United States Patent [19]

Tallman

[11] **3,781,779**

[45] **Dec. 25, 1973**

[54] **GAS IMPERMEABLE EXPANSION DIAPHRAGM**

[75] Inventor: **Charles V. Tallman,** Rye Beach, N.H.

[73] Assignee: **Sanders Associates, Inc.,** Nashua, N.H.

[22] Filed: **Dec. 10, 1971**

[21] Appl. No.: **206,696**

[52] **U.S. Cl.** ..... **340/8 R,** 340/14

[51] **Int. Cl.** **H04b 13/00**

[58] **Field of Search** ..... 340/8, 8 L, 8 LF, 340/11, 12, 13, 14

[56] **References Cited**

UNITED STATES PATENTS

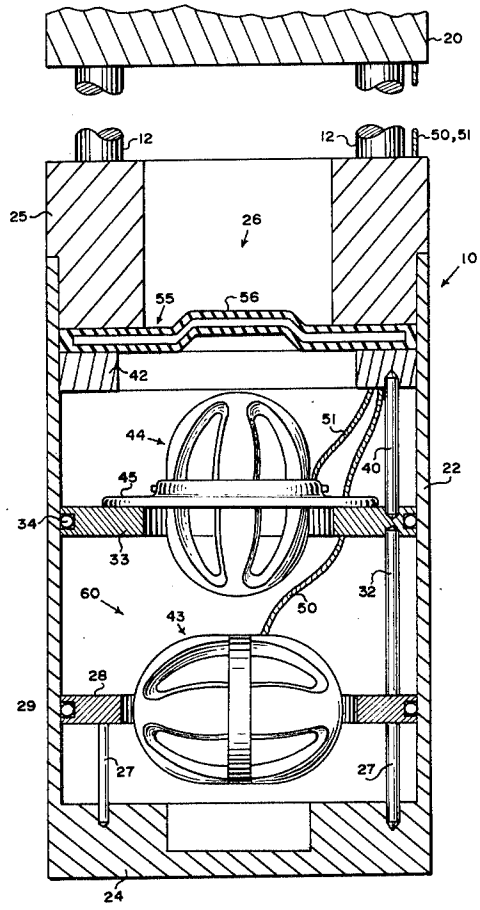
2,451,968	10/1948	Murdock, Jr.	340/11
2,978,669	4/1961	Harris	340/8
2,444,911	7/1948	Benioff	340/8 LF
3,239,801	3/1966	McGaughey	340/8 L
3,550,072	12/1970	Babikyan	340/13 R

Primary Examiner—Benjamin A. Borchelt
Assistant Examiner—H. J. Tudor
Attorney—Louis Etlinger

[57] **ABSTRACT**

A hydrophone assembly for suspension below the surface of a body of water, the hydrophone assembly having a gas impervious diaphragm comprising a layer of elastomer material encapsulating a layer of metal for sealing a closed chamber which is filled with a gaseous evacuated liquid. The diaphragm compensates for changes in volume of the evacuated liquid which occurs with fluctuating temperatures and prevents any penetration of ambient air gases.

8 Claims, 2 Drawing Figures



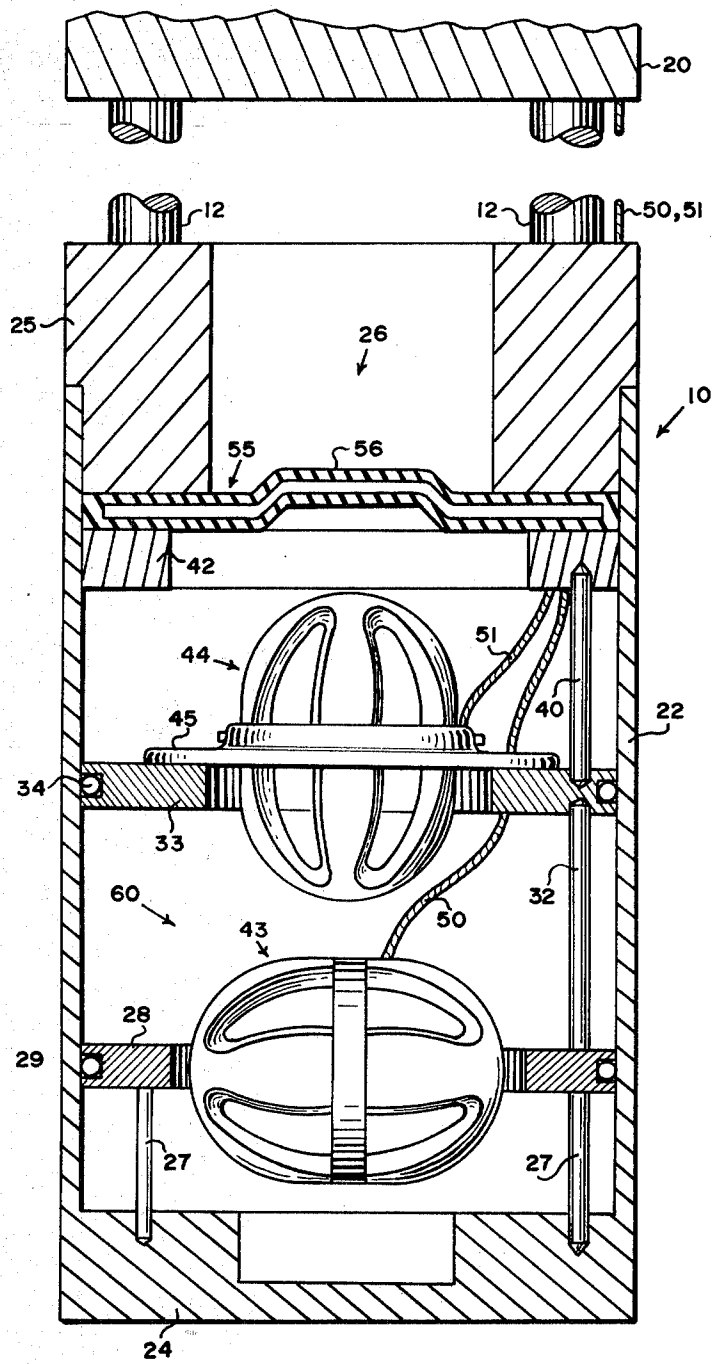


FIG. 1

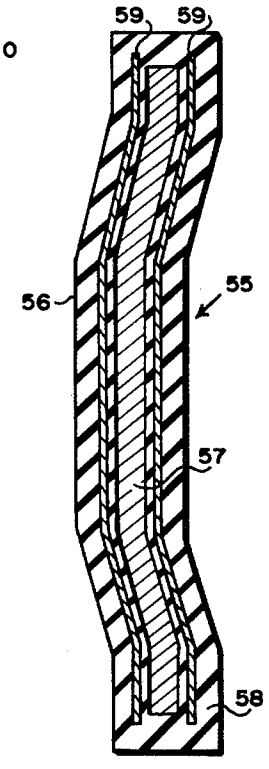


FIG. 2

CHARLES V. TALLMAN
INVENTOR.
BY Ronald B. Willoughby
ATTORNEY

GAS IMPERMEABLE EXPANSION DIAPHRAGM

FIELD OF THE INVENTION

This invention relates to diaphragm assemblies, and more particularly, to gas impervious diaphragm particularly adapted for use in hydrophone assemblies.

The invention described herein was made during the performance of a contract with the Department of the Navy.

BACKGROUND

Hydrophone assemblies are commonly used in sonobuoy systems and are used to detect the presence of underwater acoustic waves produced by a remotely located source. Typically, the assembly comprises hydrophone units positioned within a cavity of a housing with the cavity being filled with oil so as to surround and fill all voids of the hydrophone unit. The housing is then suspended from and electrically connected to a floating surface unit of the sonobuoy system.

The hydrophone unit is designated to generate an electrical signal when an acoustic pressure wave strikes the hydrophone housing. The oil transmits these acoustic pressure waves causing electrical coils positioned circuit to move thereby generating the electrical signal. During assembly of the unit, all gases have been removed from the oil for the presence of gas bubbles may effect the freedom of movement of the electrical coils. More particularly, gas bubbles may prevent or so restrict the movement of the coil assembly as to prevent the detection of acoustic waves. The sonobuoy system arrangements are very useful and have been used very extensively. Sometimes, however, it may be necessary to place the systems in storage for extended periods of time, and it is therefore necessary to provide a permanent impermeable gas barrier between the oil and the surrounding atmosphere.

SUMMARY OF THE INVENTION

Accordingly, it is a primary object of this invention to provide a novel and improved diaphragm assembly.

Another object of this invention is to provide a diaphragm assembly having a metallic element molded in layers of an elastomer material.

It is a further object of this invention to provide a hydrophone assembly which incorporates a gas impervious diaphragm for sealing a chamber containing oil from the atmosphere for extended lengths of time and capable of flexing to compensate for changes in the volume of the oil;

Another object of this invention is to provide a hydrophone assembly which incorporates a diaphragm having a metallic substance molded between layers of elastomer material to provide a permanent air barrier.

According to this invention, these and other objects which will become apparent upon reading the specification are embodied in apparatus comprising a flexible assembly for enclosing and sealing an open end of a housing, the flexible assembly having a metallic substance integrated within a layer of resilient material.

BRIEF DESCRIPTION OF THE DRAWINGS

For a clearer understanding of the invention, reference may be made to the following detailed description and accompany drawing in which:

FIG. 1 is a schematic view, partly in section, of a hydrophone assembly incorporating the invention; and

FIG. 2 is an enlarged sectional view of the gas impervious diaphragm.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a hydrophone assembly, indicated generally at **10**, is shown as it would appear positioned beneath the surface of the water at a desired depth and held there by means of a cable **12**, or by any other means well known in the art, one end of which is secured to unit **20** at the water surface.

The hydrophone assembly structure comprises a generally cylindrical casing or housing **22** having a bottom portion **24** and a top portion or bulkhead **25** with a central opening **26** therein, which portions close the ends of the housing. Three posts, two of which are shown at **27** are supported from the bottom portion **24** and extend upwards where they are fastened to a generally cylindrical supporting ring **28.** Three additional posts, one of which is shown at **32,** extend from the supporting ring **28** to another supporting ring **33** positioned closer to the bulkead **25** with posts **32** being secured to both supporting rings. Three additional posts, one of which is shown at **40,** extend from supporting ring **33** to an auxiliary ring **42** adjacent to the top bulkhead **25.** It will be understood that three posts of each group are angularly displaced in a circular pattern so that not all of them appear in FIG. **1.** A pair of O rings **29** and **34** assist in supporting rings **28** and **33** respectively in lending stiffness to the sides of housing **22.** The hydrophone sensing units, indicated generally by reference characters **43** and **44,** are each generally mounted to support rings **27** and **33,** respectively by four mounting brackets **45,** respectively, (brackets for sensing unit **43** are not illustrated). As explained with reference to the posts above, the brackets are positioned in a generally circular pattern and therefore not all of them appear in FIG. **1.**

The sensing units **43** and **44** are positioned so that their longitudinal (sensitive) axis are substantially perpendicular to each other. The sensing units may be similar to the one set forth with particularity in U. S. Pat. No. 3,550,072, issued to Jirair A. Babikyan, assigned to the assignee of this invention. Briefly, the units include a coil comprising many turns of fine wire, which is supported within the housing structure and further positioned within an air gap in a magnetic circuit. The magnetic circuit may be formed of any material which will provide a sufficiently strong magnetic field across the defined air gap. The air gap of the magnetic circuit is constructed in such a manner that the lines of force forming the magnetic material are perpendicular to the longitudinal axis of the sensing unit. Accordingly, the coil as previously indicated is supported within the sensing unit housing and it is arranged to travel substantially perpendicular to the lines of force forming the magnetic field. Stated in another way, the coil is arranged to travel in a direction parallel to the sensitive axis of the sensing unit. It follows that any axial movement of this coil attributable to underwater pressure waves will cause an electrical signal to be generated in the coil windings as the coil cuts the line of force forming the magnetic field. This signal is led by means of cables **50, 51** through the bulkhead **25** to unit **20** at the water surface **20.** The details of package **20** are not illustrated since they are well known in the art and are not part of this invention.

While the above description describes the hydrophone assembly as having two sensing units, it is to be understood that the number of units will depend upon the requirements of the system and other physical limitations.

Between the auxiliary ring **42** and the bulkhead **25** is positioned a generally circular, flexible gas impervious diaphragm **55**, a feature of this invention. The diaphragm **55** comprises a raised portion **56** which is positioned within the opening **26** of the bulkhead **25**. The function of the diaphragm **55** in part, is to provide a gas impermeable barrier for extensive periods of time. This is successfully accomplished as best shown in FIG. **2** (enlarged view for purposes of clarity) by having the diaphragm comprise essentially a metal insert **57** encapsulated by a suitable, flexible coating **58**, such as an elastomer. Normally, the flexible coating exhibits a greater degree of elasticity than does the metal insert, and for comparison purposes the elastomer will be described as having a unit elastic limit.

Applicant has found that a lead composition characterized by its ductility and ability to undergo repeated flexing cycles, is a preferred element for the metal insert. The physical properties of lead may be found in any metallurgical handbook. Further, applicant has found that it is prefereable to place a fabric **59**, such as Dacron, on each side of the lead when the elastomer is bonded to the lead in the molding process. This fabric maintains the integrity of the lead, that is, the fabric protects the lead from a shearing action caused by the elastomer flowing into the mold and also provides the means for entrapped air and gasses to escape from the mold. Also, if the fabric exhibits very little elasticity, it assists in preventing the elastomer from over stretching during service in the hydrophone assembly and thereby insuring that the lead will not be torn or ruptured. In this fashion, the lead retains the desirable characteristic of gas impermeability even after undergoing repeated flexing cycles. Still another advantage of a lead insert is its non-magnetic properties, a characteristic which insures that a metal insert cannot affect the magnetic circuit in the hydrophone units **43** and **44**.

Further, applicant has found that chlorbutyl rubber is especially suited for the flexible coating **58**, and its physical properties may be found in a chemical handbook. This material also exhibits a high degree of impermeability for a short time duration but is not by itself effective when the unit is to be stored for time periods measured in months.

Describing now the function of the diaphragm **55** including the hydrophone assembly **10** for which it has been adapted, the interior of housing **22** and all the voids therein including the interior area of the sensing units **43** and **44** are filled under pressure with a gas evacuated liquid **60**, such as oil until the assembly **10** is at a completely neutral state. The phrase neutral state as used herein means the pressure on each of the diaphragm surfaces is equal. It is important to maintain this established neutral state at all times to insure accurate and reliable operation of the sensing units, and will be further explained hereinafter. By this, it is meant no gaseous material whatsoever shall be allowed to pass through the diaphragm regardless of how long the assembly **10** may be stored before use, if at all. Also, it is important that the diaphragm be capable of expanding and contracting so as to follow the change in the unit volume of the liquid or, conversely, the change in pressure against the surface of the diaphragm opposite the liquid. The phrase unit as used herein means that volume of liquid which will achieve the aforementioned neutral state for the assembly. Any change in the volume of the liquid such as caused by temperature variations, causes a corresponding change in the surface of the diaphragm within the bulkhead opening, that is, the crown of the diaphragm may go through several flexing cycles while expanding or contracting depending upon the volume of the oil while maintaining the desirable neutral state.

Normally, when the hydrophone assembly **10** is placed into operation, it is transported by an aircraft to the particular destination. If the gasses had penetrated through the diaphragm **55** while the assembly is in storage, the gaseous material would tend to be attracted to each other so as to form larger pockets or bubbles when the assembly **10** is subjected to less pressure at higher elevations, and these bubbles could prevent the hydrophone assembly from operating at all.

When the sonobuoy enters the water, the cold temperatures may cause the oil to contract and the diaphragm must follow to prevent the formation of any voids or air pockets. Also, the diaphragm assists in keeping the water from mixing with the oil.

When the sonobuoy unit is placed in the water, the hydrophone assembly **10** is positioned beneath the water surface at a predetermined depth where pressure waves travelling in the water strike the side **22** or bottom **24** of assembly **10**, and travel through the liquid **60** where the pressure waves cause a moveable coil in hydrophone units **43** and **44** to pass through a magnetic field at a frequency determined by the source of the waves and produce an electric signal which is also a function of the direction of travel of the pressure waves. It is necessary that these moveable coils freely move through the magnetic field.

To insure free movement of the coils, liquid **60** is free of all gasses or gas bubbles since a gas bubble could become positioned within the field of travel of the coil and thereby prohibit or cause erratic movement thereof through the magnetic field. For example, if the coil fails to move then no electrical signal would be generated; or erratic coil movement would produce a false signal; that is, a signal which is not a true function of the direction of travel of the pressure waves. Thus the diaphragm must be gas impermeable for all periods of time.

While in the foregoing, I have described certain preferred forms and methods of practicing my invention, it is to be understood that this description is made only by way of example and not as a limitation thereon for one skilled in the art may make modifications and changes thereto without departing from the true spirit and scope thereof.

What is claimed is:

1. The combination, comprising means having a unit elastic limit for enclosing and sealing an open end of a housing, said housing having a compartment therein filled with a liquid capable of transmitting pressure waves which strike said housing;

said means being substantially parallel with a surface of said housing and responsive to changes in unit volume of said liquid; and

said means being substantially impervious to the passage of gaseous elements, said means having a first, second and third layers, said first and third layer

having a given unit elastic limit and said second layer having a lower unit elastic limit, said second layer being formed from a metallic substance, said matellic substance being gas impervious, and

a layer of fabric positioned between said second layer and at least one of said first and third layers.

2. The combination in accordance with claim 1 wherein said second layer is formed from lead.

3. The combination in accordance with claim 2 wherein said first and third layers are formed from an elastomer.

4. A pressure compensated hydrophone assembly for detecting underwater pressure waves, comprising;

a housing having a compartment therein and an opening at one end;

at least one sensing unit mounted within said compartment, said sensing unit responsive to said underwater pressure waves;

a unit volume of liquid filling said compartment and voids within said sensing unit, said liquid capable of transmitting pressure waves which strike said housing; and

a resilient means across said opening of said housing, said resilient means responsive to changes in the unit volume of said liquid and substantially impervious to gaseous elements, said resilient means comprises a first, second, and third layers, said first and third layers having a given unit elastic limit, said first and third layers being formed from an elastomer, said second layer having a lower elastic unit, said second layer being formed from a non-magnetizable metal, said second layer being substantially gas impervious, and a layer of fabric positioned between said second layer and at least one of said first and third layers, said fabric providing means for gasses to escape when said first, second and third layers are molded thereby preserving the integrity of said second layer.

5. Apparatus in combination with claim 4 wherein said second layer is formed from lead.

6. Apparatus in combination with claim 4 wherein said liquid is free from all gasses.

7. Apparatus for detecting the presence of underwater pressure waves, comprising

a hydrophone assembly for generating signals in response to incident pressure waves, said hydrophone comprising

a housing having a cavity therein and open at one end thereof;

a sensing unit mounted within said cavity, said sensing unit responsive to said underwater pressure waves and arranged to generate a corresponding electrical signal;

a unit volume of liquid filling said cavity and voids within said sensing unit; and

a diaphragm assembly across said opening, said diaphragm responsive to changes in the unit volume of said liquid and substantially impervious to the passage of gaseous elements, said diaphragm assembly comprising a first and third layer of resilient material having a given unit elastic limit, and a second layer of metallic substance having a lower elastic limit positioned between said first and third layers, said second layer being formed from lead and being substantially gas impervious, and a layer of fabric being positioned between said second layer and at least one of said first and third layers to preserve the integrity of said second layer when said first, second and third layers are assembled into an integral unit; and

means for maintaining said hydrophone assembly in position in the region of the underwater waves.

8. Apparatus in accordance with claim 7, wherein said first and third layers of said diaphragm are form from an elastomer.

* * * * *