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Gilbert et al.

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[54] ANGULAR RISE FLOTATION GEAR

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[52] **U.S. Cl.** .... **9/8 R,** 102/14
[51] **Int. Cl.** **B63b 21/52**
[58] **Field of Search** 102/3, 4, 14, 10, 81; 9/8, 8.3; 114/209; 244/138, 76, 138.5

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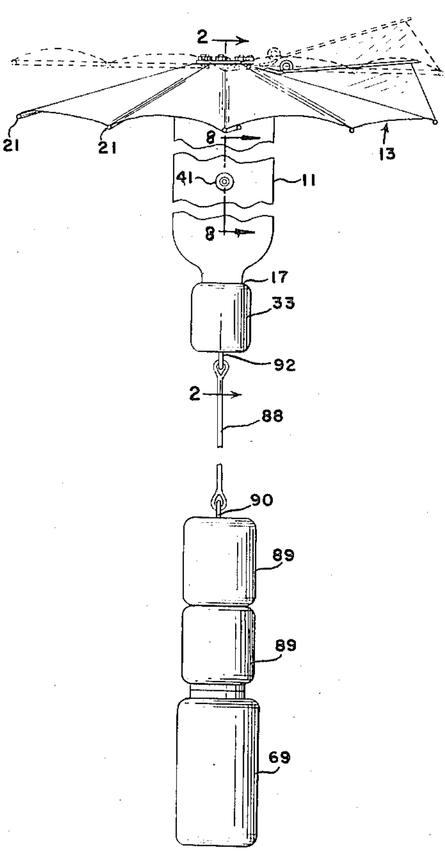
EXEMPLARY CLAIM

1. A parachute for use with a submerged buoyant system comprising a center plate adapted to be secured to the submerged buoyant system, a first and a second foldable semi-circular piece each having a plurality of radial rods pivotally connected to said center plate, lock means on said center plate engageable with the rods on said first piece to lock said first piece in a horizontal position after an initial increase in depth of the submerged buoyant system from a predetermined depth opens it, and said second piece having means enabling it to open to a horizontal position or to a downwardly folded position whenever the submerged buoyant system deviates from said predetermined depth.

8 Claims, 8 Drawing Figures



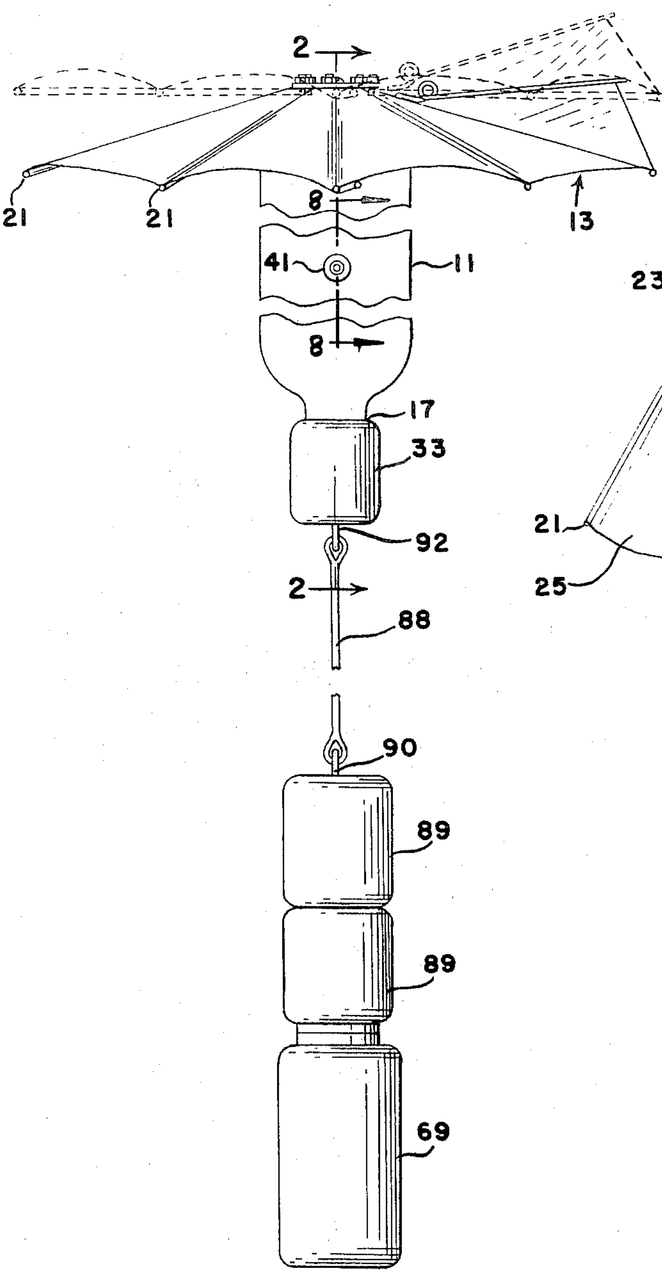


FIG. 1

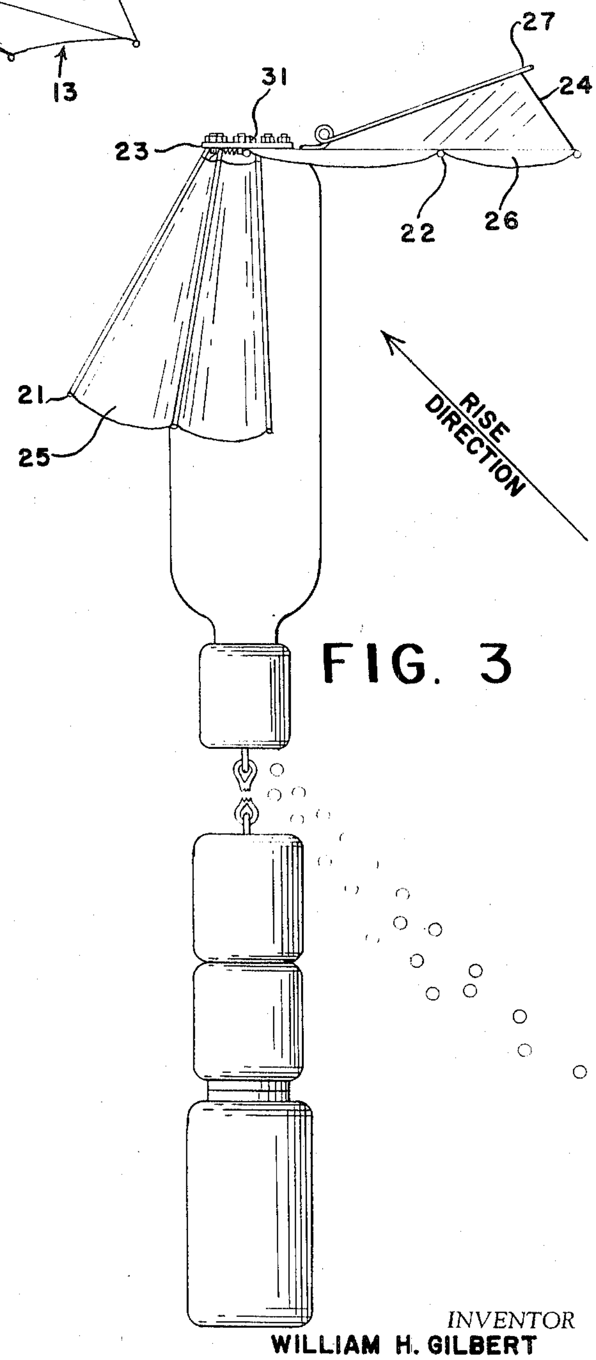


FIG. 3

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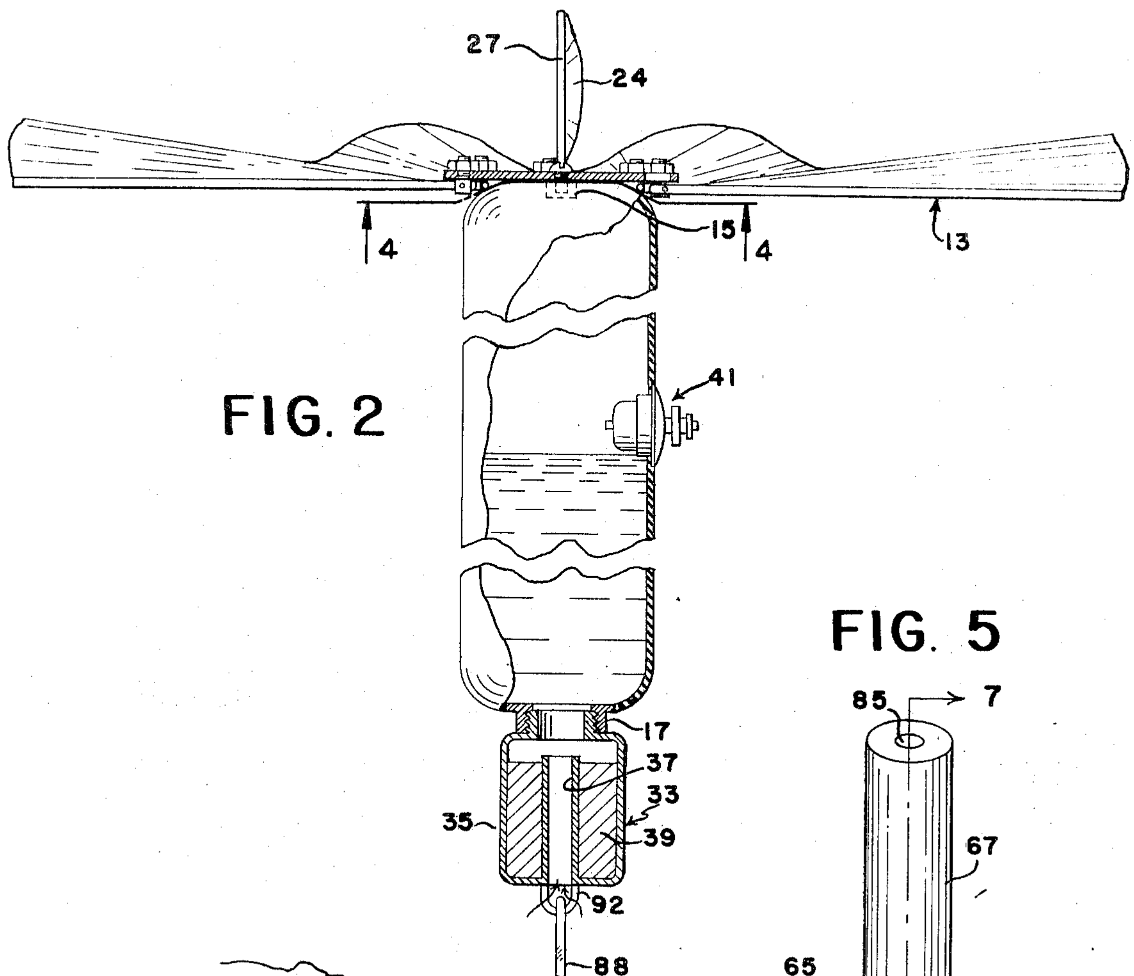
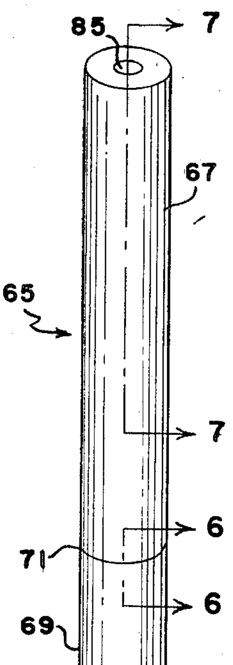


FIG. 2

FIG. 5



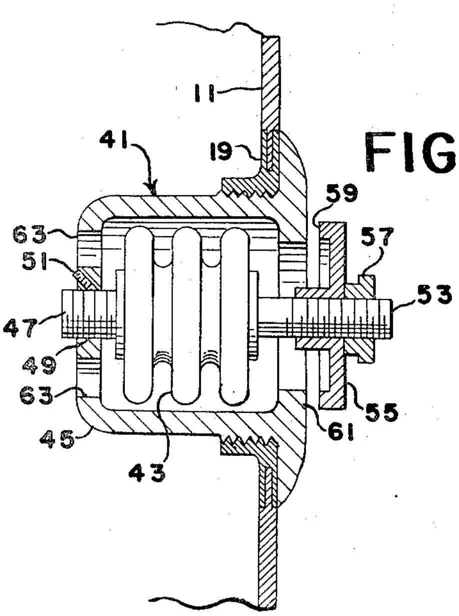


FIG. 8

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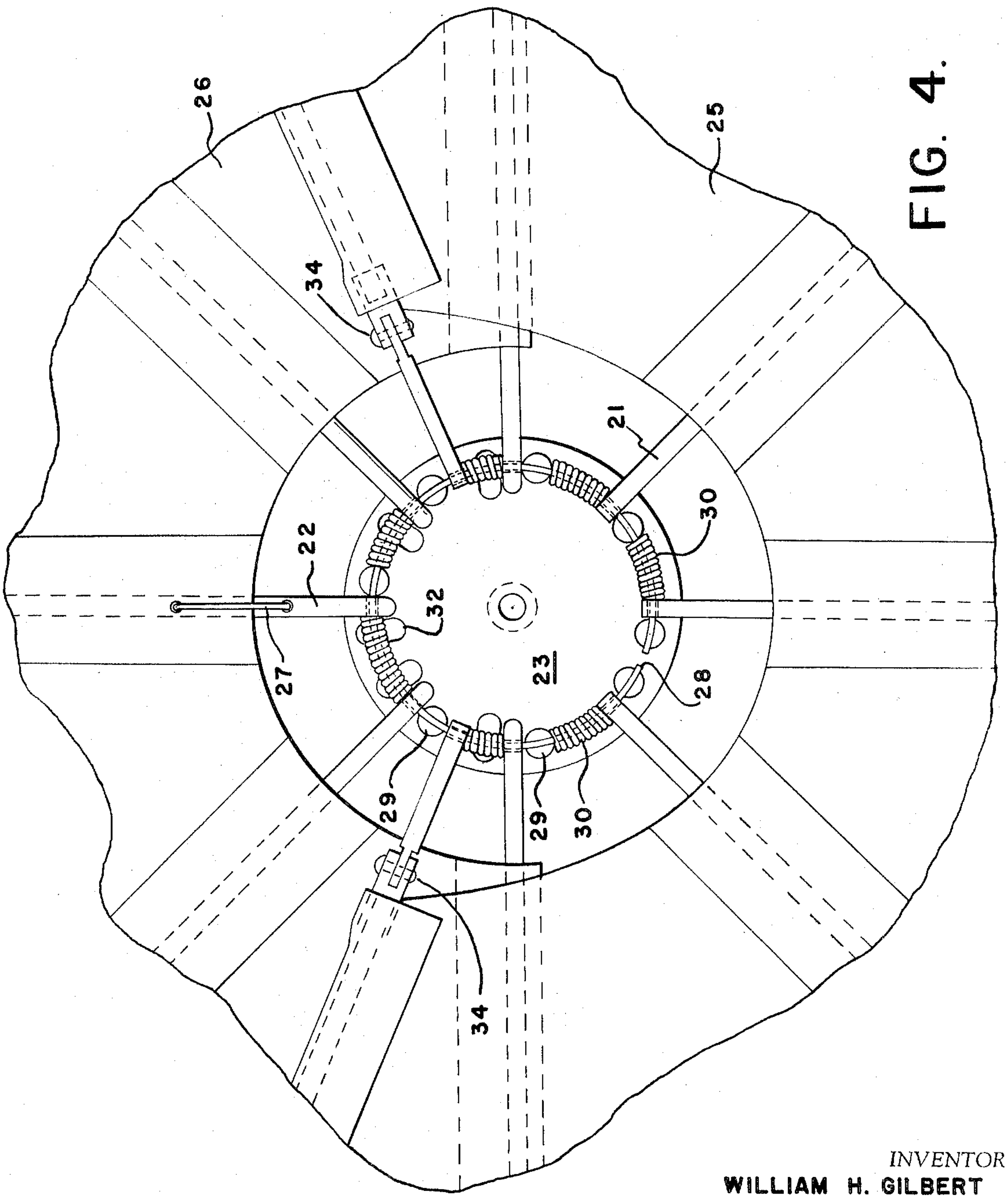

FIG. 4.

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FIG. 7

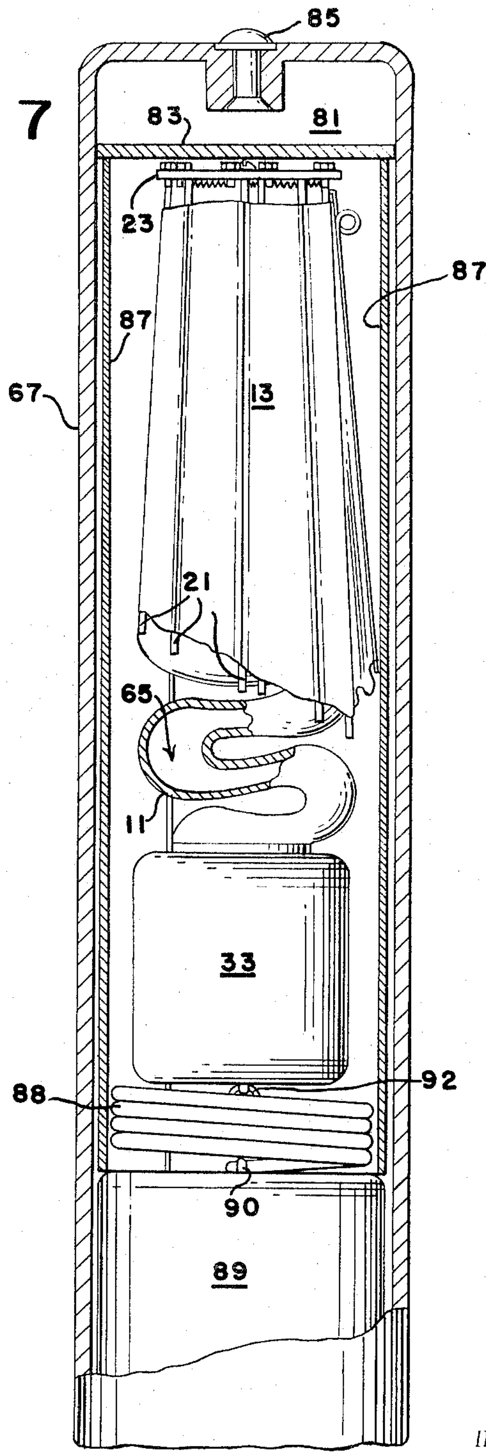
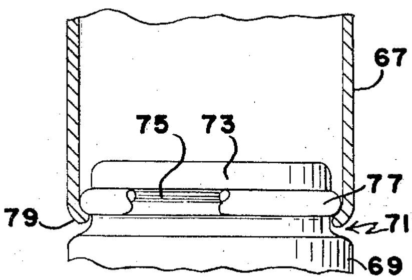


FIG. 6



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ANGULAR RISE FLOTATION GEAR

The invention herein described may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to an underwater suspension system, and more particularly to a suspension system for a buoyant acoustic system adapted to angularly rise and maintain itself at a predetermined depth below the surface of deep water.

In modern warfare it is frequently desirable to position acoustic equipment in the water at a predetermined depth below the surface of deep water, and to launch such equipment from either surface ships or from a submerged submarine. In launching a buoyant acoustic system from a depth of several hundred feet in water, the system's acoustic equipment is subjected to detrimental interference from the buoyancy device of the system, and since it is usually desired to position the equipment within about 40 feet of the surface, the system must operate to elevate the equipment to its proper operating depth without interference to the acoustic equipment. It is impractical to employ a rigid tank for buoyancy because of its size and weight so that a non-rigid structure is required which can successfully operate at water pressures of several hundred pounds per square inch. It is also necessary that the equipment maintain its proper depth for an extended period, and remove itself after its useful life is expended.

The acoustic equipment supported by the suspension system may be of any suitable type, such as a noisemaker. A usable device may be the noisemaker described in U.S. Pat. No. 935,750 to H. B. Gale, issued Oct. 5, 1909.

In acoustical or radiant energy problems, it is a well known and accepted principle that any change in the characteristics of the transmission medium will cause a reflection of at least a portion of the energy being transmitted, and that the amount of energy which is deflected will depend upon the degree to which the transmission medium is changed. It will be readily apparent that the energy transferred to the new medium will be greatly reduced. An example of such reflected energy is found in sound energy passing through a screen of bubbles, whereupon the energy is diffused by the irregular surface and reflected in going through the variable density media and is therefore rapidly attenuated by the surrounding water.

In order for the acoustic equipment to be effective in transmitting sound energy, the medium surrounding the acoustic equipment must remain relatively free of interference in order to maintain the specific acoustic resistance of the medium at a nearly constant amount. In the present invention, this principle is applied to the elimination of the attenuation of sound energy from the acoustic equipment by diverting the acoustic equipment from the flow of bubbles generated by the buoyancy device, thereby maintaining the specific acoustic resistance constant which results in the transmission of sound. energy in a medium having a nearly constant density.

The underwater suspension system herein disclosed may be launched from any depth up to four hundred feet of water and may be launched from the flare tube of a submarine. The buoyancy device is vented to the sea, thus equalizing the pressures inside and outside the non-rigid buoyancy tank, so that flexible impervious material may be employed therefor. The equipment to be supported has a constant weight and the buoyancy device is provided with a gas generator having a substantially constant generating rate to replenish the gas in the buoyancy tank, or balloon as it is called herein. A pressure responsive valve closing on increased pressure serves to maintain the suspension system at a predetermined depth, and a sectionally collapsible parachute or damper serves to prevent rapid descent of the system thus insuring proper functioning of the control system and to provide the system with lateral velocity when rising.

It is an object of the present invention to provide a buoyancy device for use with acoustic equipment which will angularly rise to a predetermined depth in deep water.

It is a further object of the present invention to provide a buoyant acoustic system having a sectionally collapsible parachute.

It is still a further object of the present invention to provide a buoyant acoustic system having a sectionally collapsible parachute wherein substantially half of the parachute is collapsible to produce an angular rise.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings in which like reference numerals designate like parts throughout the figures thereof and wherein:

FIG. 1. is an elevation view of the present invention showing the relationship of the parts when descending in the water, with the dotted lines indicating the actual position of the parachute while the full lines show it in a slightly closed position in order to clarify the structural details;

FIG. 2 is an elevation view partially in section of the apparatus taken on line 2—2 of FIG. 1, looking in the direction of the arrows;

FIG. 3 is an elevation view of parts of the invention showing the relationship of the components when angularly rising in the water;

FIG. 4 is a detail view of the parachute of the present invention taken along line 4—4 of FIG. 2, looking in the direction of the arrows;

FIG. 5 is a showing of the present invention packed for launching;

FIG. 6 is a detail view, partially in section, taken along line 6—6 of FIG. 5, looking in the direction of the arrows;

FIG. 7 is a sectional view of the present invention as packed taken along line 7—7 of FIG. 5, looking in the direction of the arrows; and

FIG. 8 is a cross-section view of the pressure responsive valve of the present invention taken along line 8—8 of FIG. 1, looking in the direction of the arrows.

Referring now to the drawings in which the same or corresponding parts are identified by the same number, there is shown in FIG. 1 an envelope or balloon 11 constructed of flexible impervious material. The material employed is preferably not resilient, so as to prevent changes in the volume of the balloon itself, although plastic and similar material may be employed if desired. A suitable material for the construction of the balloon 11 and the parachute 13 later to be described is rubberized fabric, since it may be readily folded into a small space and stored for extended periods of time. The balloon may be of any desired shape, but is illustrated herein as cylindrical with rounded ends. Couplings **15**, **17** and **19** are sealed into the upper end, lower end, and the side, respectively, of the balloon for purposes later to be described.

The gas generator employed with the present invention may be of any desired type, the major requirements being that it be lightweight and provide a substantially constant emission of gas over a considerable period of time. Because the weight of any gas is negligible with respect to the weight of water, the kind of gas employed is unimportant. The gas generator herein described is inexpensive to construct, rugged, and capable of producing a substantially constant flow of gas at high pressures, although many other types of generators may also be employed if desired.

As best seen in FIG. **2**, the gas generator **33** comprises an outer cup **35** and a vent tube **37** extending through the bottom of the cup to a point near the top of the cup. The cup is adapted to be sealed to the coupling **17** in the bottom of the balloon **11**, and the volume between the inside of the cup **35** and the vent tube **37** is filled to within about ½ inch of the top of the vent tube with a chemical **39** which liberates a gas upon contact with water. Suitable chemicals include lithium hydride, calcium hydride, lithium metal, and others. In the present disclosure and for the purpose of illustration, lithium hydride is employed, since it liberates approximately 45 cubic feet of hydrogen at atmosphere pressure per pound of chemical and is capable of creating very high pressures.

The rate at which gas is generated depends in a large measure upon the effective area of chemical exposed to the water. Thus the area of the surface of the chemical and the extent to which the chemical is compacted into its holder affect the rate of generation, and the addition of wax to the chemical will greatly retard its emission of gas. In the present generator, lithium hydride without wax compacted with a pressure of about 4 tons per square inch of surface area is employed.

Water entering the gas generator **33** through the vent tube **37** flows onto the lithium hydride, and immediately sets up a chemical reaction liberating hydrogen gas. The hydrogen gas liberated in the concavity between the cup **35** and the vent tube **37** forms a gas pocket which forces the major portion of the water away from the chemical **39** until the remaining water is exhausted in the reaction. The gas generator thus allows the lithium hydride to receive only a small quantity of water at any time with which to react and the generation rate is therby maintained substantially constant.

Gas liberated by the generator **33** rises through the water into the balloon **11**, creating a pressure therein which forces water from the balloon through the vent tube **37** to increase the buoyancy of the system. It will be noted that the pressure within the balloon **11** is equal to the pressure on the outside, so that substantially no pressure is exerted on the impervious material.

The pressure-responsive valve **41** is screwed into the coupling **19** in the side of the balloon **11**, the coupling being positioned so that the gas volume above the valve produces a slightly negative buoyancy in the suspension system including the supported equipment. The valve **41** comprises a sealed bellows **43** which is exposed to the pressure within the balloon, and contracts in length with increases in pressure. The bellows **43** is secured to the valve frame **45** by means of the threaded stud **47** fitting the threaded bore **49**, and locked in position by means of the set screw **51**. The other end of the bellows is provided with a threaded rod **53** which carries the valve plate **55** and the lock nut **57** threadedly engaged thereon. The valve plate **55** is provided with a raised lip **59** which contacts the valve seat **61** on the valve frames **45** when the valve is closed, and holes **63** are provided in the valve frame to allow passage of gas therethrough. The valve frame **45** is secured to the coupling **19** in any secure gas-tight fashion, such as threading.

The size of the holes **63** is proportioned to allow the escape of gas at the normal operating depth of the balloon **11** at a rate somewhat in excess of the generating rate of the gas generator **33**, and the position of the valve plate **55** is adjusted on the threaded rod **53** to cause the raise lip **59** to close against the valve seat **61** at a depth slightly below the required operating depth of the balloon **11**.

It is necessary at great depths that the balloon **11** be inflated immediately, even though the required replenishment rate of the gas generator is small. In order to provide an immediate supply of gas, lithium hydride crystals are placed within the folds of the balloon **11** when it is packed. Water entering the balloon in launching reacts with the chemicals to generate a considerable volume of gas which opens the balloon at once and provides a high positive buoyancy to cause the unit to rise rapidly. The feature is indicated in FIG. **7** by the reference numeral **65**. An excess quantity of lithium hydride within the balloon is used to insure that the balloon will be completely filled under all launching conditions, since any excess gas will be discharged through the vent tube **37** without damage to the apparatus.

The parachute **13** is adapted to be folded into a compact bundle when the suspension system is packed and before launching, best seen in FIG. **7**. However, when the system is launched, downward movement through the water causes the parachute **13** to open and retard such movement. The parachute is divided into two overlapping and substantially semi-circular pieces **25** and **26** of flexible impervious material, of which the piece **25** remains free to pivot relative to the balloon as the system rises and falls through the water. However, the other semi-circular piece **26** is provided with latching means, later to be described, which operates to maintain piece **26** in an extended position relative to the balloon **11**, so as to create an unbalanced drag on the balloon **11** in the upward movement thereof which will cause the system to move laterally upward.

The parachute **13**, best seen in FIGS. **1**, **2**, **3** and **4**, consists of a circular metal plate **23** secured to the coupling **15** by an attaching means such as screw **31** or the like. The under side of plate **23** is provided with a circular wire ring **28**, indented a predetermined distance from the periphery of plate **23** and secured at a predetermined distance from the under side of plate **23** by a plurality of holding means such as a rectangular-head bolt **29** with a slot in the head of the bolt to receive the wire ring **28**, or the like. The parachute piece **25** is connected to the plate **23** by a series of radial ribs **21** evenly distributed over the under surface of piece **25** and secured thereto. The radial ribs **21** are transversely bored at a predetermined distance from their inner ends, so that the wire ring 28 passes through the bored ends to pivotally secure ribs 21 to the under side of plate 23. The predetermined distance between the wire ring 28 and the ends of ribs 21 is less than the predetermined distance between the wire ring 28 and the under side of plate 23, thereby permitting the radial ribs 21 to freely pivot about the wire ring 28 between the limits determined by the balloon 11 in the downward direction and the under side of plate 23 in the upward direction. Each of the end radial ribs 21 of piece 25 is interrupted by a pivotal joint 34 at a predetermined distance outwardly of the plate 23 to facilitate the pivoting movement of piece 25 relative to the balloon 11.

The parachute piece 26 is pivotally connected to wire ring 28 by a series of radial ribs 22 evenly distributed over the under surface of piece 26 and secured thereto. The inner ends of ribs 22 are transversely bored at a predetermined distance from the inner ends, equal to a distance greater than the distance between the under side of plate 23 and the wire ring 28, so that the wire ring 28 passes through the bored ends to pivotally secure ribs 22 to the under side of plate 23. The predetermined distance between the inner ends and the tranverse bores of ribs 22 is greater than the predetermined distance between the wire ring 28 and the under side of plate 23, thereby locking the ribs 22 in the extended position relative to the balloon 11. The wire 28 is provided with a plurality of coaxial springs 30 thereon, each of the springs biasing one or more of the ribs 21 and 22, as shown in FIG. 4, to adjustably maintain the rib ends stationary relative to the wire ring 28 and in juxtaposed relationship with one of the bolts 29. A rudder 24 of flexible impervious material is attached to the piece 26 and held perpendicular to the piece 26 by a resilient wire 27 to facilitate folding the parachute into a compact bundle for packing. The rudder 24 serves to stabilize the suspension system when angularly rising by preventing undesirable oscillatory movement of the system through the lateral forces induced on the system by the rudder 24.

The plate 23 is provided with apertures 32 adjacent each inner end of the rib 22, wherein each aperture is adapted to receive one of the extended inner ends of ribs 22. To fold the parachute into a compact bundle for packing, each inner end of radial ribs 22 is moved against the bias of one of the springs 30 along the wire ring 28 until the inner ends of the ribs 22 are directly over the apertures 32, whereupon the radial ribs 22 are free to pivot about ring 28. It will be readily apparent that the ribs 21 are free to pivot about the wire ring 28 below a horizontal position but are prevented by the plate 23 from pivoting upward past the horizontal position, so that the piece 25 has little effect on upward movement but greatly retards downward movement of the balloon 11 in conjunction with the piece 26. Also, it will be apparent that the spring biased ribs 22 are not free to pivot about the wire ring 28 below a horizontal position but are prevented by the extended ends abutting against the under side of plate 23 and further, the ribs 22 are prevented by the plate 23 from pivoting upward past the horizontal position, so that the piece 26 coacts with the piece 25 to retard the downward movement of the balloon 11 and acts to angularly divert the direction of upward movement of the balloon 11 while the rudder 24 guides it.

As the balloon 11 rises the water pressure declines so that the entrapped gas within the balloon expands in accordance with known physical laws and part of the gas is exhausted through the vent tube 37. The parachute piece 25 tends to fold downward, while the parachute piece 26 remains horizontally locked, so that the balloon 11 with the attached acoustic equipment rises at an angle toward the surface. At the point at which the valve 41 opens, additional gas is vented from the balloon, and the angular rise continues until a negative buoyancy is reached. The balloon 11 then begins to sink, opening the parachute piece 25, to create a large resistance, so that the descent is slow.

As the balloon 11 sinks, the water pressure on the entrapped gas increases which reduces the volume of gas therein. The gasing rate of the gas generator 33 must therefore replenish the gas in the balloon as well as the gas escaping from the valve 41. However, as the balloon 11 returns to its proper operating depth, the valve also closes to reduce the quantity of gas being vented, so that the volume of gas in the balloon increases at a faster rate. An equilibrium point is reached when the net buoyancy of the system is zero, and careful adjustment of the valve causes the equilibrium point to coincide with a valve opening which equilizes the amount of gas generated and the amount of gas vented.

It is desirable that the amount of gas released by the valve 41 be as small as possible, since a small gas loss reduces the required generating rate from the gas generator 33. However, rapid descents of the balloon 11 with correspondingly rapid increases in pressures which decrease the volume of gas entrapped in the balloon require high gasing rates to quickly supply the required volume of gas to the balloon. The parachute 13 therefore reduces the generating capacity required in the generating unit while stablizing the action of the suspension system by preventing rapid decreases in depth.

In order to launch the buoyant acoustic system from a submarine at a depth of several hundred feet, the entire assembly is packed in a cylindrical container 65 as shown in FIG. 5. In the present device, the cylindrical container 65 has a diameter of about 3 inches and a length of about 34 inches and comprises an upper compartment 67 containing the packed buoyancy device and a lower compartment 69 containing the acoustic equipment to be suspended from the balloon. The two compartments are joined together by a watertight joint at the juncture 71.

As best seen in FIG. 6, the lower compartment 69 is provided with a neck 73 having a reduced diameter adapted to extend within the end of the upper compartment 67. The exterior of the neck 73 is provided on its exterior with a groove 75 adapted to receive the O-ring 77 of natural or synthetic rubber material, and the end 79 of the upper compartment 67 is crimped over the O-ring. It will be apparent that the upper compartment 67 is securely fastened to the lower compartment under conditions of ordinary handling but may be separated by an axial force.

The buoyancy device of the present invention is packed into the upper compartment 67, as shown in FIG. 7. An explosive charge 81 is located in the upper end of the upper compartment 67 which upon detonation acts upon the disc 83 to force the two sections of the container apart and to eject the buoyancy device from the upper compartment. In order to insure that the container **65** is clear of the launching structure before explosive charge **81** is detonated, a delayed-action detonator **85** is used. The system for actuating the detonator **85** varies with the application in which the apparatus is used, and is not per se part of the invention, so that extensive explanation is not required. The detonator **85** is actuated by the launching of the container, and supplies a delay of about 4 seconds.

In order to prevent the force of the explosion from damaging the balloon **11** and the parachute **13,** arcuate segments **87** are placed around the buoyancy device to transmit the thrust to the lower compartment **69.** The arcuate segments **87** are maintained in place around the buoyancy device by the inner surface of the upper compartment **67,** and drop off when the buoyancy device is ejected therefrom.

The lower compartment **69** of the container **65** houses the equipment to be supported by the buoyancy device and is attached to the buoyancy device by means of the rope **88.** The rope **88** may be made of any substance which is relatively free from tendencies to kink or tangle, and as used herein is sash cord. The attachment of the rope to the buoyancy device and to the lower compartment **69** may take any desired form and is illustrated herein as rings **90** and **92** attached to the gas generator **31** and to the lower compartment **69** respectively.

For most acoustical applications, it is desirable to provide electric power to operate such apparatus as is to be used in the lower compartment **69,** and for this reason, sea water batteries **89** are attached to the upper end of the lower compartment. Such batteries, as is well known to those skilled in the art, produce a potential when emersed in sea water and are inactive until so emersed. When equipped with such batteries, the apparatus is inactive until launched.

In operation, the container **65** is ejected from a suitable launching device, and in being so ejected, actuates the delayed action detonator **85.** After the time delay of the detonator, the explosive charge **81** is detonated, which separates the two compartments of the container **65** and ejects the buoyancy device from the upper compartment **67.**

When the buoyancy device is ejected into the water, water enters the gas generator **33** and the balloon **11** where it comes in contact with the lithium hydride, which immediately liberates hydrogen in large volume. The hydrogen thus liberated inflates the balloon, creating a positive buoyancy which causes the balloon to rise to its predetermined operating depth. As the balloon rises the pressure of the water surrounding it decreases in proportion to the depth, and the gas within the balloon expands accordingly, excess gas escaping from the vent tube **37.**

When the balloon **11** reaches the setting of the pressure responsive valve **41,** that valve opens to vent gas from the balloon. The balloon **11** will rise above its operating depth, and start to sink as the buoyancy of the suspension system becomes negative, downward movement of the balloon causing both pieces of the parachute **13** to open and retard the rate of descent and allow the lithium hydride to gas sufficiently. When the balloon **11** begins to rise, the parachute piece **25** folds downward and the parachute piece **26** remains in its open position to divert the direction of rise and to allow the acoustical equipment to avoid the excess gas bubbles escaping from the vent tube **37** and thus have an effective output throughout its rise. The balloon **11** arrives at equilibrium as the gasing rate of the gas generator **31** equals the rate at which gas is vented by the valve **41.**

When the lithium hydride is exhausted, the gasing rate of the generator **31** is reduced to zero and the balloon sinks to the bottom, thus automatically removing itself at the end of its useful life. The final descent of the device is rapid, because the increasing depth creates pressures which compress any remaining gas in balloon to further reduce the buoyancy, so that the effect is cumulative.

For the purposes of illustration of one embodiment of the present invention, where it is desired to suspend a total weight of 12.2 pounds including the weight of the buoyancy device and to have the balloon operate at a depth of 20 feet, the balloon **11** has a length of 12 inches and a diameter of 5⅝ inches. The parachute **13** is 16 inches in diameter, the maximum rate of rise is 5 feet per second.

The gas generator **33** comprises a cup **35** having a depth of 4 inches and an inside diameter of 1-31/32 inches, and the vent tube **37** has an outside diameter of 7/8 inch. The chemical charge consists of 50 grams of lithium hydride compressed under a total pressure of **11** tons and having a generating life of 26 minutes during which time 5.5 cubic feet of hydrogen is produced.

The pressure responsive valve **41** has a throat ⅜ inch in diameter, and the holes **63** are ⅛ inch in diameter spaced 45° apart. The center line of the valve **41** is 6 inches from the top of the balloon **11** and the valve closes at 9 pounds per square inch. The spacing between the member **61** and the lip **59** at atmospheric pressure is approximately .07 inch.

If the projection of the vent tube **37** is not substantially ½ inch above the chemical, the gasing rate is increased until that projection is reached by consumption of the lithium hydride. The useful life of the buoyancy device is thereby shortened slightly but the device operates in a satisfactory manner. The depth of the lithium in the cup **35** is not critical.

It will be readily apparent to those skilled in the art that only a preferred modification has been described herein, and that many changes therein are possible without departing from the spirit of the present invention. It should be understood, of course, that it is intended to cover all changes and modifications of the example of the invention herein chosen for the purposes of the disclosure, which do not constitute departures from the spirit and scope as set forth in the appended claims.

What is claimed is:

1. A parachute for use with a submerged buoyant system comprising a center plate adapted to be secured to the submerged buoyant system, a first and a second foldable semi-circular piece each having a plurality of radial rods pivotally connected to said center plate, lock means on said center plate engageable with the rods on said first piece to lock said first piece in a horizontal position after an initial increase in depth of the submerged buoyant system from a predetermined depth opens it, and said second piece having means enabling it to open to a horizontal folded position or to a downwardly folded position whenever the submerged buoyant system deviates from said predetermined depth.

2. The invention as recited in claim 2, but further characterized in that said first piece has a third piece attached at right angles thereto thereby to prevent oscillatory motion of said system about a vertical axis.

3. In a submerged buoyant acoustic system a parachute, an impervious balloon connected to said parachute, a gas generator connected to said balloon, and a pressure responsive valve operatively attached to said balloon responsive to hydrostatic pressure to close at a predetermined water pressure, whereby to maintain said submerged buoyant acoustic system at a predetermined depth, said parachute comprising a first and a second semi-circular foldable piece, said foldable pieces being structurally and operationally independent of one another, lock means associated with said balloon and selectively engageable with said first piece, whereby said first piece is pivotally locked in a horizontal position or a downwardly folded position in response to movement of said buoyant system below and above said predetermined depth in response to the initial downward deviation of the buoyant acoustic system from the predetermined depth, and said second piece assuming a horizontal position.

4. The invention as defined in claim 3 but further characterized in that said first piece has a vertical guiding rudder attached thereto.

5. An impervious parachute for use with a submerged buoyant system comprising a center plate adapted to be secured to the submerged buoyant system and having a circular wire ring secured to its underside in spaced relation therefrom, a first and a second overlapping semicircular piece, said first piece having a series of first radial rods, said second piece having a series of second radial rods, said first and second radial rods each being pivotally mounted on said circular wire ring, said wire ring having axially mounted thereon a plurality of compressive spring members biasing each of said first and second radial rods along the periphery of said wire ring, each of said first radial rods having an extension portion extending inwardly of said wire ring, each of said extensions being of a length greater than the space between said wire ring and the center plate, said center plate having an aperture formed therein adjacent each of said extensions, whereby each of said first radial rods may pivot on said wire ring against the bias of said spring means so that each of said extensions protrudes into one of said apertures.

6. The invention as defined in claim 5 but further characterized in that said second radial rods have non-extended ends, whereby said second radial rods freely pivot about said circular wire ring to a horizontal position incontact with the under side of said center plate.

7. The invention as defined in claim 5, wherein said extended ends of said first radial rods are displaced laterally of said apertures by said springs after said first radial rods reach a horizontal position, whereby said first radial rods are locked after reaching said horizontal position.

8. In combination with a submerged buoyant system having an impervious balloon, a gas generator connected to said balloon, and a pressure responsive valve operatively attached to said balloon responsive to hydrostatic pressures adapted to close at a predetermined water pressure, whereby to maintain said system at a predetermined depth, the improvement comprising a parachute attached to said balloon, said parachute comprising a first semi-circular piece having means for locking it in a horizontal position after an initial downward deviation, and a second semi-circular piece having means enabling it to assume a horizontal position when said system is sinking whereby it acts together with said first piece to brake the downward movement of said system, said last named means enabling said second piece to assume a downwardly folded position when said system is rising, whereby said system will rise in a combination vertical and lateral direction away from said horizontally locked semicircular piece, said rising being further controlled by said pressure responsive valve, said gas generator and said balloon.

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