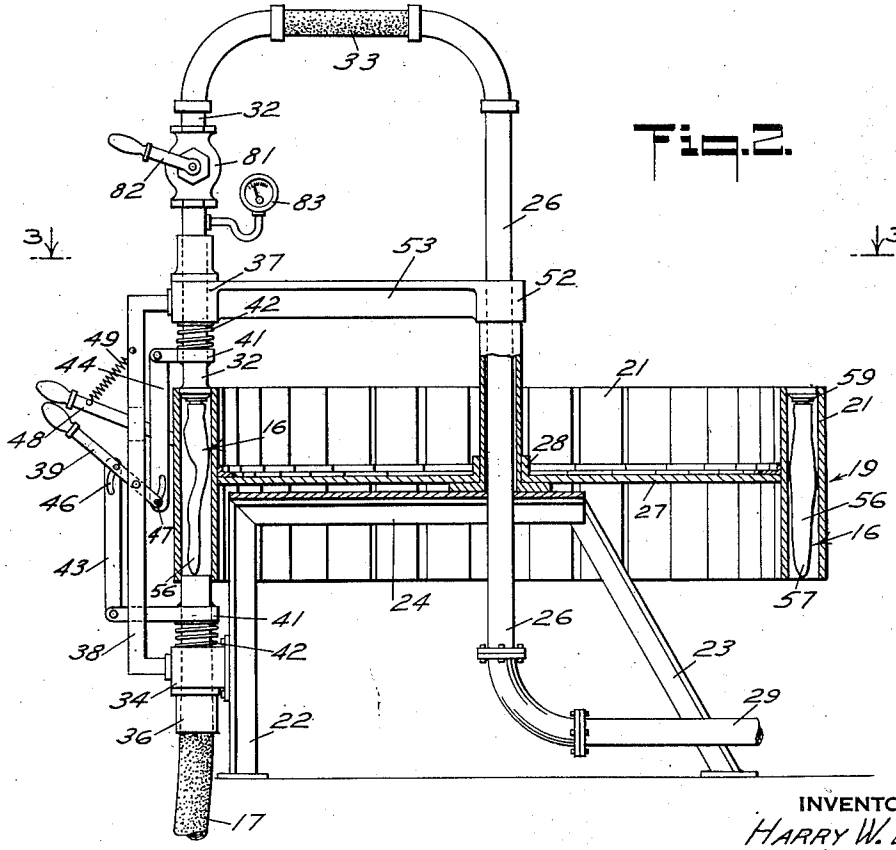


Fig. 2.



INVENTOR
HARRY W. DAVIS
BY Gardner & Zimmerman
ATTORNEYS

Oct. 30, 1956 H. W. DAVIS 2,768,601

APPARATUS AND METHOD FOR RAISING SUBMERGED VESSELS

Filed Oct. 19, 1951 2 Sheets-Sheet 2

Fig. 3.

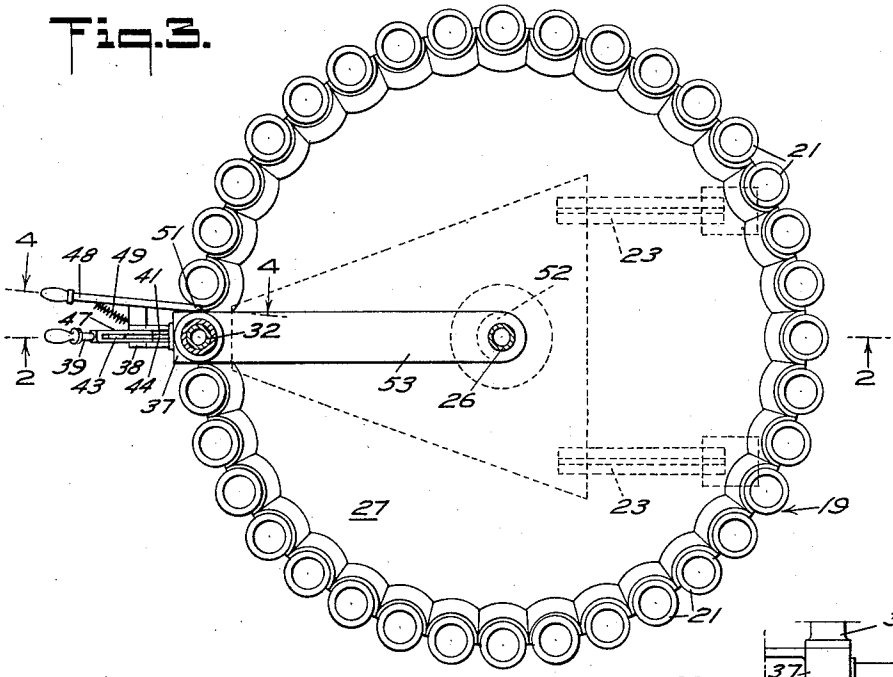
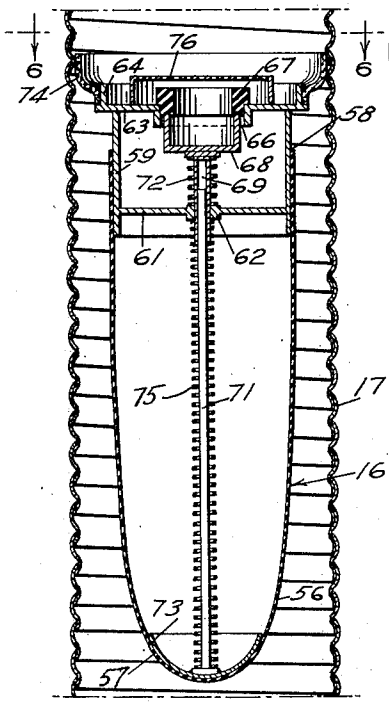
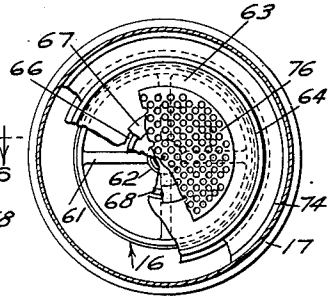


Fig. 5.





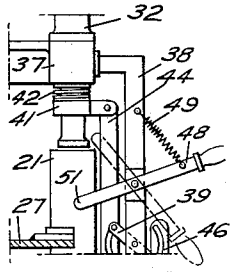


Fig. 4.

Fig. 6.

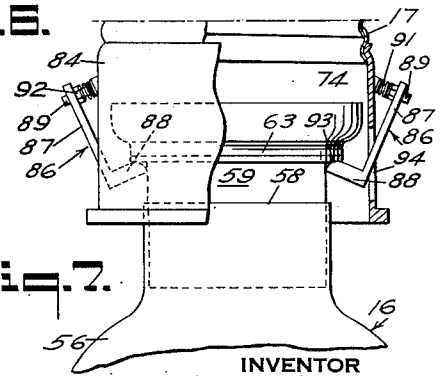


Fig. 7.

INVENTOR
HARRY W. DAVIS

BY Gardner & Zimmerman

ATTORNEYS

United States Patent Office 2,768,601 Patented Oct. 30, 1956

2,768,601

APPARATUS AND METHOD FOR RAISING SUBMERGED VESSELS

Harry W. Davis, Berkeley, Calif.

Application October 19, 1951, Serial No. 252,045

4 Claims. (Cl. 114—54)

This invention relates to apparatus and methods for raising objects from a submerged position to a floating position on the surface of the water, and is particularly directed toward a mechanism and process for raising sunken vessels for subsequent salvaging operations.

The apparatus and method of the present invention is designed to overcome the difficulties attendant with modern salvaging techniques, and a primary object or feature of the invention is to provide means for raising submerged vessels in an economical and safe manner so as to take advantage of the valuable metals and cargoes now resting on the bottom of the water.

Another object of this invention is to provide a novel method for raising submerged vessels in which the bulk of the operation is controlled and operated at a safe location remote from the submerged vessel, and in which a diver need only be employed to attach certain portions of the mechanism to the vessel.

A further object of the invention is to provide a method for the purpose above described in which one or more of the compartments of a sunken vessel may be substantially completely emptied of water irrespective of the condition of the hull of the vessel, until the weight of the vessel and any remaining water contained therein is the same as or less than the weight of water displaced by the vessel.

A still further object of my invention is to provide apparatus for raising submerged vessels in which a plurality of buoyant objects may be introduced into the compartments of a vessel and displace the water contained therein, and in which such objects may be rapidly fed from a surface vessel or from a submarine, diving bell, or other controllable submerged vessel.

Still another object of this invention is to provide apparatus and a method of the character described in which the water contained inside the sunken vessel will be ejected by displacement objects which may possess a size substantially larger than the size of the vessel opening through which they are introduced.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the invention which is illustrated in the drawings accompanying and forming part of the specification. It will be understood that the invention is not to be limited to the exemplary apparatus or the specific procedure herein shown and described, as variations thereof may be employed which come within the scope of the appended claims.

Referring to said drawings:

Figure 1 is a side elevational view, diagrammatic in character, indicating a surface salvaging vessel in position over a submerged vessel, preparatory to raising the latter.

Figure 2 is a cross-sectional side elevational view of the balloon ejecting mechanism, the plane of the figure being generally indicated by the numeral 2—2 of Figure 3.

Figure 3 is a top plan view of the structure disclosed in Figure 2, taken substantially in the plane indicated by the line 3—3 of Figure 2.

Figure 4 is an elevational view of a portion of the balloon ejecting mechanism taken substantially in the plane indicated by numeral 4—4 of Figure 3.

Figure 5 is a cross-sectional view of a balloon within the balloon conduit after being ejected from the mechanism disclosed in Figures 2 and 3.

Figure 6 is a plan view taken substantially in the plane indicated by the line 6—6 of Figure 5.

Figure 7 is a side elevational view of the distal end of the balloon conduit, portions of the view being illustrated in cross section.

It is a well known physical law that when a vessel is floating in equilibrium in still water, the weight of water she displaces is exactly equal to the weight of the vessel herself with everything she has on board. It is equally well known that if the weight of the vessel with everything she has on board exceeds the weight of the maximum amount of water capable of being displaced by the vessel, the vessel will sink. Thus, when a vessel is damaged to such an extent that water enters her compartments until the combined weight of the vessel and the water therein exceeds the weight of the displaced water, the vessel can no longer float in equilibrium, but will sink to the bottom surface of the body of water.

In broad terms, the present invention is related to a method of raising such a submerged vessel by reversing the process that caused her to sink. That is, by displacing all or a portion of the water contained in the vessel with air, until the combined weight of the vessel and any remaining water is less than the weight of water displaced by the vessel, the vessel will rise to the surface of the water and achieve a stable or equilibrium position. More specifically, this invention contemplates the removal of internal water from the vessel by introducing to the interior of the vessel a plurality of buoyant articles such as air-filled balloons or bladders which would serve to displace the internal water and consequently effect a reduction in vessel weight. This phenomenon is readily explainable by virtue of the fact that a cubic foot of air weighs in the neighborhood of 0.07 pound per cubic foot (varies according to temperature and pressure changes) whereas a cubic foot of water weighs approximately 64 pounds. It is a practical impossibility to completely seal off the compartments of a damaged submerged vessel and then pump out the water, but according to the teachings of the present invention, substantially the same result may be effected by filling the compartments with buoyant objects so that in spite of holes or other means of access for the water to enter the compartment, the buoyant objects being sufficiently strong to withstand the underwater pressure will occupy most of the volume of the compartment and thus displace the water previously contained therein.

Referring first to Figure 1 of the drawings, a vessel, generally indicated by the numeral 11 is shown on the bottom surface 12 of a body of water 13, with a salvaging vessel 14 floating on the upper surface of the water. Although the present invention is to be described in terms of a surface type rescue vessel, it will be apparent that sub-surface types of vessels could also be used, and it is also within the scope of my invention that the mechanism about to be described could be installed in vessels such as submarines so that in event of a disaster, the submarine crew could effect their own raising of their sunken ship.

As previously explained, vessel 11 has sunk due to the excessive weight of water which has entered the vessel in some manner. Consequently, to raise the vessel without resort to dangerous and impracticable pontoon

method, the water in the vessel must be displaced. I prefer to accomplish this by injecting a plurality of air-filled objects, such as the balloons or bladders **16** into the compartment of the vessel until the gross weight of the vessel is reduced to a weight less than the weight of the displaced water. Balloons have been selected for purpose of illustration and convenience in use, but other displacement objects such as sealed rigid air containers could likewise be satisfactorily utilized. It will of course be understood that where deformable balloons are used, the air pressure inside the balloons must at least equal the water pressure at the level where the balloon is placed in the ship. As 1 foot head of water equals 0.433 pound per square inch pressure, if the balloon is operating fifty feet under the water surface, the balloon pressure should exceed 21.6 pounds per square inch, whereas in a 200 foot depth, the balloon pressure should be in excess of 86.6 pounds per square inch. If such pressures are not maintained in the balloons, the water pressure will collapse the same.

Mechanism is provided on the salvage vessel **14** for introducing the balloons into the compartment of the vessel **11**, and such mechanism preferably includes a flexible conduit or hose **17** which may be of the metal ring type as illustrated. One end of the conduit is fixed to the salvage vessel, and the other end is inserted through any suitable aperture, such as a port hole **18**, in the vessel, and secured thereto by a diver. This act of inserting and fastening the distal end of the conduit into the vessel is all that is required of the diver, as the remaining portions of the operation are performed from the salvage vessel.

Mounted on the deck of salvage vessel **14** is a horizontally disposed rotary conveyor, generally indicated by the numeral **19**. Conveyor **19** includes a plurality of peripherally spaced vertically disposed cylindrical chambers **21**, each arranged to frictionally support a balloon **16** with the open end of the latter disposed upwardly in the chamber. To support the conveyor in spaced relation to the deck of the vessel, a suitable framework is provided which includes generally vertical members **22** and **23** and a horizontally disposed member **24**. The conveyor is rotatable in a generally horizontal plane around an axis defined by a vertical pipe **26**, and as best seen in Fig. 2, an annular member **27** secured to the cylinders and having a collar **28** journaled on pipe **26** is rotatably supported on the member **24**. It will be noted that as the conveyor is rotated, successive cylinders **21** will become vertically aligned with the conduit **17** whereby sequential balloons may be moved from the cylinders, through conduit **17**, and thence into a compartment in the vessel **11**. To effect this action, the following apparatus is utilized.

Pipe **26** is connected to a conduit **29** which communicates with an air compressor **31**, and mounted in parallel spaced relation to pipe **26** and in axial alignment with conduit **17** is a movable pipe section **32**. Interconnecting section **32** and pipe **26** is a short length of flexible hose **33** whereby the section **32** may be axially moved relative to the stationary pipe **26**. Secured to support member **22** is a collar element **34** which slidably receives a short pipe **36** which in turn is secured to the upper end of balloon conduit **17**. A similar collar element **37** slidably receives pipe section **32**, and means are provided for placing the free ends of section **32** and pipe **36** against the upper and lower ends of a cylinder **21** whereby air from compressor **31** will be placed in direct flow communication with balloon conduit **17**. As here shown, a vertical member **38** extends between and is secured to the collars **34** and **37**, and is provided with a pivotally mounted lever arm **39** arranged for oscillating movement in a generally vertical plane. Disposed intermediate each of the fixed collars and the conveyor **19** is an annular member **41** welded or otherwise secured

to section **32** and pipe **36** respectively, and a coil spring **42** is positioned between each collar and annular member so that section **32** and pipe **36** are normally urged into contiguous sealing relation with one of the cylinders **21**. Suitable gaskets may be placed at the junction of the section and pipe with the upper and lower ends of the cylinder to insure an air tight joint, but as such sealing means are well known in the art and form no part of the present invention they have not been illustrated in order to avoid unnecessary confusion in the drawings. In order to revolve conveyor **19** and place other of the cylinders **21** in alignment with section **32** and pipe **36**, it is necessary to cause these latter elements to move axially apart. This may be accomplished by providing each of the members **41** with vertical bar extensions **43** and **44** disposed on each side of the member **38** and terminating adjacent the pivotal connection of lever **39**. Each of the extensions are provided with slots **46** having a center of curvature corresponding to the said pivotal lever connection and arranged to slidably receive guide pins **47** extending from spaced portions of lever **39**. With reference to Figure 2, it will be seen that by moving lever **39** downwardly, the pipe section **32** will be slightly raised and pipe **36** will be slightly lowered so that both of these conduits will be spaced from the aligned cylinder **21** and the next cylinder may then be brought into registration with these conduits. To facilitate prompt registration of successive cylinders, a conveyor locking lug **48** is utilized. As best disclosed in Figs. 3 and 4 of the drawings, the lug is pivotally mounted on member **38** and normally maintained in the position indicated in solid lines in Fig. 4 by means of a spring **49**. In this position, the distal end **51** of the manually actuable lug is disposed between adjacent cylinders **21** and effectively prevents rotation of the conveyor. When it is desired to rotate the conveyor, it is only necessary to pull the lug toward the dotted line showing in Fig. 4 to clear the cylinders. Naturally, numerous other devices such as ratchet and pawl arrangements could be substituted for the foregoing without departing from the scope of the invention. A collar **52** is secured to pipe **26** and is connected to collar **37** by means of a horizontally extending element **53** to impart greater rigidity to the fixed parts of the mechanism.

As hereinabove stated, the balloons **16** are designed to be propelled from the cylinders **21** through the conduit **17** and thence into the compartment of vessel **11**. It is preferable to utilize an expandible ballon rather than a rigid air cylinder or the like as a balloon requires little space in its collapsed condition so that it can be readily moved through the comparatively small conduit **17** and yet may be blown up within the compartment to a relatively large size so as to displace as large as possible a quantity of water. Each balloon as here shown is composed of an elongated, extendible and resilient bladder portion **56** having a closed end **57** and an open upper end **58**. Vulcanized or otherwise secured to the open end of the bladder is a metal or other rigid cylindrical element **59** which is telescoped in the bladder for a short distance and extends beyond the open end of the bladder. Adjacent the lower end of the element **59** and secured thereto is a spider **61** having a centrally disposed annular ring **62** for a purpose to be hereinafter explained. Secured to the upper end of element **59** is a radially enlarged annular plate **63** having a vertically extending flange **64** adjacent the periphery thereof, the flange extending beyond the peripheral surfaces of the bladder **56** when the latter is deflated. The plate is further provided with a centrally disposed air-receiving opening **66**, and a gasket **67** is secured to the plate adjacent the opening. A cup-shaped valve **68** is disposed within the bladder and is secured to the upper end of a short valve stem **69**, the latter being telescopically engaged with a stationary post **71** extending for substantially the entire length of the bladder and

journaled in the ring 62. Spring 72 normally urges the valve against its valve seat defined by gasket 67, and it will be noted that the general elongated shape of the bladder is effected by means of the post 71 whose lower end is secured to a concave plate 73 secured to the balloon end 57, and to assist the post 71 in this regard, a spring 75 is provided around the post extending from ring 62 to plate 73. To frictionally support the balloon in the cylinder 21, a leather or similar gasket 74 is secured to the flange 64 which engages the walls of the cylinder and also engages the inner walls of conduit 17 as the balloon is moved therethrough. If desired, a screen-like member 76 may be secured to plate 63 overlying the opening 66.

To eject the balloon from the cylinder 21 and effect its passage through the conduit 17, the section 32 and pipe 36 are first caused to engage the conveyor 19 in alignment with one of the balloon supporting cylinders 21. Pipe section 32 is provided with a valve 81 having a manually operable lever 82 to open and close the supply of air from compressor 31, and is further provided with a conventional pressure gauge 83. By opening valve 81, high pressure air will flow from the compressors through lines 29, 26, 33 and 32 into the cylinder 21 whence it will strike against the upper surface of plate 63 and the valve 68. Such action will cause the balloon assembly to slide out of the cylinder and slide for the entire length of the conduit 17. The air pressure required to force the balloon through conduit 17 will not be sufficient to overcome the pressure of spring 72 and therefore the balloon will not be inflated. Such inflation takes place only after the bladder has passed entirely through the conduit as will now be explained.

Referring to Fig. 7 of the drawings, it will be noted that the terminal end of conduit 17 is provided with a cylindrical extension 84 which is secured to the conduit in any suitable manner. The extension is provided with a pair of diametrically opposed lugs 86 having shank portions 87 and 88. The upper end of each shank is apertured to receive a pin 89 secured to extension 84 and extending angularly therefrom. A compression spring 91 is disposed between the cylinder and shank so as to normally urge the distal end of the flange radially inwardly, and it will be noted that the spring pressure may be selectively varied by means of a nut 92 threadedly engaged in the pin 89. The said distal end of each flange is provided with an upper convex surface 93 normally disposed in the path of the outer peripheral bottom surface of balloon plate 63. It will be noted that the flanges pass through suitable openings 94 provided in the extension member. With this structure, it will be evident that as the bladder of the balloon passes through the extension 84, the lug flanges will catch the plate 63 and prevent further movement of the balloon assembly. It will be remembered that the extension will be disposed within or adjacent the compartment of the vessel 11 so that the bladder will likewise be in the submerged compartment. At this time, the operator opens valve 81 to a larger extent so as to overcome the pressure of spring 72 and move the valve 68 from the valve seat. This will result in the expansion of bladder 56, and as hereinabove explained, the air pressure required to fill and expand the balloon will be slightly in excess of the pressure head created by the depth of water. In any event, the balloon is filled with compressed air until the air pressure is sufficient to force the balloon and its plate past the convex surface 93 of the lugs 86, and at such time the plate will slide by the arcuate flange portions 93, urging the latter radially outwardly, and the inflated balloon assembly will be freely disposed in the vessel compartment. The lugs 86 will of course return to their plate intercepting position so that the foregoing cycle can be repeated. The setting of springs 91 will depend on the depth at which the salvaging operation is taking place, for it will be obvious that in greater depths, more air pressure is required to fill the bladders, and consequently more spring pressure is required to avoid premature release of the balloons. After the balloon is released from extension 84, the air pressure within the bladder, together with the pressure of spring 72 will shut the valve 68 against its valve seat and prevent water from entering the balloon.

The operator on the vessel 14 can readily ascertain when the lugs have released the balloon as the recorded pressure on the gauge 83 will suddenly drop. He is then required merely to shut valve 81, move levers 39 and 48, and rotate the conveyor to align the succeeding cylinder with the conduit 17. The lever 39 is again actuated to effectively close the air circuit, valve 81 is opened, the next balloon is started on its journey, and the entire cycle of operation is repeated.

As will be understood, the number of balloons required to raise the vessel will depend on several factors including the amount of water within the vessel and the size of the balloons in their inflated condition. Obviously, the balloon bladders must be constructed of a material which will withstand the internal air and the external water pressure, and numerous synthetic rubber materials are capable of so serving without requiring an excessive thickness which would prevent free expansion and inflation. As will be understood, after a particular compartment has been substantially filled with inflated balloons, the diver will, if necessary move the conduit 17 to another compartment where the same procedure is followed.

From the foregoing description, it will be clear that a method of raising sunken vessels has been conceived in which the vessel may be raised to the surface in a minimum of time and with little or no danger to the salvage personnel. Various modifications could be made in the mechanism disclosed herein to carry out the salvaging operation, but for reasons of simplicity and economy, the structure illustrated in the drawings may be preferred. In the event the vessel 11 is disposed at a depth too deep for normal diving operations, a diving bell may be utilized to place the distal end of conduit 17 within the vessel. Also, it is contemplated to have submarines equipped with mechanism of this type so that even if one or more of its compartments became flooded, balloons could be ejected into the flooded compartment. Naturally, air would be required, and it is believed possible to obtain air from the compressor by floating an air line from the submarine to the surface of the water.

I claim:

1. Apparatus for injecting inflatable tubular objects having an open end comprising, a first conduit, a rotary member having a plurality of peripherally spaced vertically extending bores arranged to support tubular inflatable objects in a deflated condition with the open ends uppermost, means for axially aligning successive bores of said rotary member with said first conduit, a second conduit in axial alignment with and axially spaced from said first conduit and arranged to be connected to a source of compressed air for inflating said objects, and means for sequentially placing each of said conduits in flow communication with the respective open ends of one of said bores.

2. Apparatus for displacing a quantity of water from a flooded compartment in a submerged vessel comprising, a rotary conveyor having a plurality of peripherally spaced chambers, a conduit having at least one end portion thereof in axial alignment with one of said chambers and adjacent thereto and another end portion arranged to be placed in a compartment of a submerged vessel, a second conduit having at least one end portion in axial alignment with said one of said chambers and adjacent to said chamber end remote from said first named conduit, means for creating a flow of air through said second conduit and toward and into said chamber, means for selectively placing sequential chambers in flow communication with each of said conduits, and an inflatable member disposed within each chamber prior to its being placed in communication with said conduits, and said

member being arranged to be forced through said first named conduit by said flow of air.

3. Apparatus for raising a submerged vessel having a quantity of water contained in a compartment thereof comprising, a balloon-like member having an opening therein for receiving a gas under pressure, means normally closing asid opening, a conduit having one end arranged to be inserted in a compartment of a submerged vessel and another end arranged to be disposed on a rescue vessel, means including an air compressor for moving said member in a deflated condition through said conduit, means adjacent said first mentioned end of said conduit for releasably engaging a portion of said member adjacent the opening therein and for holding said member while the latter is filled with air; said engaging means being releasable upon a predetermined pressure being created in said member.

4. A member arranged to be inflated in a flooded compartment of a submerged vessel to displace water contained in said compartment comprising an extendible bladder-like element having an open end, a rigid member secured to said bladder adjacent said open end and completely overlying the latter, said rigid member have a peripheral flange and a central bore therein communicating with the interior of said element, means adjacent said bore defining a valve seat, a valve member disposed substantially within said interior, a rigid arcuate member

extending entirely within said element adjacent the other end thereof; means including a spring extending from said rigid member to said arcuate member to urge said rigid member away from said arcuate member, and spring means normally urging said valve member against said valve seat.

References Cited in the file of this patent

UNITED STATES PATENTS

258,881	Bosshard	June 6, 1882
426,259	Garland	Apr. 22, 1890
438,059	Cady	Oct. 7, 1890
630,542	Jones	Aug. 8, 1899
689,431	Tattu	Dec. 24, 1901
867,983	Lake	Oct. 15, 1907
1,486,131	Dutton	Mar. 11, 1924
1,772,709	Culbertson	Aug. 12, 1930
1,848,581	Stein	Mar. 8, 1932
1,863,732	Schwager	June 21, 1932
2,411,649	Brizay	Nov. 26, 1946
2,412,205	Cook	Dec. 10, 1946
2,495,754	Nance	Jan. 31, 1950

FOREIGN PATENTS

622,900	Great Britain	May 9, 1949
964,036	France	Jan. 18, 1950