

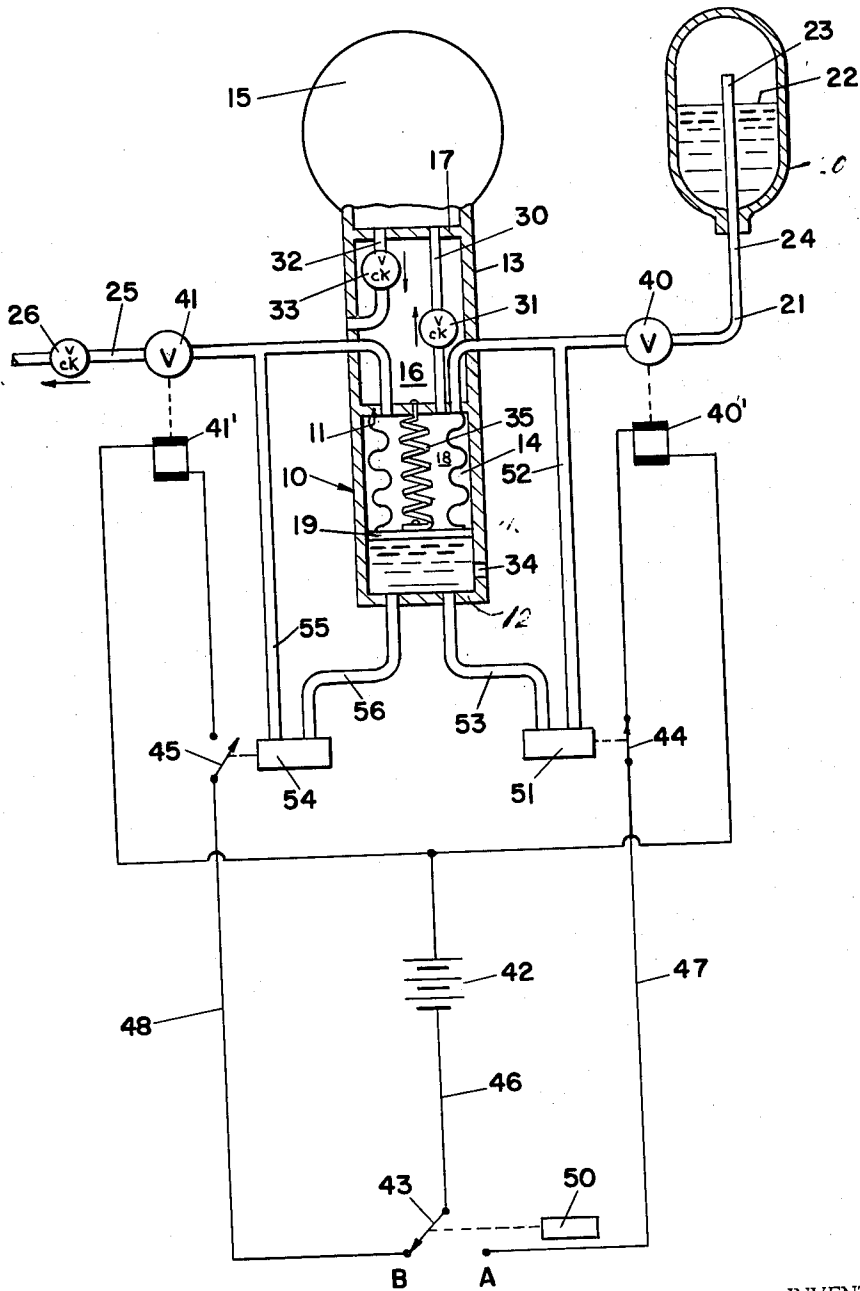
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FLOTATION APPARATUS AND ELECTRICAL CONTROL THEREFOR

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FLOTATION APPARATUS AND ELECTRICAL CONTROL THEREFOR

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7 Claims. (Cl. 9-8)

This invention involves flotation and is concerned particularly with apparatus for locating or positioning a device in a body of water and for controlling the movement of the device.

The apparatus or system of the invention consists of an electro-mechanical assembly of elements which are arranged to coact automatically for suspending another device beneath the water surface. The mechanical side of the assembly is made up of a control chamber which includes a pneumatic section in communication with a pressure medium and a liquid section in communication with the body of water. Pressure gas is supplied to and removed from the pneumatic section for regulating the water volume in the liquid section. The electrical side of the assembly includes a power source and pressure switches which are adjustable to control the gas pressure in the pneumatic section for operating the device at a selected depth for a predetermined time period.

The principal object of the invention is to provide flotation apparatus for suspending a device in a body of water at a preset depth and period of time.

Another object of the invention is to provide flotation apparatus which is constructed of a multiplicity of operating parts arranged as a unitary assembly.

Another object of the invention is to form a flotation apparatus of a multiplicity of elements which are arranged to coact automatically to attain a preset depth for a predetermined period.

Another object is to provide a flotation apparatus which is relatively inexpensive to produce and to operate.

Other objects and advantages will become apparent from the following detailed description of the invention taken in conjunction with the accompanying drawings in which the single figure of the drawing is generally a schematic diagram of the apparatus or assembly with certain elements sectioned to show essential details.

Referring to the figure, a housing is indicated at 10 and may, for example, be simply a cylinder formed as shown by a top wall 11, a bottom wall 12 and side wall 13 to form a control chamber indicated at 14 when the unit or housing has a gravimetric weight less than the displaced weight of liquid in which it is used. When the gravimetric weight of the unit is greater than the displaced weight, other buoyancy is required and may, for example, take the form of an inflatable bag or container shown at 15 and accordingly the housing 10 may be modified as shown to provide an upper compartment 16 having a supporting wall 17 for attachment of the inflatable bag or container 15. The control chamber 14 is provided with a bellows type cylindrical control diaphragm 18 which has its upper end open and secured adjacent the top 11 and a lower closed end formed by a plate 19.

A gas source is shown at 20 for supplying gas to the diaphragm 18 by conduit 21. The gas source comprises a closed chamber for a high pressure gas which is maintained at an absolute pressure that is higher than the maximum pressure at which other equipment of the system, which will be described later, is set to operate. Liquid carbon dioxide has been found satisfactory for pressure depths in sea water of around 500 feet. Below that depth nitrogen may be used. Consider the gas source to be liquid carbon dioxide at a level indicated by

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the line 22 and having a siphon conduit 23 extending into the carbon dioxide positioning its inlet end above the level 22 and its outlet end 24 connected to the conduit 21 for supplying the carbon dioxide in gaseous form to the diaphragm 18. An outlet conduit 25 has one end communicating with the cylindrical diaphragm 18 and its other end arranged to vent gas from the diaphragm 18 to the sea water and is provided with a check valve 26.

When the inflatable container 15 is used, a tube 30 having a check valve 31 therein provides communication between the diaphragm 18 and the inflatable container but prevents gas from returning to the control diaphragm 18. Another tube 32 has a check valve 33 therein which permits gas to pass into the sea water in order to reduce pressure in 15 and also functions to prevent the admission of sea water to 15.

The control chamber 14 is apertured at 34 adjacent the lower wall 12 to provide direct communication with the body of sea water. The plate 19 of the control diaphragm forms with the lower wall 12 a liquid section, the volume of which decreases in accordance with pressure increase in 18 and conversely increases as the pressure in 18 decreases. The plate 19 is spring loaded by means of a return spring 35 connected to the top 11 of the housing and the plate 19 and functions to constantly urge the plate 19 against pressure in control diaphragm 18 and toward the top 11 in retracted position. The level of liquid in the lower section of the compartment 14 is thus controlled in accordance with the pressure of gas in control diaphragm 18.

For the purpose of automatically regulating the gas supply to and removal of gas from the control diaphragm 18, a first solenoid operated valve 40 is provided in conduit 21 and a second solenoid operated valve 41 is provided for conduit 25. Energy for operating these valves is provided by a source of electrical power such as the battery 42 which may be of the nickel cadmium type. The control arrangement for the valves comprises a single pole double throw absolute pressure switch 43 connected with the battery 42 by conductor 46, with solenoid 40' by conductor 47 having a single throw switch 44 therein and with solenoid 41' by conductor 48 having a single throw switch 45 therein. The switch 43 is set for operation at a selected pressure depth and will move selectively to contact A when the flotation unit is below the selected depth and to contact B when the unit is above the selected depth.

Switches 44 and 45 will operate in accordance with the differential pressure between the gas in diaphragm 18 and the sea water. Switch 44 is normally closed, as shown, and when the differential pressure between gas in 18 and the water reaches a predetermined value, for example, 10 p.s.i.d., this switch opens. Switch 45 is normally open and closes when the gas pressure differential is, for example, 5 p.s.i.d. above the water pressure. A depth pressure actuator 50 is provided for operating switch 43 and is set to operate at a selected depth. A differential pressure actuator 51 is shown connected between inlet pressure conduit 21 and liquid in the lower sea water section of control chamber 14 by tubes 52 and 53 respectively and another differential pressure actuator 54 is connected between the outlet conduit 24 and the lower sea water section of control chamber 14 by tubes 55 and 56 respectively. No detail structure of actuators or sensors 50, 51 or 54 is shown since each item is commercially available to carry out their respective functions.

In operation, the flotation unit is assembled with a device which is to be suspended beneath the surface of the water. Upon ejection into the water, the assembly may be located above or below the pressure depth at which it is set to hover and for explanation purposes as-

sume that the assembly has been ejected at a depth below the preset pressure depth of switch 43. To increase buoyancy of the assembly, the absolute pressure switch 43 moves to contact A and differential pressure switch 44 will then be in circuit with the nickel cadmium battery and the solenoid 40' will actuate valve 40 from its closed to open position. High pressure gas then flows into the control diaphragm 18 and when the inflatable container 15 is used, the gas flows through check valve 31 and into the container. As the control diaphragm 18 expands, water is expelled from the compartment 14 and the assembly will acquire positive buoyancy and ascend. When the gas pressure in 18 reaches 10 p.s.i.d. above the water pressure, the switch 44 will open and valve 40 returns to closed position. The switch 45 will then close since the gas pressure is above 5 p.s.i.d. and switch 43 will move to contact B and energize solenoid 41' to open valve 41 and permit gas to exit through conduit 25, causing the gas pressure in 18 to fall. As the pressure in the control diaphragm 18 drops, return spring 35 retracts the diaphragm and permits more water to enter the water section of the control chamber 14 and the unit will acquire negative buoyancy and begin to descend.

When the unit reaches the lower end of the pressure depth error zone, absolute pressure switch 43 moves back to contact A and the solenoid valve 40 is again actuated to open position, water ballast is expelled from the control chamber 14 and the unit begins to ascend.

The heretofore described flotation unit may be considered a pneumatic discontinuous type servomechanism requiring energy only for its operation when it drifts out of the hovering error zone. The average time period of each cycle of operation of the unit is constantly changing, since gas is expelled each time the device descends and consequently the device loses a fractional amount of its gravimetric weight during each cycle, while the displaceable volume in the water section remains constant. As the cycling proceeds, a point is reached when retraction of the control diaphragm no longer gives the unit negative buoyancy, and the unit will continue to ascend toward the surface of the water where it will float until retrieved.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

We claim:

1. Flotation apparatus for suspending an object in a body of water which comprises

- (a) a housing having an opening communicating with the body of water,
- (b) an expansible container secured within the housing,
- (c) a gas source having an inlet conduit communicating with the expansible container,
- (d) a gas outlet conduit communicating between the expansible container and the body of water,
- (e) means for controlling the volume of gas in the expansible container which comprises,
- (f) a first electrically operated valve in the inlet conduit and a first switch means therefor,
- (g) a second electrically operated valve in the outlet conduit and a second switch means therefor,
- (h) a source of electrical energy and a two position switch connected therewith and
- (i) said two position switch being operable in one position to make circuit with said first switch for regulat-

ing the supply of gas to said container and said two position switch being operable in its other position to make circuit with said second switch to regulate the removal of gas from the container whereby the volume of water in the container may be varied for changing the depth of the object in the body of water.

2. Flotation apparatus as in claim 1, further characterized by

- (j) an inflatable buoyant container exteriorly of the housing,
- (k) a tube providing communication between the expansible container and the buoyant container and
- (l) valve means in said tube permitting the passage of gas into the buoyant container from the expansible container and preventing the passage of gas from the buoyant container into the expansible container.

3. Flotation apparatus as in claim 1, further characterized by

- (j) an inflatable buoyant container exteriorly of the housing,
- (k) a first valved tube between the expansible container and the buoyant container for inflating the buoyant container and maintaining it in inflated condition and
- (l) a second valved tube communicating between the buoyant container and the body of water for preventing over pressurizing of the buoyant container.

4. Flotation apparatus as in claim 1, further characterized by

- the housing of section (a) having an opening communicating at its lower end portion with the body of water and the expansible container of section (b) being in the form of a bellows secured at its upper end adjacent the upper end of the housing and positioning its lower end for the expulsion of water from the housing when the container is expanded.

5. Flotation apparatus as in claim 4, further characterized by

- the expansible container of section (b) being in the form of a bellows and having means for biasing its lower end toward its upper end to contracted position under decreasing pressure conditions in the container.

6. Flotation apparatus as in claim 1, further characterized by

- both the first switch of section (f) and the second switch of section (g) being operable in accordance with the differential pressure between the gas pressure in the expansible container and the water pressure in the body of water and the two position switch of section (h) being operable at a preset pressure depth in the body of water.

7. Flotation apparatus as in claim 1, further characterized by

- the first switch of section (f) being operable to supply gas to the expansible container when the two position switch is below a preset pressure depth and the second switch is operable to remove gas from the expansible container when the two position switch is above a preset pressure depth.

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