

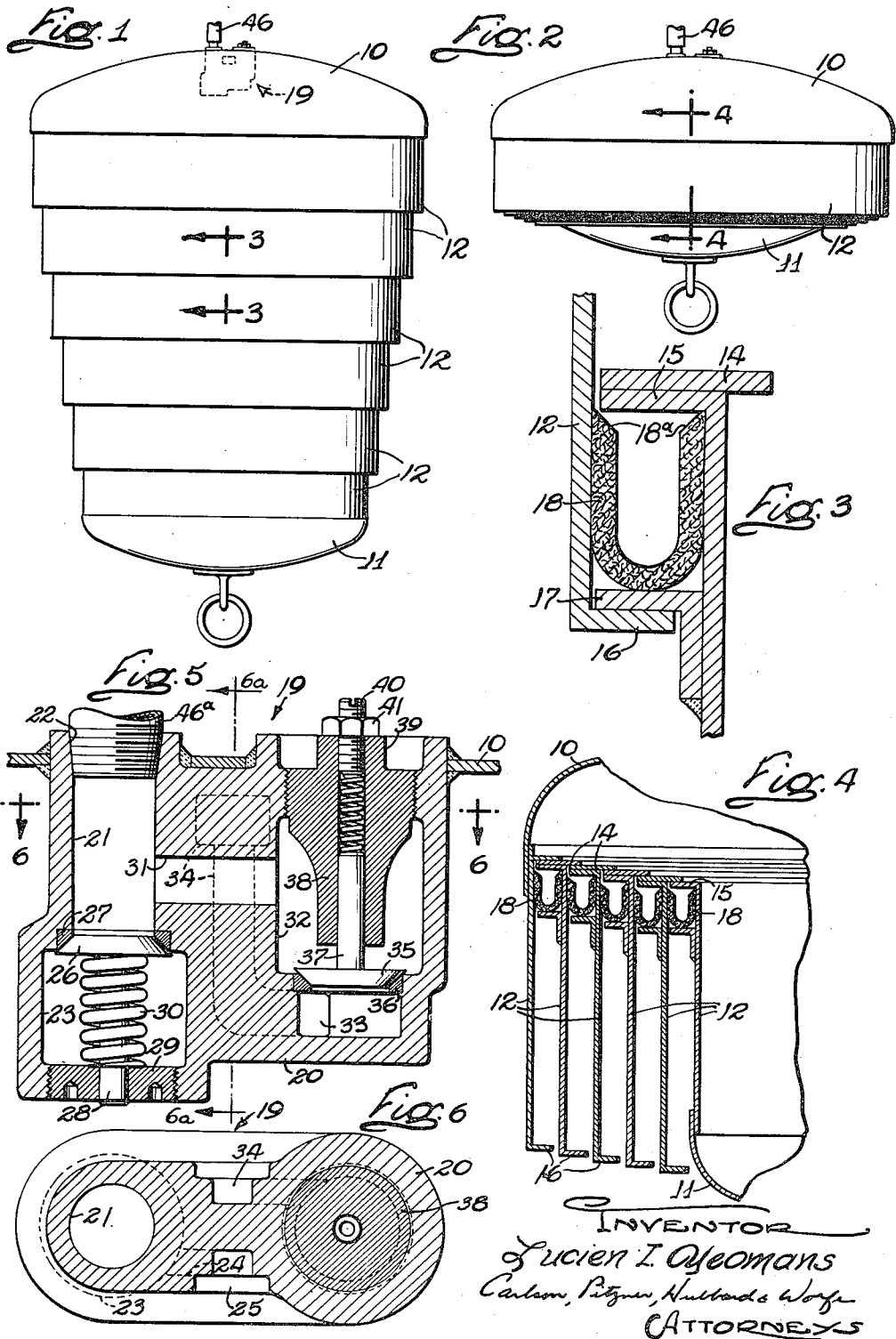
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L. I. YEOMANS
SUBMERSIBLE BUOY

2,546,956

Filed Oct. 6, 1944

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 7

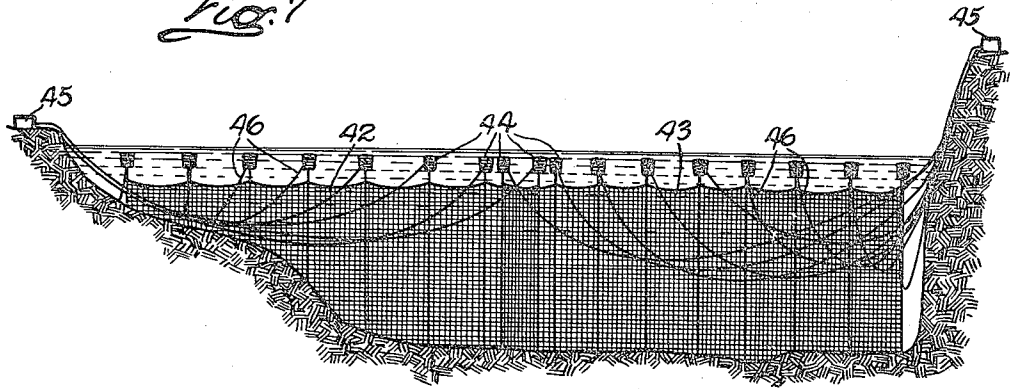


Fig. 8

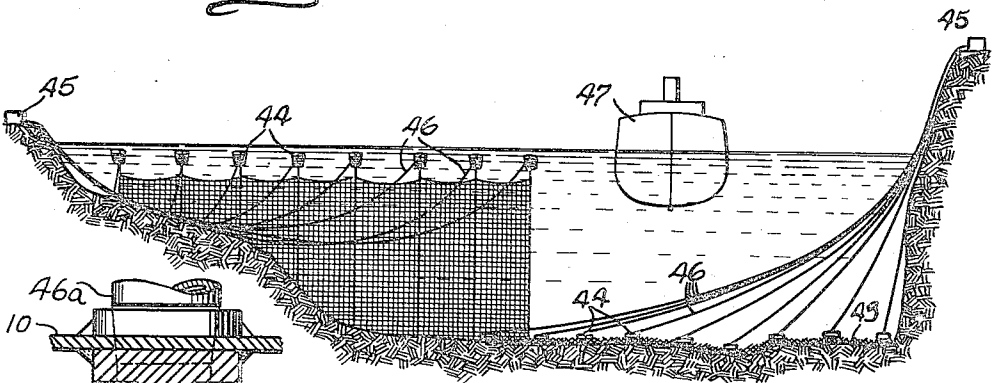
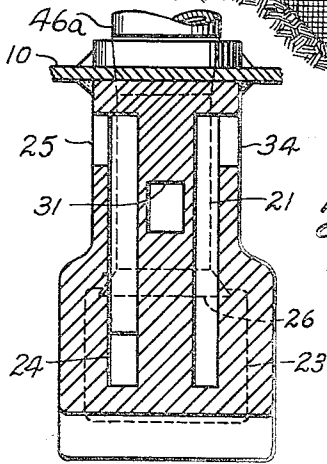


Fig. 6a

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SUBMERSIBLE BUOY

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15 Claims. (Cl. 9—8)

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The present invention pertains to buoys.

One general object of the invention is to provide a buoy of novel construction adapting it to be distended to float on the water or collapsed to sink to the bottom, all through simply the admission or exhausting of air or like pressure fluid to and from its interior.

More particularly, it is an object to provide such a buoy adapted for fabrication from steel or like metal parts substantially throughout so that it has the ruggedness and strength requisite to withstand the battering and abuse incident to use at sea and long periods of complete or partial immersion.

Another and important object of the invention is to provide a buoy whose displacement may be readily and simply controlled in a manner to cause it to sink when desired or to float, either on the surface or submerged at some predetermined depth. Such ability to cause the herein described buoy to float submerged at a pre-selected depth, through controllable variation of its displacement, is of prime importance in many instances, as will hereinafter appear in greater detail.

Further objects and advantages of the invention will become apparent as the following description proceeds, taken in connection with the accompanying drawings in which:

Figure 1 is a side elevation of a submersible buoy embodying the present invention, the buoy being shown in its fully distended or surface-floating condition.

Fig. 2 shows the buoy of Fig. 1 in completely collapsed condition.

Fig. 3 is an enlarged detail sectional view taken substantially along the line 3—3 in Fig. 1.

Fig. 4 is a detail sectional view taken substantially along the line 4—4 in Fig. 2.

Fig. 5 is an enlarged vertical sectional view of the valve unit fixed in the top portion of the buoy of Fig. 1.

Fig. 6 is a transverse sectional view taken substantially along the line 6—6 in Fig. 5.

Fig. 6a is a sectional view in elevation taken substantially along the line 6a—6a in Fig. 5.

Fig. 7 is a more or less schematic showing of a net installation at the mouth of a harbor and including nets equipped with buoys like that of Fig. 1 arranged to suspend the same.

Fig. 8 is a view similar to Fig. 7 but showing the series of suspension buoys for one of the nets collapsed, and the coacting net thus lowered, for the passage of a vessel.

While the invention is susceptible of various

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modifications and alternative constructions, I have shown in the drawings and will herein describe in detail the preferred embodiment, but it is to be understood that I do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

Referring more particularly to the exemplary embodiment of the invention herein illustrated, the buoy of Fig. 1 comprises a pair of opposed end members, here shown as a convex or dome-shaped top 10 and an inverted dome-shaped bottom 11 of somewhat smaller diameter. These end members 10, 11 are joined by a nested series of annular wall members 12, here shown as six in number. Each of these wall members is of successively smaller diameter than the next adjacent one in the series, the largest one being fixed to the top member 10 and the smallest fixed to the bottom member 11. When the buoy is distended in floating condition, as shown in Fig. 1, the overall structure thus has a downwardly tapering shape which lends itself well to stability of the buoy while it is afloat.

Each wall member 12 is arranged with reference to the next adjacent one in the series for limited axial sliding movement. To limit the upward movement of the wall members 12 with reference to each other, when collapsing the buoy, stops in the form of rings 14 are provided. Such rings are welded or otherwise fixed to outturned flanges 15 on the tops of the wall sections. As each wall section 12 reaches its upper limit position, the upper face of the ring 14 thereon strikes the overhanging underface of the ring on the next adjacent larger wall section. Similarly, downward movement of the wall sections 12 with respect to each other, during distention of the buoy, is limited by inturned annular flanges 16 on the lower edges of the wall sections coacting with outwardly projecting annular flange members 17 rigid with respective ones of the wall members. As each wall member 12 descends the flange 17 thereon abuts against the flange 16 of the next larger wall section, stopping further downward movement.

To seal the interior of the buoy against leakage of water between adjacent ones of the telescoping wall sections 12, annular packing or sealing rings 18 are employed (Figs. 3 and 4). Such packing rings are made of yieldable, somewhat resilient, non-metallic material, such, for example, as leather or leather reenforced with

fabric, and in the particular form illustrated herein are U-shaped in cross-section so that the legs of the U are pressed outward by the resilience of the material against the opposed faces of the adjacent wall members 12. Preferably the upper edges of the packing rings 18 are beveled or relieved as indicated at 18a. It will be observed that the upper sides of the packing rings are exposed to the air pressure within the buoy so that such pressure tends to press the rings out against the faces of the wall members 12, thus retaining the rings in firm sealing engagement with the latter despite the fact that the rings 18 may slide freely with reference to such wall surfaces. Each of the packing rings 18 is interposed between the upper flange 14 and intermediate flange 17 on respective ones of the wall sections 12 so as to be retained properly in position.

When in transit to point of use, buoys like those described above may be retained in collapsed condition so that they occupy a minimum of cargo or deck space on a vessel. On the other hand, when the illustrated buoy is in use it is either fully or partially distended so as to float on the surface or at some desired depth. The displacement of the buoy is calculated with reference to the weight of the materials from which it is fashioned in such manner that when the buoy is collapsed it will sink, and when fully distended will float on the water. Most simply, compressed air may be fed to the interior of the buoy through a flexible hose line to distend the same fully for floating, or the line connected to a slight vacuum to collapse the buoy so that it will sink. Desirably, however, provision is made for adjusting the pressure within the buoy so that it may be caused to float submerged at a predetermined depth in accordance with the displacement resulting from the controlled pressure.

As a means of controlling the pressure within the buoy for the purposes indicated above, a valve unit, designated generally as 19, may be employed (Figs. 1, 5 and 6). As illustrated, this unit comprises a casting 20 fixed within the top dome 10 and cored out to form a passage 21 leading from an inlet opening 22 to a chamber 23. From the latter chamber a passage 24 opens at 25 into the interior of the buoy so that 21, 23 and 24 constitute in effect a single passage leading from the inlet 22 to the interior of the buoy. The flow of air through 21, 23, 24 is controlled by a check valve comprising a valve element 26 coacting with an annular seat 27 and having a stem 28 slidably received in a plug 29. A coiled spring 30 yieldably urges the check valve element 26 to closed position. When compressed air is supplied through the inlet 22 the valve element 26 is forced open, permitting the air to pass on into the interior of the buoy, but when pressure at the inlet 22 is relieved the valve element snaps closed, preventing escape of air past it from the inside of the buoy.

A second path of communication between the inlet 22 and the interior of the buoy is provided by a branch passage 31 leading laterally from the passage 21 into a chamber 32, and thence through a passage 33 to an outlet 34. A bleeder or relief valve is interposed in this path, the same comprising a valve element 35 adapted to close against an annular seat 36 and carried by a stem 37 slidably in a plug 38. A coiled spring 39 interposed between the stem 37 and an adjusting screw 40 equipped with a lock nut 41 serves to urge the valve element 35 yieldably toward closed

position. It will be observed that the upper face of the valve element 35 is exposed to pressure prevailing at the inlet 22, whereas the opposite or lower face of the valve element 35 is exposed to the pressure prevailing within the buoy.

With the valve arrangement described above, the valve 35 serves to regulate the pressure within the buoy at a value determined by the adjustable stress of the spring 39. Thus in a normal cycle of operation compressed air is supplied to the inlet 22, whereupon the check valve 26 is opened and the compressed air permitted to pass on into the buoy, the regulating valve 35 remaining closed due to the fact that its upper face is of greater area than its lower one and that the spring 39 moreover augments the effect of fluid pressure on the upper face. Having thus filled the buoy with compressed air until it is fully distended and hence floating on the water, the inlet 22 is connected to atmosphere. Thereupon the check valve 26 snaps closed, but the pressure on the upper face of the regulating valve 35 being relieved, such valve opens and bleeds air from the buoy through the opening 34 and communicating passage 33 past the open valve 35 and thence through the chamber 32 and connecting branch passage 31 to the inlet 22 open to the atmosphere. This bleeding continues until the air pressure in the buoy diminishes to a point at which its effect on the valve element 35 is overcome by the spring 39 and the valve element closed. In the course of such bleeding of air from the buoy the exteriorly applied water pressure imparts a gradual collapsing movement to the elements of the buoy so that its displacement is progressively decreased. Consequently the buoy slowly sinks until the regulating valve 35 closes, the depth of submergence being thus accurately determined by the adjustable spring 39. It will be obvious that in carrying out the foregoing procedure the buoy need not be raised all the way to the surface from the bottom. Instead only enough air may be pumped in to raise it slightly above the desired level of submergence and the supply line then opened to atmosphere. One of the obvious inherent advantages of my structure is that air pressure may be applied to the air line or inlet port to serve as an additional force on the bleeder valve tending to keep it closed, and alternatively vacuum may be applied to the line to assist the pressure within the buoy to open the valve. Such pressure or vacuum may be applied whenever necessary as an additional control of the level of submergence.

Buoys of the type described above are useful in a wide variety of installations. To name but a few, they may be used in supporting antisubmarine nets in channels or harbor entrances or bordering anchorages, or in supporting anti-torpedo nets about anchored vessels, in mooring vessels or planes. To afford a somewhat better perception of their utility, a protective net installation for a channel or harbor mouth has been illustrated more or less schematically in Figs. 7 and 8. As there indicated two steel nets 42, 43 are supported across a harbor mouth by a series of buoys 44, each of the construction heretofore detailed. The adjacent ends of the nets are overlapped and the lower edges of the suspended nets permitted to lie on the bottom so that the channel is completely closed. The buoys 44 for the two nets 42, 43 may be supplied with compressed air from shore mounted compressors 45 through individual hose lines 46, each connected to its corresponding buoy by a coupling or nipple 46a (see

Fig. 5). It will be noted in Figs. 7 and 8 that the bottom of the net follows irregularities of the ocean floor. However, in order to insure that submarines do not take advantage of the deeper irregularities to make their way under the net, and to insure that the lower edge of the net remains in contact with the bottom, such net may, as is common practice well known in the art, be anchored to the bottom by any desired means.

In such an installation as that illustrated (Figs. 7 and 8) the regulating valves of the several buoys 44 are preset so that the buoys will float submerged a few feet below the surface with the nets suspended as shown in Fig. 7. The net installation is therefore not only hidden from enemy observation, but in addition the buoys are protected from gunfire or strafing in contrast with ordinary surface buoys which constitute easy, stationary targets.

To open the channel for passage of a friendly vessel, as indicated at 47 in Fig. 8, it is necessary merely to collapse the buoys for one of the nets. For example the intake of the compressor 45 for the buoys 44 of the net 43 may be closed and a slight vacuum pumped in their lines 46 by such compressor. Thereupon the valve elements 35 of such buoys open and they collapse, dropping the net 43 as shown. After the vessel has passed, the tender has only to adjust the compressor to pump air through the lines 46 to restore the net 43 to its original position (Fig. 7). It will thus be seen that powerful tugs or other net tending vessels are not required for hauling the nets into and out of position to permit passage of vessels, nor is any clearance required between the lower edge of the net and bottom of the channel to facilitate haulage without dragging of the net on the bottom.

I claim as my invention:

1. A variable displacement buoy comprising, in combination, a pair of opposed end members joined by a series of telescoping annular wall members to form a hermetically sealed enclosure, said wall members being slidable relative to each other for movement of said end members toward and from each other in varying the displacement of the buoy, means for positively limiting the movement of said end members both toward and from each other with the limit positions such that the buoy is respectively of sinking and floating displacement dimensions in water, with reference to its weight, when the end members are in corresponding ones of said limit positions, and valve means for admitting pressure fluid to the interior of the buoy for distending the same from collapsed position and for withdrawing fluid from said buoy for restoring said buoy to said collapsed position.

2. A variable displacement buoy comprising, in combination, a nested series of annular wall members each of successively lesser diameter than the next, top and bottom members fixed respectively to the largest and smallest wall members of the series and closing the same, said wall members having annular outturned flanges on the ends thereof adjacent said top member and intumed flanges on the ends thereof adjacent said bottom member, said flanges being dimensioned for overlap of each intumed flange with reference to the outturned flange on the next smaller wall member, an annular packing ring of yieldable non-metallic material disposed between the adjacent faces of said wall members intermediate the outturned and intumed flanges projecting from each pair of the same, and means for

admitting pressure fluid to the interior of the buoy for distending the same.

3. A variable displacement buoy comprising, in combination, a nested series of annular wall members each of successively lesser diameter than the next, opposed convex top and bottom members fixed respectively to the largest and smallest wall members of the series and closing the same, said wall members having annular outturned flanges on the ends thereof adjacent said top member and intumed flanges on the ends thereof adjacent said bottom member, said flanges being dimensioned for overlap of each intumed flange with reference to the outturned flange on the next smaller wall member, an annular packing ring disposed between the adjacent faces of said wall members intermediate the outturned and intumed flanges projecting from each pair of the same, and means for admitting pressure fluid to the interior of the buoy for distending the same.

4. A variable displacement buoy comprising, in combination, a nested series of annular wall members each of successively smaller diameter than the next, top and bottom members fixed respectively to the largest and smallest wall members of the series and closing the same, said wall members having annular intumed flanges on the lower edges thereof and presenting both intumed and outturned flanges on the opposite or upper edges thereof for limiting the relative axial movement of said wall members in the course of distending and collapsing the buoy, and means for admitting pressure fluid to the interior of the buoy.

5. The combination of a buoy volumetrically distensible under the influence of internally applied air pressure, a coupling adapted for connection of the buoy to an air pressure supply line, means defining first and second passages leading from the interior of said buoy to said coupling, a check valve in said first passage for admitting air from such passage to the interior of said buoy while preventing escape from the latter through said first passage, a valve element disposed in said second passage for movement between open and closed positions with reference to a seat in said second passage and with the opposite faces of said element exposed respectively to the pressure within the buoy and to the pressure in the portion of said second passage leading from said coupling, and an adjustable biasing spring urging said valve element toward closed position.

6. In a submersible buoy, the combination of a body structure volumetrically distensible under the influence of internally applied air pressure and having an air inlet, an air line for application of air pressure or vacuum to said inlet and means including a valve unit fixed to said structure having a check valve for admitting into said body structure air supplied to said inlet and having a bleeder valve for automatically bleeding out of said structure and into said air inlet sufficient air to reduce its interior pressure to a preset value said bleeder valve being so constructed as to cause bleeding as long as the pressure in the air inlet is less than the air pressure in said body by a predetermined adjusted amount.

7. In a buoy having telescoping adjacent engaging sections forming concentric annular walls designed for repeated expansion and contraction, an outer engaging section and an inner engaging section, a sealing ring mounted therebetween, said sealing ring having a U-shaped cross section, one leg of said U-shaped cross section in contact with said outer section, the other leg of

said U-shaped section in contact with said inner section, the space between said legs having access to the internal pressure of said buoy, the sealing pressure exerted by said legs being thereby reduced upon decrease in the internal pressure of said buoy, and means associated with said inner section engaging said ring and preventing axial movement thereof with respect to said inner section upon relative movement of said sections.

8. In a buoy having an expansible body adapted for repeated contraction and expansion, a housing including a check valve and a bleeder valve, an inlet port in said housing, a chamber in said housing connected to said inlet port, said check valve arranged exclusively to allow air to pass from said chamber into said buoy upon the exceeding of a given inlet pressure, said bleeder valve arranged exclusively to allow air to pass from said buoy to said chamber upon the exceeding of a given pressure in said buoy, said buoy being sealed so that said inlet port constitutes the normal path for the passage of air into and out of said buoy.

9. In a buoy of the type adapted for repeated expansion and contraction, an inlet port, check valve means associated with said port for the admission of air, a bleeder valve having an entrance side and an exit side for allowing the removal of air from said buoy from said entrance side to said exit side upon pressure within said buoy exceeding the pressure in said port by a predetermined amount, said exit side arranged to discharge air into said inlet port whereby said bleeder valve normally operates out of contact with sea water.

10. In a buoy of the type adapted for expansion and contraction in volume, an inlet port, an air line for application of air pressure or vacuum to the said inlet port, a chamber associated with said inlet port, a check valve controlling the admission of air from said chamber to said buoy, a bleeder valve for allowing air to escape from said buoy, spring means normally biasing said bleeder valve in a closed position but allowing escape of air from said buoy upon the exceeding of a predetermined air pressure in said buoy, said bleeder valve having opposed surfaces exposed to the air pressures of said chamber and the interior of said buoy respectively, whereby the application of pressure within said chamber tends to keep said bleeder valve closed and whereby the application of vacuum in said chamber tends to open said bleeder valve against the force of said biasing means thereby to determine the pressure maintained in said buoy.

11. In a buoy adapted to be expanded and contracted upon the respective admission or withdrawal of air; an inlet port; a check valve and a spring-biased bleeder valve, effective respectively to add air to and exhaust air from said buoy, each of said valves having access to said inlet port and so arranged that a given pressure in said inlet port is effective to produce an additive effect with said spring bias to retain air contained in said buoy up to an air pressure in said buoy which is higher than that existing in said line.

12. The combination comprising a buoy distensible under the influence of internally applied fluid pressure, an air line, first valve means for admitting air from said air line to the interior of said buoy, second valve means for releasing air from said buoy, said second valve means being arranged so that the pressure in said air line is applied to one of the faces thereof in a valve closing direction and said second valve member

having a biasing spring for biasing the same in the valve closing direction so that the air retained in the buoy may exert a pressure which is greater than the pressure in the air line by a predetermined magnitude.

13. In a buoy distensible under the influence of internal air pressure to vary its buoyant effect, a bleeder valve for limiting the internal pressure to a predetermined magnitude, a load producing a downward force on said buoy, said bleeder valve being adjusted to maintain a pressure within said buoy resulting in a volume at a given depth which produces sufficient buoyant effect at said given depth to equal said downward force whereby no net upward or downward force exists at said given depth tending to change the depth of said buoy, an air line having means for applying air pressure thereto during inflation of said buoy, said bleeder valve arranged to discharge into said line, whereby the absence of discharged air in said line may serve as an indication that said buoy has not descended appreciably below said given depth.

14. In a buoy of the type adapted to increase in volume upon an increase in internal pressure, an adjustable bleeder valve for maintaining the pressure within said buoy below a preset magnitude, a gravity load freely suspended from said buoy, said load and the weight of said buoy producing a downward force on said buoy, said adjustable bleeder valve being preset to maintain such magnitude of internal pressure that at a predetermined submergence the volume of said buoy produces a buoyant force equaling said downward force thereby removing any tendency at said predetermined submergence for the buoy to move upwardly or downwardly.

15. The combination comprising a buoy for use in a body of water distensible under the influence of internally applied fluid pressure, said buoy having an inlet for pressure fluid, a check valve in the inlet and a bleeder valve for discharging excess pressure fluid from said buoy into the pressure fluid inlet, said bleeder valve being spring biased against said internally applied fluid pressure and being selectively presettable to discharge excess pressure fluid upon the internally applied fluid pressure exceeding the pressure in said inlet by a predetermined amount, and a suspended vertically distributed gravity load attached to said buoy, said load being of such length as to engage the bottom of the body of water and to be increasingly borne thereby as the distance between said buoy and said bottom decreases.

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