

[54] LOCATOR DEVICES

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[51] **Int. Cl.**.....B63c 7/26

[58] **Field of Search** 9/9, 8, 321; 244/33;
116/124 B

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[57] **ABSTRACT**

This invention relates to a device useful as an aid in locating submerged equipment and submersibles while at depth or after the equipment has returned to the surface of the ocean.

The device comprises a clam-shaped container, made up of a top and bottom cover, an inflatable aerial balloon-kite, embodying a radar reflective material, a kite string and reel, a fixed flotation ring, a triggering valve, a fuel cartridge actuator, a fuel cartridge, a gas cooler-water separator and associated flood valves and release mechanisms. The balloon-kite is releasably attached to the cooler outlet from the gas generator that produces hydrogen gas to inflate the balloon-kite when the device returns to the surface of the sea after being submerged with oceanographic equipment to which it has been attached either by tether or by fixed mounting. The gas generating means, preferably made up of solid chemical fuel, reactive upon contact with water to generate a gas, such as hydrogen gas, is provided within the container. The container is free-flooding and when the gas generating means is activated to expose said chemical compound, such as a hydride of a metal selected from the group consisting of lithium, sodium, calcium, potassium and aluminum and mixtures thereof, to contact with water, the resulting generated gas releases the top cover from the bottom cover and, being attached to the balloon-kite, inflates the balloon-kite fully and then causes the balloon-kite to detach itself automatically from the generator and fly aloft tethered to the container by means of a kite strong. The passive reflector surface incorporated in the balloon-kite enables the device to be located by surface radar equipment and, thereby, provides a target by means of which the oceanographic equipment has previously been attached can be located from great distances.

8 Claims, 7 Drawing Figures

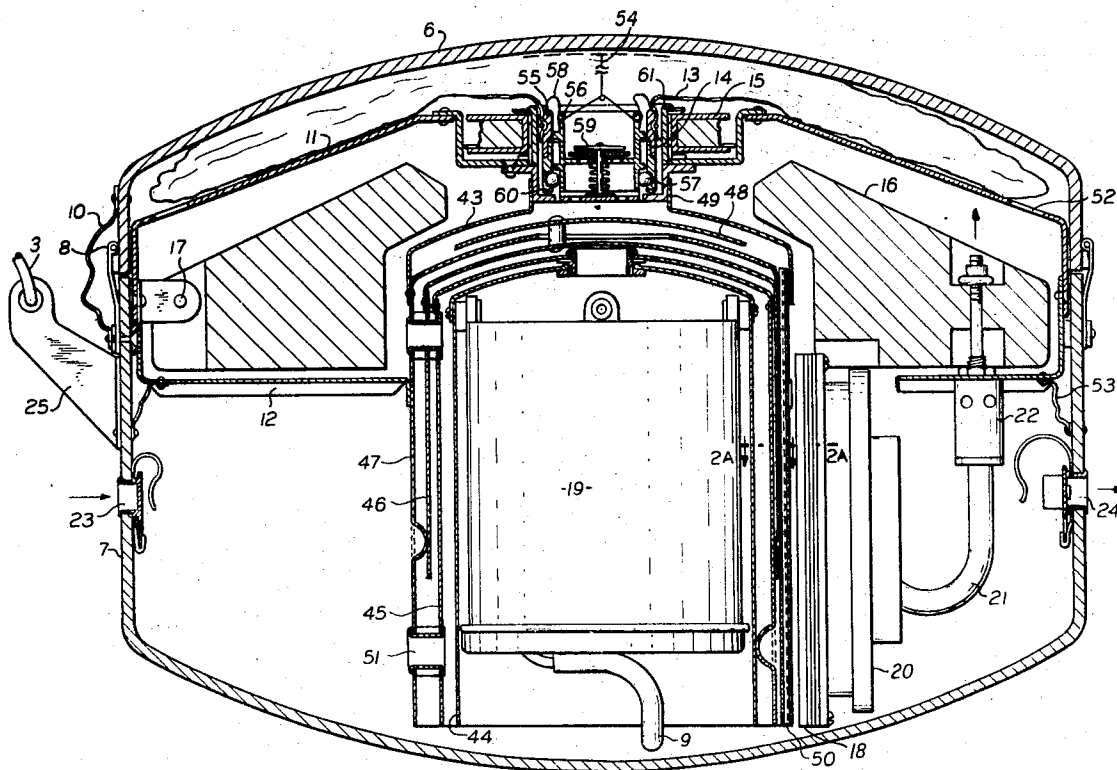


FIG. 1.

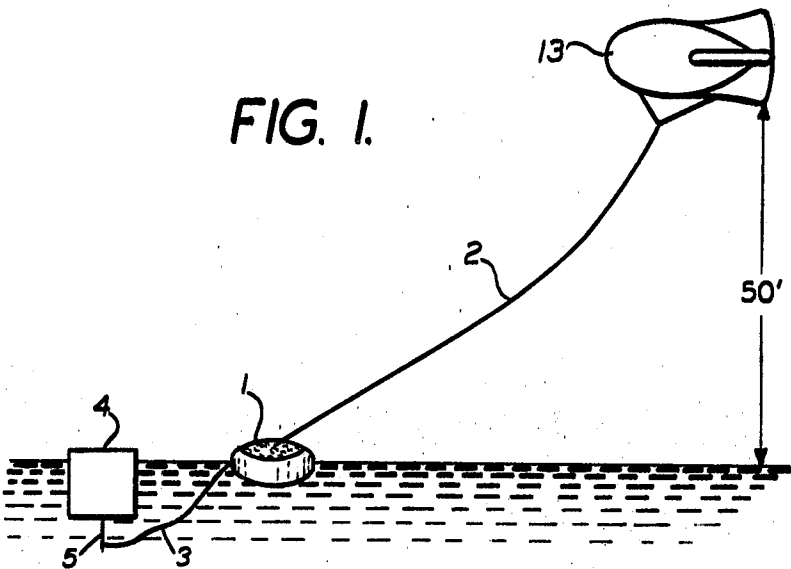


FIG. 4.

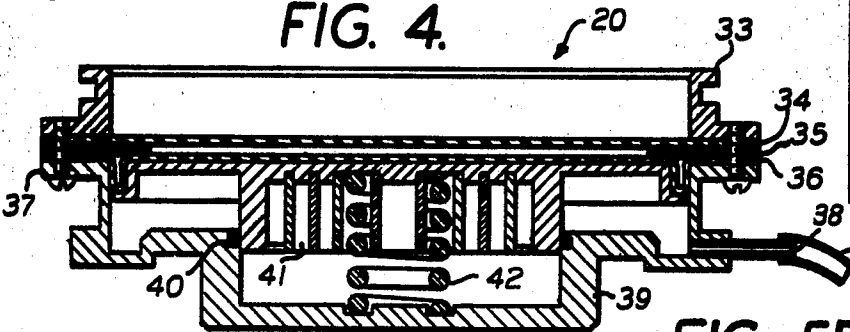


FIG. 3.

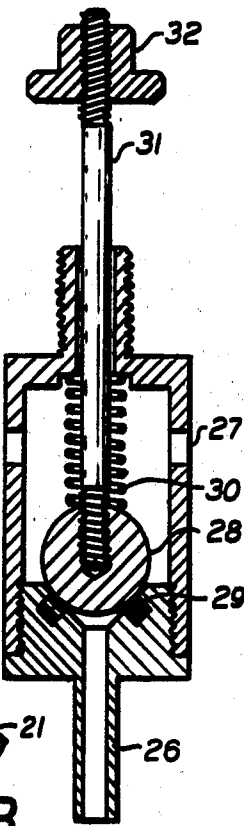


FIG. 5B.

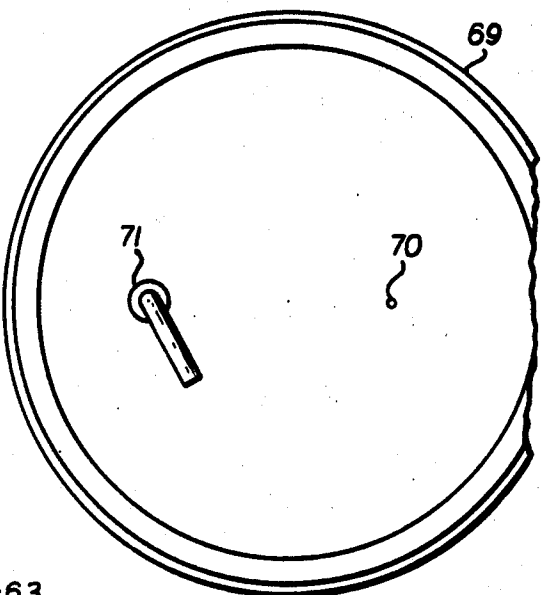
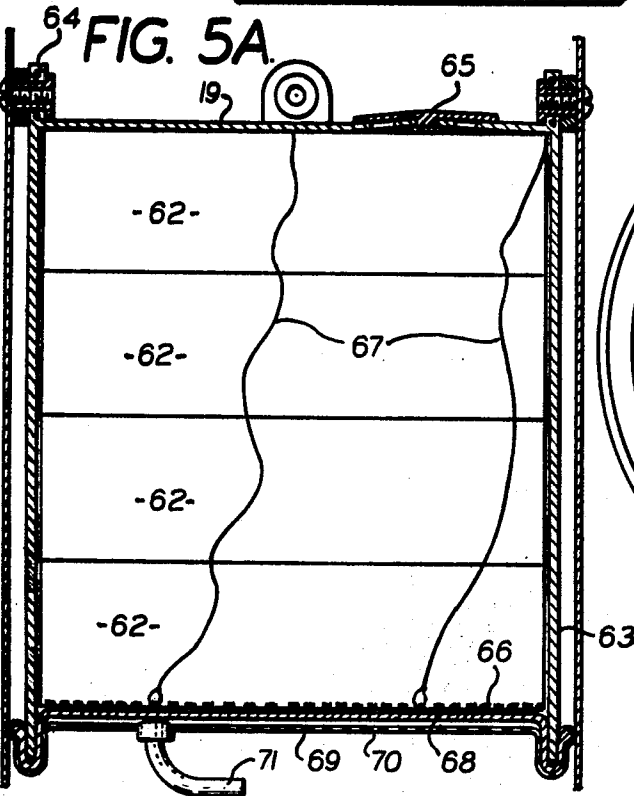
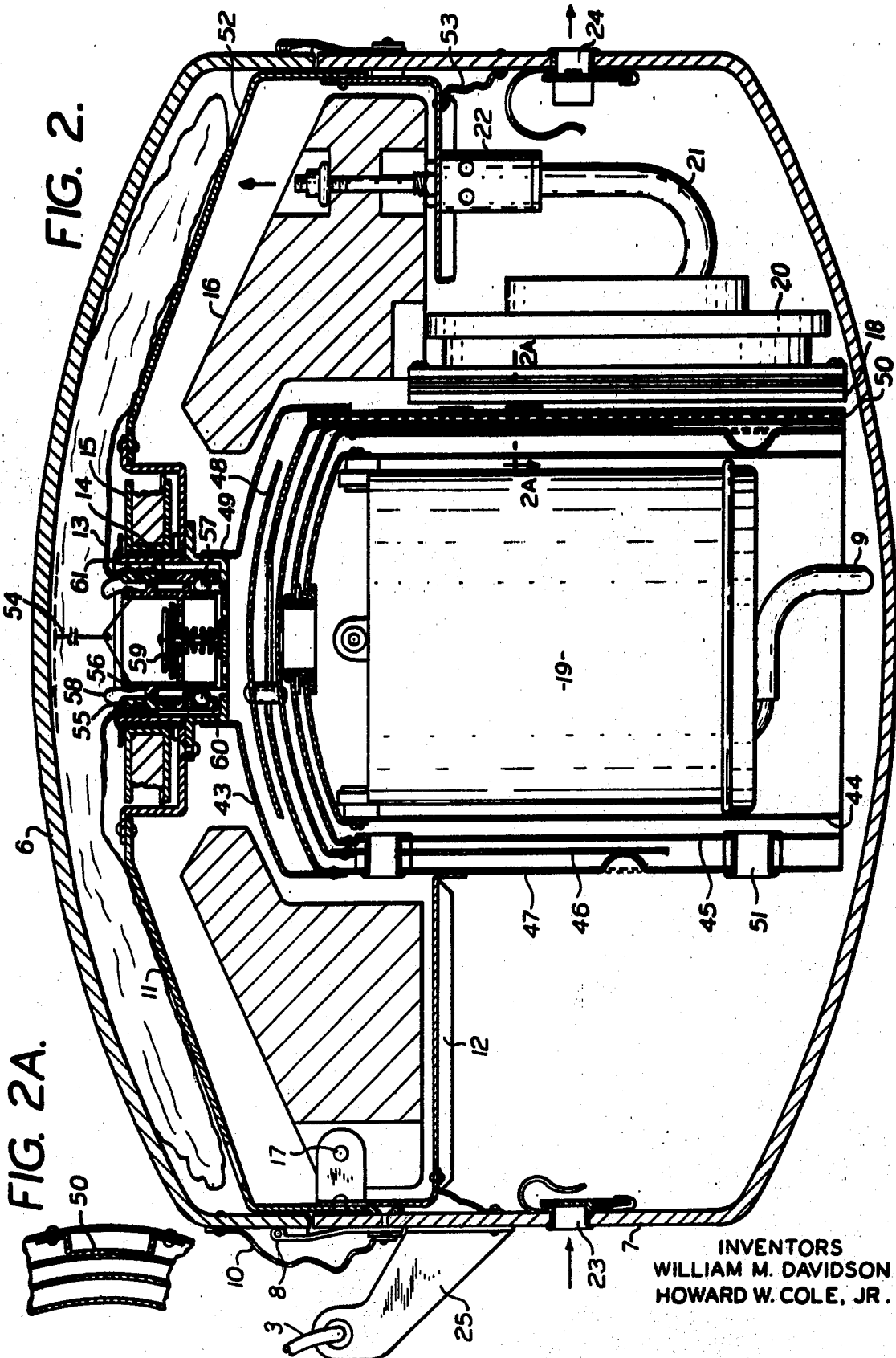


FIG. 5A.



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LOCATOR DEVICES

This invention further relates to elements and compositions useful for inflating of aerial balloon devices. In accordance with one embodiment this invention relates to a light-weight, readily transportable device, useful for attachment to a surface or subsurface item of ocean equipment, for locating the same by radar from a distance of 15 miles or more; the locator device being passive does not require the use of electric power for its operation. In accordance with another embodiment this invention is directed to an actuating means or system for actuating a wide variety of other devices, the actuating means or system being able to sense when the surface of the ocean has been reached after having been submerged for a period of time to a depth of at least 25 feet.

In accordance with yet another embodiment this invention is directed to gas generating means and gas generating compositions particularly useful in combination with buoyancy devices whether submerged or airborne.

In accordance with yet another embodiment this invention is directed toward chemical compositions capable of reacting upon contact with water, including sea water, to generate a gas, such as hydrogen gas, and having controlled reactivity, gas cooling, vapor condensation and gas/water separation devices incorporated into the mechanism, such that the resulting gas output can be fed directly into aerial balloons or other light-fabric structures that require cool, essentially dry gas generated at substantially controlled rates.

In accordance with yet another embodiment this invention is directed to a compact, lightweight, simple system for inflating aerial balloons.

In accordance with yet another embodiment this invention is directed to an aerial balloon or balloon-kite that can be immersed in the ocean at great depths for extended periods of time, then returned to sea level, inflated with gas, deployed aloft and flown in either light or heavy winds on the end of a tether, one end of which remains affixed to the equipment to be located on or in the sea.

In accordance with yet another embodiment this invention is directed to surface detectors that can provide an actuation force or signal, such as mechanical or hydraulic, to operate other devices upon reaching the surface of the sea after submergence to great depths; and to perform this detection and/or actuation function without the use of stored energy devices, such as batteries or other external sources of power.

Other methods of locating equipment at sea, as employed heretofore, include both visual means, such as flashing beacons, and acoustic means, such as pingers, and electronic means such as radios. All of these active types of locating devices require some form of electric power that must be stored for long periods of time prior to use. Other passive means for locating equipment at sea, such as visual or sonic targets, have the disadvantage that they cannot be distinguished reliably from the surrounding environment except at close range.

Accordingly, it is an object of this invention to provide a simple, effective, readily transportable ocean search device for aid in locating equipment, personnel or submersible vehicles.

It is another object of this invention to provide a relatively lightweight, substantially fool-proof system and compositions and controls useful in association therewith for use in locating equipment, personnel or submersible vehicles.

It is also an object of this invention to provide compositions useful for generating a gas upon contact with water, such as hydrogen gas, having not only a controlled rate of gas generation but also producing a relatively dry, low density gas with a temperature of less than 100° F.

In at least one embodiment of the practice of this invention at least one of the foregoing objects will be achieved.

How these and other objects of this invention are achieved will become apparent in the light of the accompanying disclosure and drawings wherein:

FIG. 1 illustrates schematically one use of the locator device in accordance with this invention for aid in locating an item of submerged equipment, such as an instrument package;

FIG. 2 is a vertical cross-section view of a locator device in accordance with this invention in the closed, non-operating condition;

FIG. 2A shows a section of the wall of the gas generator shown in FIG. 2.

FIG. 3 presents a cross-section view of a trigger valve that is used in conjunction with a fixed float and an actuator to initiate operation of the locator device when it has returned to sea level after being submerged to great depth;

FIG. 4 presents a vertical cross-section view of the actuator that is used to open the fuel cartridge and initiate gas generator operation after the locator device has returned to sea level;

FIGS. 5A and 5B presents two views of the fuel cartridge, both vertical cross-section and bottom views, the function of the fuel cartridge being to contain the fuel, seal out moisture and equalize pressure inside the cartridge with the ambient water pressure outside the cartridge at any depth.

The locator device in accordance with this invention is characterized by certain features that make it useful for a wide variety of applications. For example, since the locator is simple, compact and relatively light in weight, it can be readily transported and delivered to a location for use. Further, since the locator device when submerged has only slight positive buoyancy, it can be readily employed by a diver for attachment to a load that is to become the object of a search at some future date. In addition, it can be attached to a submersible and released at depth so that it returns to the surface on a reel and then deploys the balloon-kite for purposes of locating the submersible. Also, it can be alternatively attached with fixed mounting to a submerged or surface-floating equipment and triggered in a variety of ways for purposes of locating the equipment.

FIG. 1 illustrates the use of the locator device 1, as attached by rope or cable 3 to an instrument package 4, or to its mooring line 5, after release from depth and return to the surface of the ocean. The aerial balloon-kite 13 is shown flying at an elevation of 50 feet above sea level while attached to the locator device 1, called "PULSER," on a 100 feet tether or kite string 2.

FIG. 2 illustrates one embodiment of locator device 1 in accordance with this invention. The device illustrated is packaged within its own container, 6 and 7, but may, if desired, be integrated with or included as part of the load to be recovered from the sea. Upon entering the water, the interior of locator device 1 is flooded, thereby establishing near neutral buoyancy for the device itself.

The locator device 1 may be brought down from the surface for attachment to the submerged equipment, or the device may be attached to the equipment initially, either by cable 3 or by fixed mounting, and pulled down with the equipment. The locator device may remain submerged at any depth for a period up to 6 months. Upon return of the locator device to the surface, either with the equipment to which it has been attached or on a reel, the hinged float 16 is so oriented that it must move and change its position. This float movement, caused by the change in buoyancy between the surfaced position and the submerged position of float 16 and the mounting bracket 12 to which the float is hinged at 17, operates trigger valve 22 which in turn releases actuator 20 which activates fuel cartridge 19. As illustrated, locator device 1 comprises in a single container, 6 and 7, a collapsed, inflatable balloon-kite 13, a gas generating unit, actuating means to start the gas generator, provisions for flooding the container, a surface detector, a fixed flotation collar 16, a reel containing the balloon-kite tether 15 and an external attachment fixture or other mounting provision.

Referring again to FIG. 2, the locator device comprises a top cover 6 and a mating bottom cover 7 which is releasably fixed to top cover 6 by means of an extensible, flexible gripping ring 8, such as a rubber gripping ring. Top cover 6 is

secured to bottom cover 7 by string 10 so that it will not be lost after its removal for deployment of the balloon-kite. Bottom cover 7 is releasably mated with cone 11 and bracket 12, except that it is secured to bracket 12 by strings 53. Cone 11 and top cover 6 together form an enclosure for balloon-kite 13 when deflated and packed inside the locator device. Cone 11 is rigidly attached to bracket 12 and serves as a support for balloon release 14 and reel 15.

Float collar 16 is mounted inside cone 11 and attached to bracket 12 by two hinges 17 which allow it to pivot toward cone 11 as indicated by the arrow shown above trigger valve 22. Fuel cartridge 19 is mounted inside reactor 44 which is detachably mounted inside cooler 43. Cooler 43 is rigidly attached to bracket 12. Actuator 20 is fastened to the side of cooler 43 and connected by hydraulic line 21 to trigger valve 22 and by hydraulic line 9 to fuel cartridge 19.

Locator device 1 can be tethered to an instrument package 4 by means of a short flexible cable 3 tied to bracket 25. When instrument package 4 descends through the water, it pulls locator device 1 down with it by means of cable 3. Locator device 1 floods with water entering through inlet valve 23. Air is vented from locator device 1 through vent valve 24 as water enters. Vent valve 24 will assume a top position during descent because hinged float collar 16 will maintain a pull against cable 3 attached to bracket 25. When completely flooded, locator 1 is positively buoyant by virtue of float collar 16 and is designed to float with the plane of bracket 12 in a vertical position when submerged. In this position, float 16 will be approximately in line with the center of buoyancy of locator 1 and will be pivoted in such a way that it is held against bracket 12. Locator device 1, when returned to sea level with instrument package 4, will rotate upon reaching the surface so that bracket 12 becomes horizontal and the balloon compartment is elevated above the surface of the water. This righting moment is produced because the center of buoyancy is, by design, always above the center of gravity. When on the surface, float 16 pivots upward as indicated by the arrow to operate trigger valve 22. Valve 22 opens to release actuator 20 through line 21. Actuator 20 applies hydraulic pressure through line 9 to remove the seal closure from fuel cartridge 19 and thereby activate the gas generator. Gas rises through cooler 43 and outlet port 49 displacing water from the inlet to the balloon-kite 13. The pressure inside locator device 1 will increase rapidly because balloon-kite 13 is confined by cover 6; this pressure will be communicated to the balloon packing cavity through holes 52 in cone 11. The internal pressure will force the bottom cover 7 to drop until restrained by strings 53 thereby permitting free circulation of fresh water to reactor 44 and fuel cartridge 19. Similarly, top cover 6 is removed by internal pressure to permit full inflation and deployment of balloon-kite 13; top cover 6 remains flexibly attached to locator device 1 by means of string 10.

After balloon-kite 13 becomes fully inflated, it is released by means of release string 54 and release mechanism 14 consisting of nozzle 55, ball retainer 56, ball detent 57, flexible seal 58, valve 59, seal 60 and body 61. Balloon-kite 13 is permanently attached and sealed to nozzle 55 and to retainer 56 through flexible seal 58, which may be a thin plastic film such as a polyester plastic material. Nozzle 55 is releasably attached or locked with body 61 by means of ball detent 57, the balls being held in position by retainer 56. Nozzle 55 forms a seal with body 61 by means of flexible seal 60. Valve 59, by resting against body 61, is held in the open position against the force of its closure spring, to allow gas to enter balloon-kite 13 until the time of release from outlet port 49. Release string 54 located inside of balloon-kite 13 and attached internally to the top of the balloon at one end and at the other end to retainer 56 serves to pull retainer 56 upward to release the balloon after it has been fully inflated. Raising retainer 56 releases ball detent 57 thereby freeing nozzle 55 and balloon-kite 13 from outlet port 49. Upon release from outlet port 49, valve 59 closes to prevent gas from escaping from balloon-kite 13. Balloon-kite 13, now being separated from locator device 1 ex-

cept for kite string 2 (FIG. 1), is free to ascend into the air above the water by means of gas buoyancy and/or aerodynamic lift. As balloon-kite 13 ascends, kite string 2 is unreeled from reel 15 which remains rotatably attached to port 49.

FIG. 3 shows a vertical cross-section view of trigger valve 22 which is rigidly attached to bracket 12 (FIG. 2) and is operated by the movement of float 16, as has been shown. The vacuum cavity of actuator 20 is connected by hydraulic line 21 to outlet port of trigger valve 22. Referring to FIG. 3, outlet port 26 is shown without hose line 21 connected. Inlet ports 27 are open to ambient pressure at all times. Outlet port 26 is sealed from ambient pressure by ball 28 being held against seal 29 by spring 30 and by the pressure differential between ambient and outlet port 26 (actuator vacuum). Valve stem 31 is attached to ball 28 and is actuated by the motion of float 16 (FIG. 2) against adjustment nut 32. Thus, an upward motion of float 16 actuates trigger valve 22 and connects actuator 20 to ambient pressure through line 21.

FIG. 4 shows a vertical cross-section view of actuator 20. Collar 33 with suitable "O"-ring seal (not shown) serves as the seal closure for fuel cartridge 19 if it is desired to mount the actuator integrally with the fuel cartridge closure, as mentioned in earlier disclosures. However, in order to mount actuator 20 separately from fuel cartridge 19, as illustrated in FIG. 2, collar 33 is replaced with a simple flat disc cover 18 having an integrally mounted tube fitting for connection to hydraulic line 9. Diaphragm 34 or alternatively, cover 18 is separated from diaphragm 36 by thin metal spacers 35. Small radial holes in spacers 35 provide access to ambient water pressure and allow internal pressure to equalize slowly with external pressure during ascent or descent of locator device 1. Flexible diaphragm 36 is used both to seal and to operate piston 41. Piston 41 is a dual piston that operates in concentric cylinder bodies 37 and 39 simultaneously, being sealed against cylinder 37 by diaphragm 36 and against cylinder 39 by seal 40. Spring 42 provides the actuating force to pump hydraulic fluid through line 9 to fuel cartridge 19 when released by trigger valve 22. Nozzle 38 is used to connect hydraulic line 21 to trigger valve 22.

Actuator 20, upon immersion in water, floods with water at ambient pressure to fill the cavity between diaphragms 34 and 36. Diaphragm 34 remains essentially stationary because it is restrained on the upper side by the contents of fuel cartridge 19. During descent, the ambient water pressure increases and the increasing pressure between diaphragms 34 and 36, therefore, forces piston 41 to compress spring 42 as well as the air entrapped inside the sealed cavity of cylinder 39. Spring 42 is selected according to the minimum arming depth desired, which is usually at least 50 feet in depth, at which depth spring 42 will have been completely compressed. The motion of piston 41 will expel any gas or water from cylinder 37 through nozzle 38 and out through line 21 and trigger valve 22. Once piston 41 has bottomed in cylinder 39 and spring 42 is fully compressed, actuator 20 can descend to any ocean depth and the cavities in piston 41 will withstand the hydrostatic pressure.

During ascent, piston 41 remains essentially bottomed against cylinder 39 because of the reduced pressure in cylinder 37, which is sealed from ambient pressure by trigger valve 22. The area difference between cylinders 37 and 39 is selected so that only about 10 psi is needed to hold piston 41 essentially bottomed against cylinder 39. Water entering the cavity between diaphragms 34 and 36 is maintained essentially at ambient pressure at any depth because of the radial holes in spacers 35.

After reascending to sea level, the surface detector, consisting of float 16 and trigger valve 22, releases the vacuum pressure in cylinder 37, thereby equalizing the pressure on both sides of piston 41. This allows piston 41 to be pushed against diaphragms 34 and 36 by spring 42 so that the resultant force acts to remove collar 33, or equivalent seal closure, from fuel cartridge 19.

Preferably, hydraulic line 21 is prefilled with an inert fluid, such as ethylene glycol, to insure positive transmission of pressure between trigger valve 22 and cylinder 37. Also, the size of the radial holes in spacers 35 should be selected so that venting is at a much slower rate than would be determined by motion of piston 41.

Referring again to FIG. 2, the vertical cross-section view also illustrates cooler assembly 43 that surrounds fuel cartridge 19 and serves to collect gas and conduct it to balloon nozzle 55. Cooler 43, mounted rigidly on bracket 12, also serves the following functions:

1. reduce gas temperature below 100° F to protect balloon;
2. remove water and water vapor from the gas;
3. separate water from gas and permit water to return.

Cooler 43 consists essentially of four concentric cans, each of which is thin-walled and open-bottomed. Inner can 44, identified as the reactor, contains fuel cartridge 19 affixed to and suspended from the walls of reactor 44. The annular space between cans 44 and 45 allows cooling water to flow freely around the outside of reactor 44, the spacing being maintained by the use of dimples or corrugations in the wall of can 44. Reactor 44 is removably attached to can 45 by means of a screw fitting at the top of the cans. Gas generated inside reactor 44 rises and passes through the center passage in the screw fitting and displaces water from the annular space between cans 45 and 46 until the water reaches a level determined by the bottom open end of can 46. Can 46, referred to as a baffle, controls the amount of gas pressure developed by the generator. Gas that bubbles around the baffle rises in the annular space between cans 46 and 47 displacing water from that volume as well as from the head section located above can 47, referred to as the separator. Gas entering the separator head through the large hole in the center of the dome of can 47 is forced to flow radially outward under deflector plate 48. Any water in the separator head is carried by the flow of gas toward the periphery of the separator head. The gas will then rise and pass around deflector plate 48 and up into outlet port 49 that connects to balloon nozzle 55. Water trapped at the periphery of the separator head returns by gravity flow to the bottom of cooler 43 through three equally spaced passages 50 that are affixed axially to the inside of can 47 and connect with the separator head at the top by penetrating the dome of can 47 (lower dome). Cooling water bushings 51 provide for circulation of cooling water through the annular space between cans 44 and 45 by thermo-syphon action that exchanges cool water for hot water. Outlet port 49 incorporates an orifice plate to provide sufficient "head" to insure that only gas enters the balloon, water being confined below deflector plate 48.

FIG. 5 illustrates one embodiment of fuel cartridge 19 that is useful for many gas generator applications wherein the device, such as the locator device, must ascend and descend in the ocean numerous times and remain inactive until operation of the gas generator is desired on the final ascent. For this purpose and to minimize space, the hydride fuel is compacted into wafers or slugs 62 that are right circular cylinders, but may also be hexagonal or other shapes to fit within a circular cylinder cup or container 63. Cup 63 is a molded flexible rubber or rubber-like material, such as a silicone or plastisol material, of sufficient thickness to minimize moisture penetration at any depth. Tabs 64 are molded integrally with cup 63 for purposes of attaching fuel cartridge 19 inside of reactor 44. A vent-check valve 65 is incorporated into the top of cup 63 to allow gas to vent from the inside of cup 63 but prevent moisture from entering. A wire mesh grate 66 is inserted under fuel slugs 62 and attached by four fine wires 67 inside of cup 63 to tabs 64. The length of wires 67 is about ½ inch longer than cup 63 and the extra length of wire is folded inside cup 63 when the lid closure diaphragm 68 is assembled. Diaphragm 68 is a rubber closure that is the same general shape as metal diaphragm 69. Metal diaphragm 69 is bonded to rubber diaphragm 68 at the rim and rolled at the rim after assembly to cup 63 in order to form an hermetic seal between diaphragm 68 and cup 63. Metal diaphragm 69 contains one

or more small passages 70 to permit free flow of water into the space between diaphragms 68 and 69. Hydraulic tube fitting 71 is inserted in diaphragm 69. When fuel cartridge 19 is submerged in water, hydrostatic pressure compresses cup 63 and diaphragm 68 against fuel slugs 62 which are designed to withstand pressures in excess of 10,000 psi without appreciable change in shape. At any depth, there is no pressure differential across the hermetic seal formed between diaphragms 68, 69 and cup 63; therefore, the fuel cartridge 19 is always pressure equalized.

In order to open fuel cartridge 19 and expose fuel slugs 62 to sea water for activation of the gas generator, a small differential hydraulic pressure is furnished by actuator 20 through hydraulic line 21 to fitting 71. This pressure differential communicated to the space between diaphragms 68 and 69 through fitting 71 forces diaphragm 68 away from diaphragm 69 and, thereby, dissipates the clamping force at the rim between diaphragm 68 and cup 63 to break the hermetic seal. Fuel slugs 62, being negatively buoyant and the compressive forces confining them having been removed, drop by force of gravity together with grate 66 until support wires 67 are fully extended. The bottom fuel slug 62 is then exposed about ½ inch below cup 63 and, by contact with sea water, gas generation is initiated. As fuel is consumed, the residue (hydroxide) being heavy falls through grate 66 and fresh fuel comes in contact with water. The gas reaction will continue, as long as the water level is above grate 66, until all of the fuel slugs 62 have been consumed.

Vent valve 65 provides several fail-safe features both before and after activation of fuel cartridge 19. Prior to activation, fuel cartridge 19 may be subjected to wide ranges of temperature and pressure. Also, small amounts of moisture may penetrate through cup 63 over long exposure periods. Moisture penetration will react slowly with fuel slugs 62 and small amounts of gas will evolve. Gas evolved in this manner would be compressed during the descent of fuel cartridge 19 and venting is not required. However, if the same cartridge is returned to the surface without having been activated, the internal gas will expand and could cause premature activation of the cartridge unless a vent is provided. Valve 65 is so constructed that internal gas can vent freely until internal pressure is equal to ambient pressure surrounding the fuel cartridge. Also, valve 65 serves as a check valve to prevent water from entering fuel cartridge 19 through valve 65.

We claim:

1. In combination with a locator device, useful for ocean search and recovery operations, comprising an inflatable aerial balloon target and a chemical gas generator housed in a single container or shell, the combination thereof being capable of storage in the ocean at great depths prior to automatic activation and deployment upon return to the surface of the ocean: (1) an hydraulic, spring-loaded actuator that arms automatically during descent by means of hydrostatic pressure; (2) a surface detector comprised of a hinged float positioned inside of said container such that it provides a righting moment when resurfaced, to insure that said balloon is above the surface, and, further, pivots on said hinges to apply its full buoyancy to operate a trigger valve thereby releasing said actuator to activate said chemical gas generator; (3) an hydraulically activated fuel cartridge, consisting of a flexible container, sealed ventcheck valve and removable sealed closure containing a fuel material that generates, by reaction with water, a gas which is lighter than air; (4) a reactor that controls automatically the rate of gas generation by means of a grate to retain said fuel, thereby permitting the reaction to slow or to stop and restart by the removal of water to a level below said grate and by the use of gas pressure to control the level of water in said reactor; (5) a cooler consisting of a multiple number of concentric, thin-walled cans to provide heat transfer from gas to water, radial passages through said concentric cans to provide circulation of cooling water by thermo-syphon action, and a separator comprised of a deflector plate and axial passages along the walls of the outermost can

to permit collection and return of water to said reactor by means of gravity flow; (6) a baffle, in the form of one of the concentric cans forming a part of said cooler, to control the amount of gas pressure developed; (7) an orifice plate incorporated between the outlet of said cooler and the inlet to said inflatable balloon to further impede the flow of water into said balloon; (8) a closure means, such as a flexible gripping ring, for said container or shell that provides for automatic deployment of said balloon by means of gas pressure developed after activation of said generator; (9) an automatic release mechanism for said balloon consisting of a release string affixed internally to said balloon at one end and at the opposite end to a ball retainer located in the balloon fill nozzle such that internal gas pressure acting upon the surface of the balloon will effect release of said balloon only when it becomes fully inflated; (10) a spring-loaded valve located in the fill nozzle of said balloon that closes automatically upon the release of said balloon from said gas generator, thereby preventing escape of gas from said balloon; (11) a rotating reel for deploying said balloon aloft after release from said gas generator in such manner that said balloon remains tethered in flight to said container, which in turn is tethered to a moored instrument, or other equipment of value, either on the surface of the ocean or submerged.

2. An underwater device in accordance with claim 1 wherein said chemical gas generator produces cool, relatively pure and dry hydrogen gas at a controlled rate by reaction of a chemical compound, such as a hydride of a metal selected from a group consisting of lithium, sodium, calcium, potassium, aluminum and mixtures thereof with water, said reaction producing an hydroxide of the metal and heat as well as hydrogen gas, wherein said heat works in combination with said cooler to draw fresh water into the generator by thermosiphon action as well as to expel products of the reaction, and further, wherein said fresh water is used both to sustain the fuel reaction and to effect the transfer of heat from said cooler, and further, wherein said cooler also serves to condense moisture from the gas as it passes through a series of baffles formed by a number of concentric cans that readily conduct heat from the gas into the water.

3. An underwater device in accordance with claim 1 wherein both the rate of gas generation and the maximum gas pressure available for balloon inflation is self-regulating according to the difference in pressure head between the baffle located in said cooler and the reaction zone established by said fuel cartridge grate that retains said fuel inside of said reactor, as well as by the size of gas flow passages in said cooler, including its outlet ports.

4. An underwater device in accordance with claim 1 wherein said cooler not only cools said gas but also separates said gas from the water by means of a separator consisting of a deflector plate and water drain passages for the return of water to said reactor by means of gravity flow, aided by the

use of an orifice plate located between the outlet port of said cooler and the inlet to said inflatable balloon.

5. An underwater device in accordance with claim 1 wherein the volume of gas generated can be closely controlled by closing the outlet port to throttle the gas flow through said outlet port, thereby creating a back-pressure that expels water from said reactor to a level below the reaction zone established by the fuel cartridge grate; and, further, wherein it is possible to stop and restart said generator by completely expelling all of the water from the fuel reaction zone and, later, when said back-pressure is reduced, allowing the water to return to a level where it is once again in contact with said fuel and the reaction thereby resumes.

6. An underwater device in accordance with claim 1 wherein said fuel cartridge comprising a solid slug of water-reactive fuel, protected from water by a flexible container body and an hermetically sealed removable closure, an hydraulically actuated diaphragm for removal of said closure, droppable fuel and grate, and sealed said vent check valve serves to equalize external hydrostatic pressure with internal gas pressure by permitting said gas, which may be generated when moisture penetrates the container, to vent while preventing water from entering through said vent check valve; and, further, wherein said solid fuel being supported by an open wire grate that, in turn, is supported by slack fine wires, is free to drop below said fuel container upon removal of said seal closure by means of a small hydraulic pressure differential applied inside of said fuel container, wherein the purpose of dropping said fuel is to insure that the fuel is brought into contact with the water for reliable operation of said gas generator.

7. An underwater device in accordance with claim 1 embodying said surface detector operating by means of a change in net buoyancy or a change in the location or direction of applied force resulting from said change in net buoyancy, which change is produced by the movement of said float from subsurface to surface or, conversely, surface to subsurface orientation, wherein the device is comprised of a mechanically actuated release mechanism, such as a trigger valve, and a float which may consist of either fixed flotation or an inflatable device.

8. An underwater device in accordance with claim 1 including said spring loaded actuator comprising mechanical, pneumatic and hydraulic elements wherein the actuator can be armed automatically by means of hydrostatic pressure during descent which acts to compress a spring, said spring being held in compression by differential pressure at any ocean depth for extended periods, and wherein said spring may be released at any depth or upon return to the surface of the water to drive a piston that applies hydraulic pressure for actuation purposes, the release of said spring being accomplished by venting of the low-pressure cavity to ambient pressure after the device has ascended by an amount at least equal to arming depth.

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