

- [54] **GAS GENERATOR DEVICE WITHIN AN ENCLOSURE**  
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- [30] **Foreign Application Priority Data**  
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- [52] **U.S. Cl.** ..... 102/90; 9/321; 114/50  
[51] **Int. Cl.<sup>2</sup>** ..... **F42B 11/46**  
[58] **Field of Search** ..... 102/10, 90, 14, 39;  
9/321-327, 9; 114/50, 52, 54

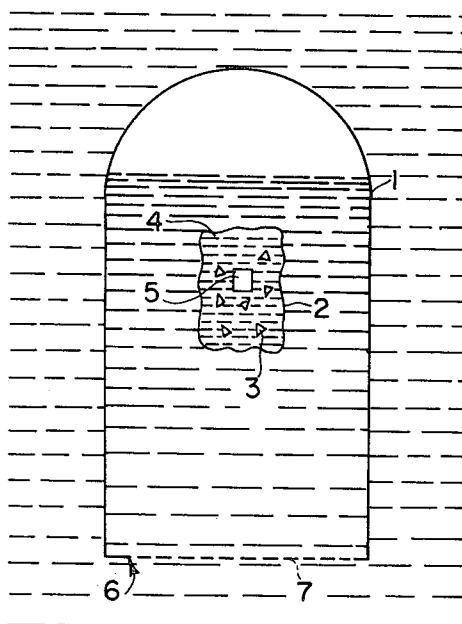
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[57] **ABSTRACT**

A gas generator for filling receptacles comprising a sealed, deformable envelope submerged in a liquid in which envelope is placed a product that reacts with the liquid to produce a gas, and means to tear the envelope at the required time, e.g. by an explosive charge in the envelope fired from a distance. This device can be used to expel water contained in ballast tanks of submarines, or to inflate inflation balloons, atmospheric balloons, or the like.

**7 Claims, 2 Drawing Figures**



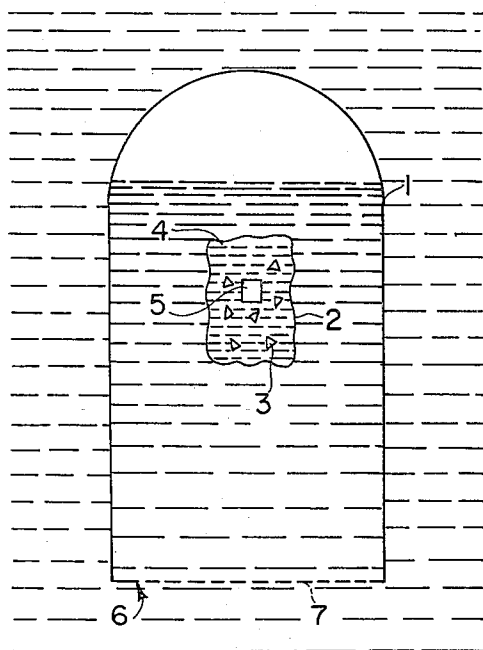


FIG. 1

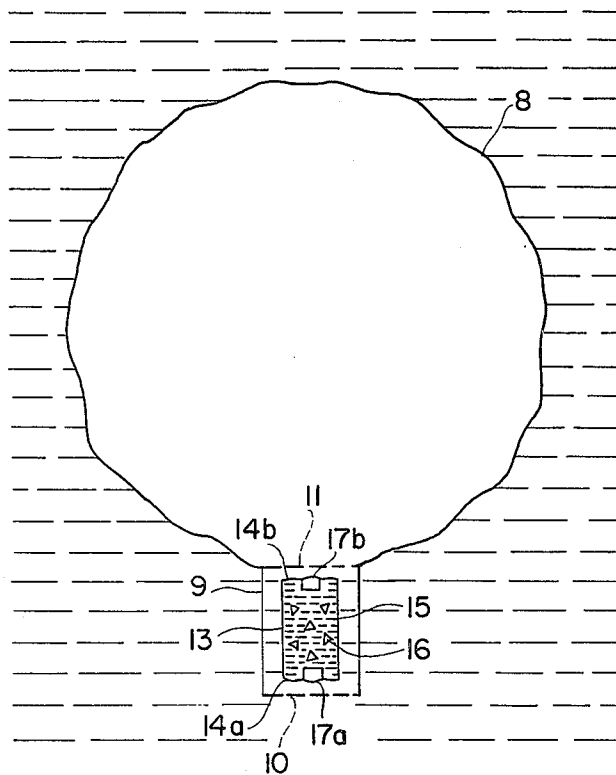


FIG. 2

## GAS GENERATOR DEVICE WITHIN AN ENCLOSURE

### BACKGROUND OF THE INVENTION

The present invention relates to a device for generation of gas by reaction of a liquid with a solid or another liquid. The field involved is that of production of gas in an enclosure, which may be inflatable, or an enclosure that is to be made floatable, e.g. ballast tank, submerged buoy or inflatable balloon.

To discharge submarine ballast, the water contained in the ballast tank can be driven out by gas compressed at a pressure above the hydrostatic pressure that prevails at the submersion depth. This compressed gas may be furnished by receptacles filled with a compressed gas at higher pressure, which is expanded. Such arrangements are heavy and bulky.

A second method consists in producing a release of gas from a reaction of a liquid or solid material that occupies little space. For this purpose there have already been used hot gas generators employing propellants. These generators require an envelope that is resistant to immersion pressure in case of submarine use, and to high internal pressure. Moreover, generators using propellants release hot gases that may entail serious difficulties, namely the possibility of corroding certain temperature sensitive apparatus or materials, e.g. joints made of rubber or elastomeric materials.

An object of the present invention is to develop a gas generator intended to fill an enclosure with gas, the device being of low bulk, light in weight and inexpensive, releasing a considerable amount of gas per unit of weight, and readily remote-controlled, and able to function under very high pressures.

### BRIEF SUMMARY OF THE INVENTION

The foregoing and other objects apparent to those having ordinary skill in the art are achieved according to the invention by means of a device comprising a sealed, deformable envelope inside of which there is a solid or liquid material capable of causing a release of gas on contact with a liquid, and means for tearing the envelope at the required moment, putting the solid or liquid product into contact with the liquid.

Preferably, the envelope is filled with a liquid that does not react with the solid or liquid material. The solid or liquid material is preferably a calcium or lithium hydride which reacts with water, producing a release of hydrogen. In this case, the liquid that fills the envelope may be a mineral oil or petrolatum, for example: these substances do not react on calcium or lithium hydride.

In numerous applications, it is necessary to trigger the release of gas from a distance. For such applications, said envelope contains, in addition, an explosive charge, and means are provided for remote control of the detonation of said charge, to cause tearing of the envelope.

The invention is thus a new product constituted by a gas generator for filling an enclosure.

The advantages of this new generator are the following:

The generator is very light and of little bulk. In fact, the ratio between the weight and volume of the solid or liquid product on the one hand and the volume of gas obtained on the other is very low, and the supplement-

ary weight and bulk introduced by an entirely flexible envelope are negligible. Thus 0.6 liters of solid carbide release 1000 liters of gas at atmospheric pressure.

The generator can operate under very high pressures, of several hundred bars, corresponding to immersion to several thousand meters. In fact, the flexible envelope transmits the hydrostatic pressures integrally. It is not therefore subject to any constraints, and it can tolerate very high pressures. In order to improve the transmission of hydrostatic pressures and to avoid tearing of the flexible envelope in contact with hydride particles, the envelope is filled with a liquid, e.g. petrolatum.

The remote control of the start of release of gas is readily effected by tearing the envelope. The firing of an explosive charge is a preferred means for effecting this telecommand, because there are many conventional ways to trigger a pyrotechnic charge either by electric conductors, by electromagnetic, or acoustic signals. On the other hand, the gas release is produced very rapidly, as soon as the carbide is put into contact with water, which allows triggering an operation at a precise instant.

The generator of the invention can be used for inflation of atmospheric balloons because of its lightness and because it releases hydrogen, which is lighter than air.

Generators of the invention, of slight volume, can be made inexpensively, which makes it possible to use them in applications that do not require large volumes of gas, e.g. for inflation of buoys, inflation floats or atmospheric balloons.

### DETAILED DESCRIPTION

The following description refers to the attached drawings which represent embodiments of the invention given as examples, without limitative character.

FIG. 1 is a diagrammatic view in section of a device of the invention, placed in a water-filled enclosure.

FIG. 2 is a diagrammatic view in section of a device of the invention, attached to an inflatable balloon.

FIG. 1 shows an enclosure 1 filled with water, e.g. submarine ballast, a buoy, a tank or a bell. This enclosure is submerged and presents at the base at least one opening 6 with a grid 7 across which it communicates with the medium that surrounds it.

In this enclosure there is placed a device of the invention, intended to produce a release of gas at the desired time in enclosure 1, forming a bubble in the upper part and modifying the buoyancy of enclosure 1.

For the sake of clarity in the drawing, the device of the invention is shown on a scale that is considerably larger than that of enclosure 1.

The device of the invention comprises a sealed envelope 2 which is flexible and which may be torn, containing a solid or liquid material, e.g. calcium or lithium hydride 3, bathed in petrolatum 4.

Since envelope 2 also contains an explosive charge 5, it can be fired at a distance.

The operation is as follows:

When it is desired to expel the water from enclosure 1, e.g. to cause a rise to the surface, a remote-controlled detonation of charge 5 is effected, which causes the bursting of envelope 2. The hydride particles are then in contact with the water, and there is immediately an abundant release of gas. The gas forms a bubble in the upper part of enclosure 1. The hydride particles are held in enclosure 1 by grid 7.

FIG. 2 shows another application.

A device of the invention is hooked to a submerged inflatable balloon 8, e.g. an inflation balloon for floating a submerged body. The device of the invention serves to inflate balloon 8 at a specific moment, by remote-controlled inflation.

The device comprises a reaction chamber 9 furnished in its lower part with an opening 10 that is in communication with the aqueous medium, and in the upper part with openings 11 for passage of gases which communicate with the interior of balloon 8. Chamber 9 is filled with water. In this chamber there is disposed a closed envelope 13, sealed at its two ends by diaphragms 14a and 14b, which are readily torn.

Envelope 13 is filled with petrolatum 15, in which there are immersed particles of calcium or lithium hydride 16, and explosive charges 17a and 17b, furnished with a remote-controlled triggering device, acting for instance by means of acoustic waves.

A device similar to that of FIG. 2 can be used to inflate atmospheric balloons.

A device of the invention can be utilized to drive out water contained in submarine ballast tanks as well as in a reservoir, buoy or submerged bell, or to inflate submarine inflation balloons or atmospheric balloons, this listing not being limitative.

Of course, without exceeding the scope of the invention, various equivalent modifications could be applied by the specialist to the gas generators just described solely as example. The pyrotechnic device can be replaced by a mechanical device that opens the envelope.

What is claimed is:

1. A gas generator device for an enclosure comprising a sealed, flexible, deformable envelope which, in use, is surrounded by a high pressure reactant liquid and inside of which is disposed a solid gas generating material for releasing a gas when in contact with the reactant liquid, said envelope further containing a non-reactant liquid and means for tearing said envelope at a desired time so as to put said solid material into contact with said reactant liquid to release said gas into the enclosure, said envelope tearing means comprising an explosive charge and said device further including means for providing remote-controlled denotation of said charge to thereby cause tearing of said envelope.

2. A device as in claim 1, wherein said solid material is a hydride that reacts with water to produce hydrogen.

3. A device as in claim 1 wherein said non-reactant liquid in the envelope comprises a mineral oil.

4. A device as in claim 1, wherein said deformable envelope comprises a pouch.

5. A gas generating device comprising a reaction chamber furnished in its lower part with an opening for the passage of a liquid and in its upper part with an orifice for the passage of a gas, an enclosure surmounted above said reaction chamber positioned to receive gas from said reaction chamber, a sealed, flexible deformable envelope inside said reaction chamber which, in use, is surrounded by a reactant liquid which enters said chamber through said opening and inside of which is disposed a solid gas generating material for releasing a gas when in contact with the reactant liquid, said envelope further containing a non-reactant liquid and means for tearing said envelope at a desired time, to put said solid material into contact with the liquid in said reaction chamber to release said gas through said orifice into said enclosure, said envelope tearing means comprising an explosive charge, and said device further including means for providing remote-controlled denotation of said charge to thereby cause tearing of said envelope.

6. A gas generator device for an enclosure comprising a sealed, flexible, deformable envelope which, in use, is surrounded by a high pressure reactant liquid and inside of which is disposed a solid gas generating material for releasing a gas when in contact with the reactant liquid, said envelope further containing a non-reactant liquid, said device further comprising means for tearing said envelope at a desired time so as to put said liquid material into contact with said reactant liquid to release said gas into the enclosure, said envelope tearing means comprising an explosive charge and said device further including means for providing remote-controlled denotation of said charge to thereby cause tearing of said envelope.

7. A device as claimed in claim 6 wherein said non-reactant liquid comprises a mineral oil and said deformable envelope comprises a pouch.

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