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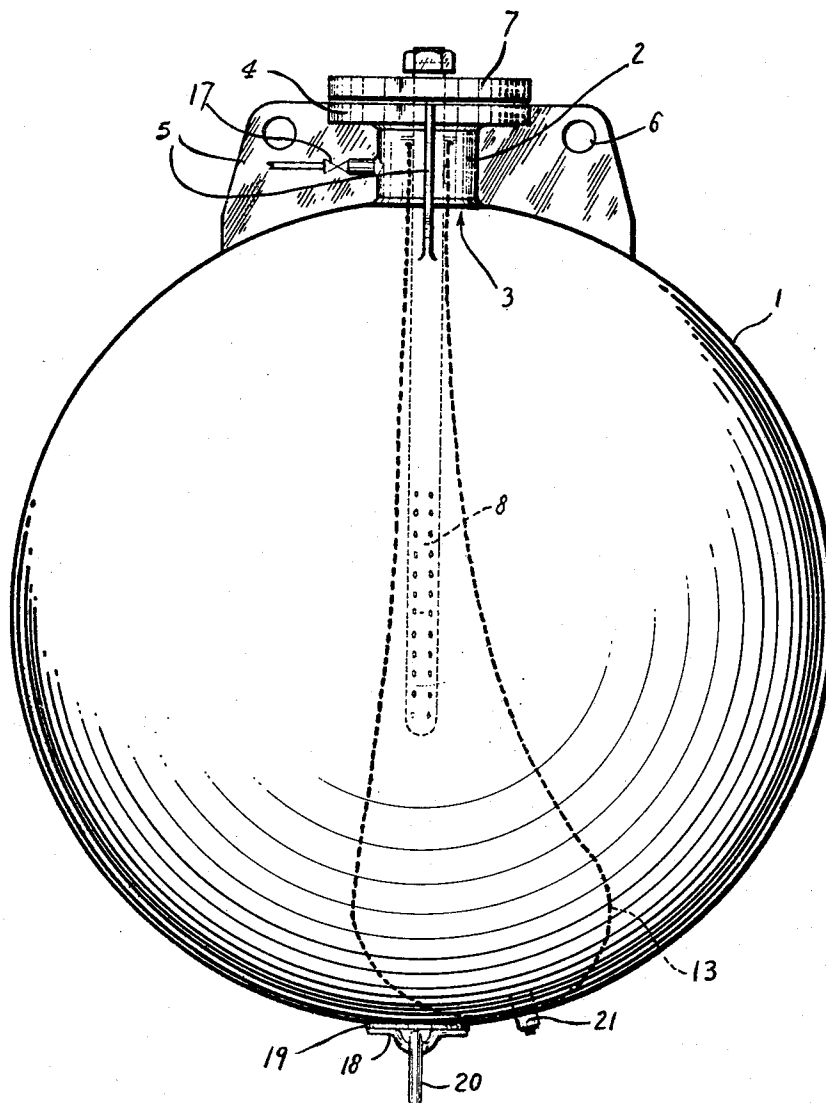
J. DELARUELLE ET AL
FLOATS

3,114,920

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3 Sheets-Sheet 1

FIG-1-



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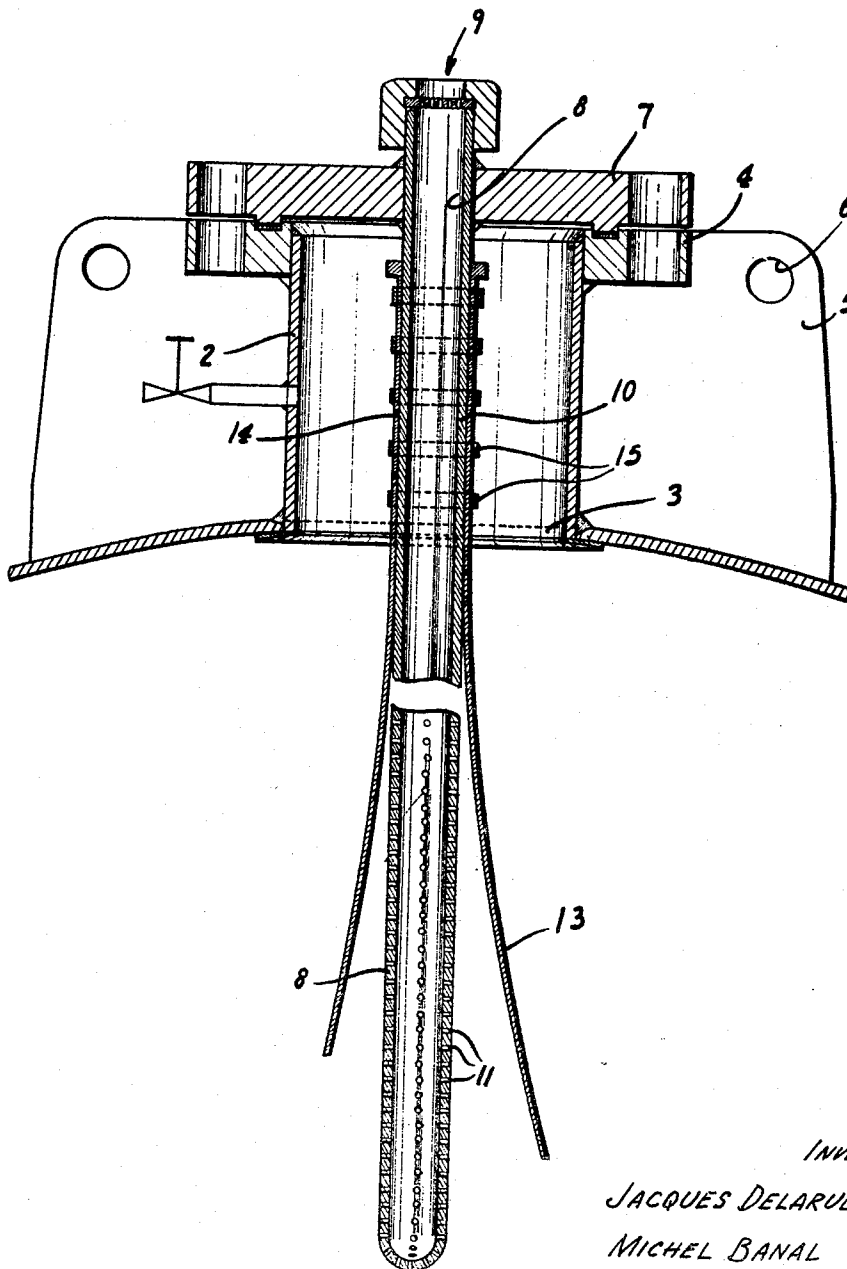
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3 Sheets-Sheet 2

FIG - 2 -



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3,114,920
FLOATS

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Claims priority, application France June 2, 1960

10 Claims. (Cl. 9—8)

This invention relates to floats, and in particular to floats intended for holding submarine cables and pipelines (hereinafter referred to as "submarine tubes" for simplicity) according to the techniques described in the specification of French Patent No. 1,206,378 of the 14th of August 1958, and the specification of a French patent application of the 4th of August 1959, filed as an application for a patent in addition to French Patent No. 1,206,378, as well as in the specification of our co-pending patent application No. 99,148 filed March 29, 1961.

This invention concerns floats of the type comprising a buoyancy mass which is fluid and compressible, and an object of the invention is to provide means permitting the utilisation of variations of the volume of this type of buoyancy mass as a function of the depth of immersion of the float. For floats in which the buoyancy mass is liquid, it is a subsidiary object of the invention to avoid crushing of the envelope due to the inevitable compressibility of the liquid.

A more particular object of the invention consists in the provision of a float having a buoyancy which is variable with the depth of immersion for use in one of the techniques described in the specification of our above-mentioned co-pending patent application.

According to the invention there is provided a buoyancy float, comprising a rigid envelope, and a flexible envelope formed from an impermeable material surrounded by the rigid envelope, the envelopes defining two chambers, the first of which contains a buoyancy mass comprising an elastic fluid under a pressure equal to the hydrostatic pressure corresponding to a predetermined immersion depth, and the second of which is in communication with the outside of the float to permit entry of the surrounding liquid into the second chamber when the float is immersed.

With this arrangement, any variation of the volume of the buoyancy mass is automatically compensated by an inverse variation of the volume of the surrounding liquid: the system is maintained under balanced pressure and any direct contact is avoided between the surrounding liquid (in general sea water) and the buoyancy mass.

A buoyancy float, the buoyancy of which decreases when the float is immersed beyond a given depth, may employ a gaseous buoyancy mass charged under a pressure of inflation corresponding to the hydrostatic pressure at the selected depth.

Alternatively, a buoyancy float, the buoyancy of which varies slowly when the float is immersed may employ a liquid buoyancy mass.

In order to enable the invention to be more readily understood, reference will now be made to the accompanying drawings, which illustrate diagrammatically and by way of example two embodiments thereof, and in which:

FIGURE 1 is an elevational view of a spherical float containing a compressed gas;

FIGURE 2 is a sectional view, on a larger scale, showing a detail of the float shown in FIGURE 1, and

FIGURE 3 is an elevational view of a cylindrical float containing a liquid charge.

Referring now to FIGURES 1 and 2, there is shown a buoyancy float for submarine tubes, the float being

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constituted by a hollow metallic sphere 1 of welded steel, of which the diameter and thickness will be chosen in accordance with the conditions under which the float will be used. A short radial neck 2 is welded to the sphere 1 and carries at one end a circular opening 3 and at the other end a collar 4, the neck being braced by four gussets or vanes 5 placed at 90° to one another. Two diametrically opposed vanes are each formed with a hole 6 capable of receiving a ring.

The neck 2 is closed by a solid plate 7 formed with bolt holes registering with bolt holes in the collar 4, and the plate 7 carries at its centre a respiration tube 8. One end of the tube 8 protrudes beyond the plate 7 and is provided with a strainer 9 whilst the internal part of the tube 8 in the region situated in the interior of the neck 2 comprises a channelled surface 10. The remainder of the tube extends radially into the sphere and is formed with numerous small holes 11, the tube terminating in a rounded end.

The diameter of the neck 2 is sufficient to allow the introduction of a bladder 13 of impermeable fabric having a reinforced nozzle 14 adapted to be engaged on the channelled part of the respiration tube 8 and to be fixed and sealed there by a series of screw-clamps 15. If desired, the nozzle 14 may be bonded on to the channelled surface 10. In an inflated state, the bladder 13 constitutes a spherical balloon with a diameter slightly greater than the internal diameter of the sphere. A mouthpiece 16, equipped with a compressed air valve 17, is welded on the neck 2, and at the lower part of the sphere opposite the opening 3, a bracket 18, which is welded on a plate 19, supports a ring 20 of cast-iron on which a support cable for the submarine tube can be fastened. A drain 21 blocked by a solid bush is welded as close as possible to the plate 19.

In the use of the float, the sphere is fitted with the bladder 13 and the plate 7 is carefully bolted down on to the collar 4 so as to ensure a perfectly sealed closure. The float is then inflated by connecting the mouthpiece 16 to a source of compressed air at a predetermined pressure. The pressure of air causes the bladder 13 to wrap itself closely around the respiration tube 8.

In the course of the progressive immersion of the float, water flows in through the strainer 9 into the respiration tube 8, but first remains confined in the interior of the latter. When, however, the hydrostatic pressure of the ambient medium exceeds the inflation pressure, the water will escape through the holes 11 of the respiration tube to the interior of the bladder 13 and increase the volume of the latter at the expense of the volume of the air which is compressed according to Mariotte's law, so that the buoyancy of the float decreases to become nil and finally negative, the procedure being reversed and the buoyancy increasing as the float is raised.

So that the float always has a positive buoyancy, there is linked to it a second float (not shown) of polystyrene, for example, adapted to compensate the weight in the water of the metallic part of the float and its accessories.

A certain number of the floats just described may be hooked at regular intervals along an immersed tube, so that if v is the volume of float added per linear metre of the tube, and h_1 is the hydrostatic pressure (in metres of water) corresponding to the inflation pressure, the corresponding buoyancy will remain equal to v whilst the depth of immersion h is less than h_1 , neglecting the weight of the air introduced under pressure and by assuming that the density of the liquid is equal to one.

For a depth h greater than h_1 , the buoyancy becomes:

$$v = \frac{h_1 + 10}{h + 10}$$

The buoyancy exerted by the assembly of floats on an immersed tube up to a depth H thus becomes:

$$F = v \left(h_1 + (h_1 + 10) \log \frac{H + 10}{h_1 + 10} \right)$$

The weight of the tube being equal to pH (where p is the apparent weight per linear metre of the immersed tube), the tube is in equilibrium if $pH = F$ and descends if $pH > F$.

It will thus be seen that it is possible to control the equilibrium or to unbalance it by varying the v , and thus by varying the volume and the spacing of the floats and the inflation pressure h_1 .

The impermeable membrane prevents the dissolution of the air in the water, which dissolution would occur at elevated pressure. Furthermore, the use of valves is completely avoided, which is an advantage since the functioning of valves can be subject to failures.

In place of the float which has just been described with reference to FIGURES 1 and 2 where the water can be present at the centre of the container, it is possible to provide an inverse type of float with the air at the centre of the container. In this case, the principle of an inflated spherical balloon which collapses when it is in a medium of which the pressure is greater than its inflation pressure is employed, and the inflated balloon may be placed inside a metallic sphere formed with holes. As in the case of the respiration tube 8 of FIGURES 1 and 2, these holes must have a sufficiently small diameter in order to avoid the effects of pricking. It is furthermore possible to replace or to double the sheet sphere by one or several layers of grids, one of which is very fine in order to avoid the effect of pricking.

In the case of floats using a charge of a liquid having a low density such as light petrol, butane, propane, cylindrical envelopes which could be either efflexible or rigid are preferred. In all cases the compressibility of the liquids, the variation of their density as a function of temperature, and the vapour pressure which necessitates the maintenance in the interior of the envelope of a dead space containing the vapour and which is compressed a substantial amount with the increase of pressure must be taken into account. These different properties act in the same direction and lead to a reduction of the volume with increase of depth, which is much more important when the density is low.

In the case of flexible envelope floats constituted for example of a cylinder of rubberised sheet or of plastic, where the contents are constantly in pressure equilibrium with the surrounding sea water, the envelope only undergoes a compression force perpendicular to its surface. Taking account of the strength of cloths available, the diameter of the cylindrical reservoir constituting the float is in fact limited by the necessity of resisting the vapour pressure of the liquid. This type of float can in practice only be used for light petrol, the use of butane and particularly of propane leading to reservoir diameters which are much too small.

Floats with rigid envelopes are not subject to these limitations and the contraction of the volume of their liquid charge will be compensated, without subjecting the rigid envelope to compression forces by the nitroduct of sea water under the pressure of the ambient medium as described with reference to FIGURES 1 and 2.

FIGURE 3 shows a float having rigid cylindrical envelope for a liquid charge. A reservoir 31 of general cylindrical form is formed from a tube of steel with caps 32 and 33 welded on to it. The end cap 32 carries a neck 34 with a collar 35 closed by a plate 36 carrying, in a manner similar to that which has been described with reference to FIGURES 1 and 2, a respiration tube 38 which is terminated outside the plate 36 by a screen 39 and which is surrounded inside the reservoir 31 by a cylinder 40 of impermeable material closed at

one end and terminated at the other end by a nozzle 41 fixed and bonded on a channelled and non-perforated part of the tube 33.

The metallic reservoir 31 comprises on its upper surface a device 42 for filling and evacuating the reservoir with the liquid (butane or propane) and for controlling of the liquid level, the device 42 also acting as a safety device. On the lower surface of the reservoir, two or more rings 43 and 44 are supported and serve for the passage of the cables for the support of the submarine tube. Another ring 45 is provided on the end cap 33 for towing the float.

When the reservoir is filled with the liquid, the cylinder 40 is completely flattened by the pressure of the liquid and its vapour pressure. As the float is immersed, the contraction of the liquid is compensated by the progressive entry into the cylinder 40 of sea water which can never come into contact with the filling liquid. The system is thus maintained in itself under equal pressure. When the float is raised, the process is reversed, and the water is progressively driven from the cylinder 40.

It will thus be seen that in this case a slow and continuous reduction of the buoyancy is obtained as soon as the float is immersed. However, by arranging in the floats shown in FIGURE 3 an appropriate evacuated space above the level of the liquid and by filling this space with a gas at a pressure higher than the vapour pressure of the liquid, a mixed float can be produced in the sense that the float then functions in part as a liquid float (as shown in FIGURE 3) and in part as a gas float (as shown in FIGURES 1 and 2). However, in practice, it is generally preferable to separate the two types of float.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. An automatically variable buoyancy float, comprising a rigid envelope, and a flexible envelope formed from an impermeable material surrounded by the rigid envelope, the envelopes defining two chambers, one of the chambers being the rigid envelope which contains and permanently confines a buoyancy mass comprising an elastic fluid under a pressure equal to the hydrostatic pressure corresponding to a predetermined immersion depth, and the second of the chambers being the flexible envelope which is in permanent communication with the outside of the float to permit entry of the surrounding liquid into the second chamber when the float is immersed beyond the said predetermined depth.

2. The float of claim 1, wherein the buoyancy mass is a gas.

3. The float of claim 1, wherein the buoyancy mass is a liquid.

4. The float of claim 1, wherein the buoyancy mass is a composite mass comprising a liquid mass surmounted by a mass of gas compressed to the predetermined pressure.

5. An automatically variable buoyancy float, comprising a rigid envelope defining a first chamber, a neck member on said envelope, a flexible impermeable envelope defining a second chamber, a neck member on said flexible envelope, a cover for the neck member on the rigid envelope, means securing said cover to said neck member on the rigid envelope, a tube passing through said cover and said neck member into the interior of the rigid envelope, means securing the neck member of said flexible envelope around said tube, and within the neck member of the rigid envelope, means establishing permanent communication between the interior of said flexible envelope and the exterior of the float through the intermediary of said tube, and means on said neck member of said rigid envelope for introducing into said first chamber and permanently confining therein a buoyancy mass at a pressure equal to the hydrostatic pressure corresponding to a predetermined immersion depth.

6. The float of claim 5, wherein said means for estab-

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lishing said communication includes an apertured screen carried on the end of the tube exterior of the float, and a perforated portion of said tube within said flexible envelope.

7. The float of claim 5, wherein the buoyancy mass is a gas. 5

8. The float of claim 5, wherein the buoyancy mass is a liquid which is substantially lighter than water.

9. The float of claim 5, wherein the rigid envelope is spherical.

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10. The float of claim 5, wherein both said envelopes are substantially cylindrical.

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