March 30, 1965 G. DE VRIES 3,175,525

WATER ACTIVATED GAS BUOYANCY DEVICE

Filed Dec. 9, 1963 2 Sheets-Sheet 1

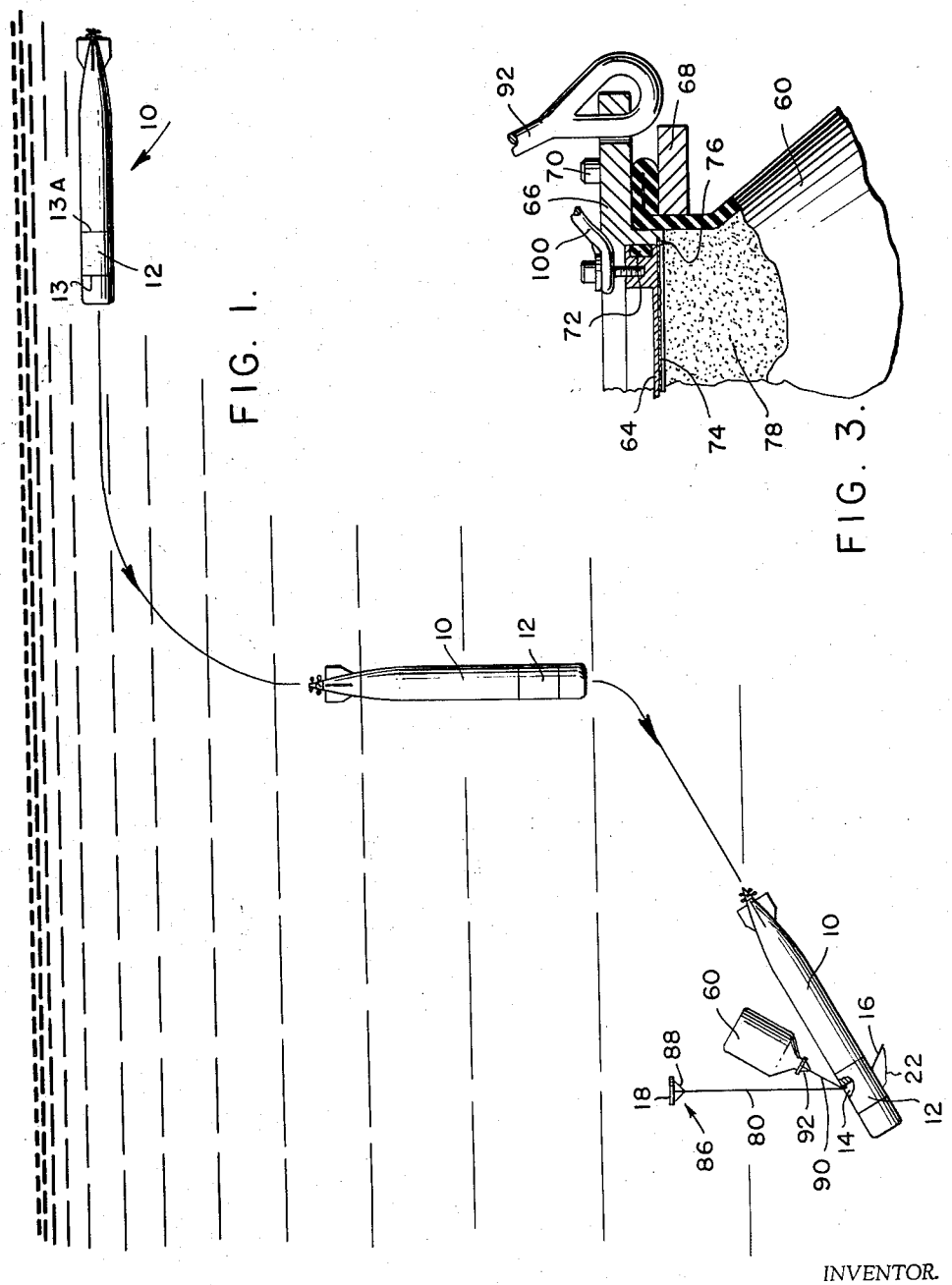


FIG. 1.

FIG. 3.

INVENTOR.
GERRIT DE VRIES

BY

ATTORNEY.

March 30, 1965 G. DE VRIES 3,175,525

WATER ACTIVATED GAS BUOYANCY DEVICE

Filed Dec. 9, 1963 2 Sheets-Sheet 2

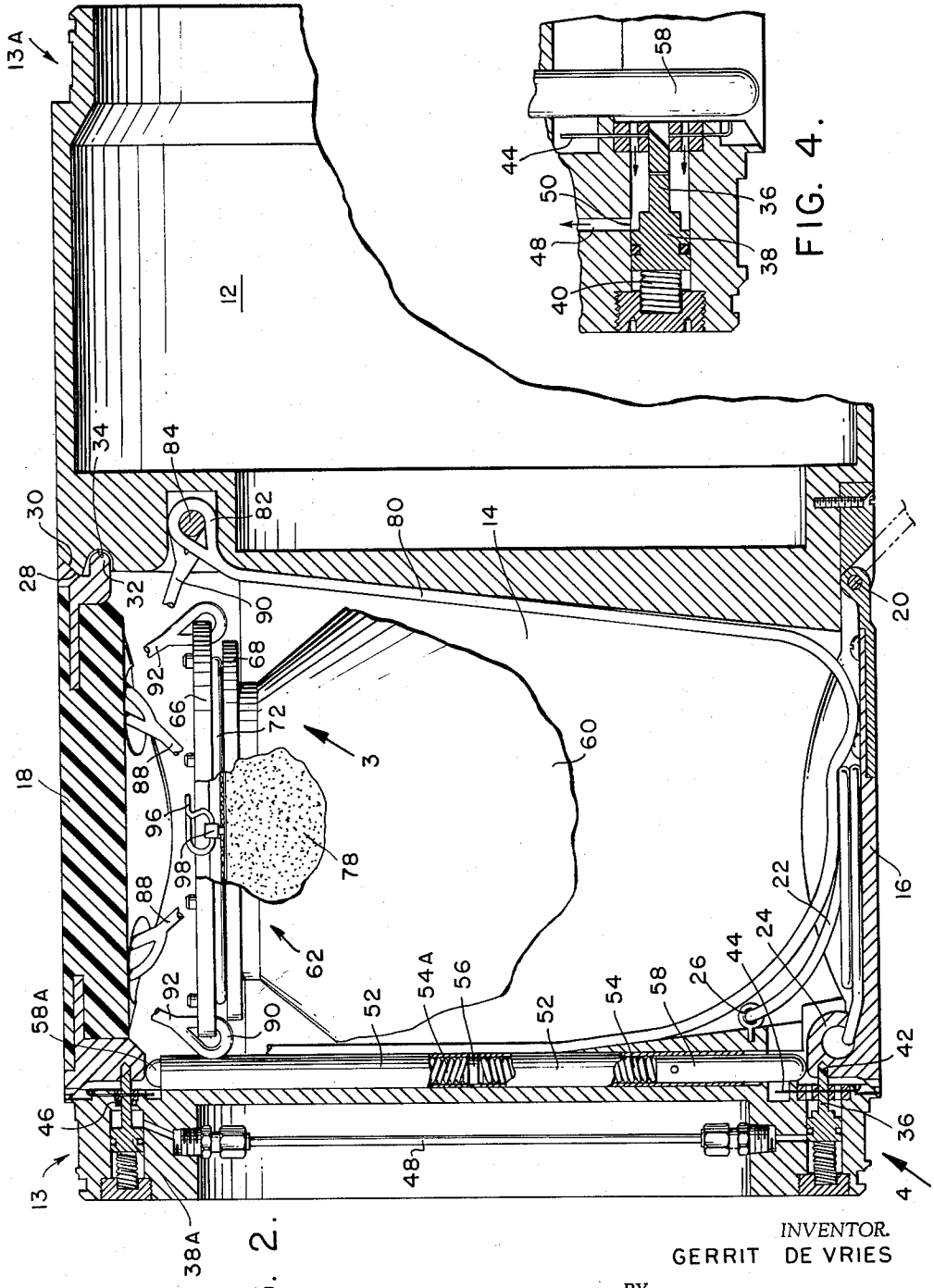


FIG. 4.

FIG. 2.

INVENTOR.
GERRIT DE VRIES

BY

ATTORNEY.

United States Patent Office 3,175,525 Patented Mar. 30, 1965

3,175,525

WATER ACTIVATED GAS BUOYANCY DEVICE

Gerrit De Vries, Altadena, Calif., assignor to the United States of America as represented by the Secretary of the Navy

Filed Dec. 9, 1963, Ser. No. 329,323
9 Claims. (Cl. 114—20)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein 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.

This invention relates to apparatus for recovering a negatively buoyant torpedo, subsequent to the completion of an exercise or test run, and from a predetermined depth in the sea which depth is above the floor of the sea.

It is common practice to recover torpedoes which have sunken to the floor of the sea after completion of an exercise or test run, exemplary of which is the patent application of Ernest N. Oeland, Jr and John Young, Jr., Serial No. 32,984, filed April 19, 1963, now Patent No. 3,123,842, and the Dayer patent referred to in such application. In devices of this type a float is released from the sunken torpedo, which rises to the surface, laying a line between the torpedo and float which latter may be located on the surface of the sea after which suitable hoisting apparatus may be employed to follow the line to the torpedo, latch to it, and permit raising the torpedo by a surface winch or the like. While such devices enable recovery of a torpedo beyond diver depths they suffer the disadvantage that if the floor of the sea is at great depth sufficient cordage cannot be carried unless the device is of excessive bulk. Additionally, the time required for the torpedo to sink to the floor of the sea from a predetermined depth and then be raised to such depth represents a considerable loss in time in the recovery operation. Another type of recovery apparatus, probably more analogous to the present invention, is exemplified by the patent to Newburn et al. 2,949,877 wherein flotation bags are inflated at a desired depth under control of a depth responsive device, such as a hydrostat, a suitable propellant being provided which generates hot gas for inflating the bags. This gas must be cooled, however, before being delivered to the bags, necessitating bulky cooling apparatus. Also, the balancing of internal bag pressure to the ambient sea pressure depends on the operation of a pressure release valve, the failure of which could cause bursting of the bags and loss of a torpedo. Additionally, at the time of inflation of the bags, the descending velocity of the torpedo may be so great that shock forces may cause failure of the apparatus.

One of the objects of this invention is to provide flotation apparatus for a negatively buoyant torpedo which generates gas within an inflatable bag which is open to the sea.

Another object is to check the speed of a topedo before inflation of the bag.

Another object is to withdraw the bag from a cavity within a torpedo by utilizing the drag and buoyancy forces of a cover closing one end of the cavity.

Further objects are to provide torpedo recovery apparatus which is extremely simple in construction, economical of manufacture and has a minimum of operative mechanical parts subjected to malfunction.

Other objects, advantages and salient features will become more apparent from a consideration of the description to follow, the appended claims, and the accompanying drawing in which:

FIG. 1 is a side elevation of a torpedo embodying the subject of the invention;

FIG. 2 is a longitudinal central vertical section through a portion of FIG. 1;

FIG. 3 is an enlarged detail of the portion of FIG. 2 indicated by arrow 3; and

FIG. 4 is an enlarged detail of the portion of FIG. 2 indicated by arrow 4 in a different position of parts.

Referring now to the drawing, any conventional negatively buoyant torpedo 10 may be provided with a recovery section 12, forming the subject of the invention, connected intermediate of the ends of the torpedo hull by conventional torpedo hull joints 13, 13A. In general, such recovery section will replace the torpedo warhead section when it is desired to exercise the torpedo or otherwise conduct test runs of the torpedo.

As shown in FIG. 2, hull section 12 is provided with a frusto-conical cavity 14 extending radially of the hull, its lower ends being closed by a lower cover 16 and its upper end closed by an upper cover 18. Lower cover 16 is secured to the section by a hinge 20 which permits it to swing to the position shown in dotted lines or to the lowermost position of the torpedo, as shown in FIG. 1. A cord 22, having one end secured to an eye 24 on the cover, and its other end 26 secured to the hull section serves as a stop to limit rearward pivotal movement.

Upper cover 18, formed of buoyant plastic or other buoyant material, is provided with a tapered edge portion 28 which engages a corresponding edge 30 which permits the cover to pivot about a transverse axis passing through their abutment. A projection 32 on the cover engages within a recess 34, locking the cover against radial outward movement but permitting the pivotal movement and also bodily release of the cover as will subsequently appear.

The forward edge of lower cover 16 is locked in the position shown in FIG. 2 by a latch pin or detent 36, forming a part of a piston 38, urged in one direction by a spring 40 which maintains an end of the projection within an aperture 42 in the cover. A shear wire 44 extends through a portion of the section and the projection to prevent movement of the piston by the pressure of the sea water until the torpedo descends to a depth sufficient to move the piston and shear the wire. As will be apparent from the drawing the upper lid is locked in the same manner. The upper piston 38A, however, is sealed against entry of sea water by an O-ring 46 and the pressure to operate it is communicated through a tube 48. When piston 38 moves to the left, as shown in FIG. 4, to uncover aperture 50, sea water enters tube 48 and actuates piston 38A. As will be apparent, this provides a time delay between operation of the pistons, piston 38 operating first to release lower cover 16 and a short time later piston 38A operating to release upper cover 18.

To initiate opening of the covers, a tube 52 is provided which contains a pair of springs 54, 54A, both engaging a common abutment 56, which urge plungers 58, 58A radially outwardly, the outer ends of the plungers engaging the respective lower and upper covers.

A collapsed bag 60 substantially fills cavity 14, the bag being constructed of rubberized fabric or the like, and having a mouth 62 at one end closed by a removable circular plug 64, which, as best shown in FIG. 3, frictionally fits within an annular metal collar or ring 66, secured to a ring 68 by angularly spaced screws 70, the edge of the bag around its mouth being clamped between the collar and ring. An O-ring 72, carried by the plug, seals against entry of water into the bag. A pop-out circular screen 74, the edge of which is disposed within a circular groove 76 in collar 66, permits entry of water into the bag when the plug 64 is removed and also retains a water reactant material 78 within the bag.

Cover 18 is connected to section 12 by a flexible cord 80, one end 82 of which is secured to pin 84, affixed to the

section. As best shown in FIG. 2, cord 80 extends around the sides and bottom of the bag, its other end terminating in a bridle 86, consisting of several lines 88.

Bag 60 is similarly connected to section 12 by a cord 90 having one end secured to pin 84, its other end terminating in a bridle 92, the bridle lines being secured to collar 66 at angularly spaced points, as best shown in FIG. 2.

Another cord or lanyard 96 (FIG. 2) has one end secured to a pullout vent valve 98 in plug 64, its other being secured to pin 84. Plug 64 is connected to a like bridle 100, its cord also being connected to pin 84. This cord is shorter than cord 90 so that it will become taut before cord 90 for a purpose to be subsequently described.

In the operation of the apparatus, and first with reference to FIG. 1, it will be assumed that negatively buoyant torpedo 10 is moving along a horizontal course at some predetermined depth in the sea and that its propulsion apparatus has ceased operation either by intentional programming or by consumption of its fuel supply or other source of energy. As illustrated, the torpedo goes into a dive and, when it reaches a predetermined depth, water pressure acting on piston 38 shears wire 44 and the piston moves to the position shown in FIG. 4, unlatching lower cover 16. Spring 54, acting on plunger 58, swings the cover toward open position and the water slipstream acts on the inner face of the cover moving it to full open position. It now acts as a rudder to turn the torpedo toward a horizontal position as best shown in the lower position of FIG. 1 which attitude of the torpedo is more favorable for initiating operation of the recovery apparatus. Some time during this turn, as determined by the time delay between operation of piston 38 and piston 38A, the latter similarly shears its shear wire and upper spring 54 initiates opening of the upper cover. As it opens, it is likewise caught in the slip stream and, due to its buoyancy and drag, moves upwardly relative to the torpedo. During this movement, and since its attaching cord extends around the bag, the bag is withdrawn from the cavity as the cord tensions. When the bag is withdrawn, it also is caught in the slip stream and is dragged with its mouth facing the direction of movement. As previously set forth, the cord connected to bridle 100 becomes taut before cord 90 which withdraws plug 64 from the mouth of the bag. Water now rushes into the bag filling it. As the water reacts with material 78, gas is formed which displaces the water, forcing it out of the mouth of the bag, the pressure within the bag always remaining only slightly above ambient pressure. As the water is forced out, the bag increases in buoyancy and when the increase is sufficient to overcome the negative buoyancy of the torpedo, the latter is lifted to the surface of the water where it may be recovered.

A water reactant material which has been found satisfactory is lithium hydride in granular form with partial size of the order of 40 mesh. When the mouth plug is removed, water rapidly enters the bag carrying the material with it and interspersing it throughout the mass of water within the bag. Rapid reaction takes place forming hydrogen under pressure which forces the water out of the bag. When substantially all of the water has been displaced by the gas any remaining lithium hydride and the insoluble products of reaction collect on the screen. In event the screen should completely clog, pressure will increase in the bag and force the screen out of the mouth of the bag thus preventing further rise of pressure which might rupture the bag. Another safety feature is the vent valve in the mouth plug. Since the water reactant material is granular, the pressure transmitted to the inside of the bag by ambient water compressing the outside of the bag may be somewhat less than ambient pressure. The force required to remove the plug is thus equal to the product of the difference in pressure and the area of the plug. Since this force might be greater than the force applied to bridle 100 it is apparent that the plug would not be removed from the mouth of the bag. By removing

vent valve 98, however, water may enter through the aperture which is formerly closed, equalizing the pressure within the bag to ambient pressure. It has been found, also, that the pressure within the bag, prior to removing the plug, can be made more nearly equal to ambient pressure by filling the interstices between the lithium hydride with lubricating oil thus forming a more solid mass upon which the bag presses. This also retards the reaction of the lithium hydride, permitting the exothermic heat of reaction to be dissipated into ambient water, preventing burning of the bag. The use of vent plug 98 or the oil referred to are optional features which may or may not be required depending upon recovery requirements of the particular torpedo. For example, if recovery must be initiated rapidly to prevent descent of the torpedo to a depth at which its hull might be crushed by ambient water, then a rapid rate of reaction of the lithium hydride would normally be required. If the depth at which recovery is initiated is not critical, however, then the reaction time could usually be increased. As will be apparent, the time for filling the bag with gas can thus be preselected by choice of particle size of the lithium hydride, the smaller the size the more rapid the reaction, and by choice of an inhibitor which will control reaction rate.

In some instances it may be desirable to increase the drag of the bag to provide a greater pulling force on the removable plug which closes the mouth of the bag. For this purpose a parachute may be employed (not shown), the shroud lines of which are connected to collar 66. The drag of the bag and parachute will open the parachute producing additional drag. The length of the shroud lines is preferably such that the parachute canopy will be disposed rearwardly of the bag when the parachute opens.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. Apparatus of the type for recovering a negative buoyant sinking torpedo, which apparatus becomes operative when the torpedo has sunk to a predetermined depth in the sea and above the floor of same, comprising;

(*a*) a transversely extending cavity within the torpedo having a first opening at one side thereof,

(*b*) a buoyant releasable closure closing said opening,

(*c*) an inflatable collapsed flexible bag disposed within said cavity having a mouth at one end of same,

(*d*) a removable plug closing said mouth,

(*e*) a water reactant material disposed within said bag, adapted to produce gas,

(*f*) a first cord extending partly around said bag having one end affixed to the torpedo and its other end affixed to said buoyant closure,

(*g*) a second cord having one end affixed to the torpedo and its other end to the bag adapted to drag the bag through the water with the mouth disposed in a position relative to the water such that water may enter the mouth and fill the bag,

(*h*) a removable plug closing the mouth of the bag having a lanyard connecting same to the torpedo adapted to be tensioned and remove the plug after the bag is withdrawn from said cavity,

(*i*) and release means for releasing said buoyant closure when the torpedo has sunk to a predetermined depth,

(*j*) the construction and arrangement being such that when said release means becomes operative said buoyant closure is bodily released from the torpedo effecting withdraw of the bag from the cavity, the plug is removed from the mouth of the bag, water enters the bag filling same and reacting with the water reactant material, producing gas which expels

the water from the bag, producing sufficient buoyancy such that the bag may raise the torpedo to the surface of the water.

2. Apparatus in accordance with claim 1 wherein,

(*k*) said cavity is provided with a second opening at the opposite side of the torpedo,

(*l*) a swingable closure closing the second opening, said swingable closure adapted to swing to a limit position to form a rudder to turn the torpedo about a transverse axis with said first opening facing in an upward direction.

3. Apparatus in accordance with claim 2 including time delay means for permitting said swingable closure to first open and turn the torpedo and thereafter cause release of said buoyant releasable closure.

4. Apparatus in accordance with claim 3 wherein said time delay means comprises first and second movable piston actuators restrained against movement by a shear wire associated with each, the first piston actuator being subjected to sea pressure and operatively connected to said swingable closure by a detent, the second piston actuator being operatively connected to said buoyant releasable closure by a like detent, and a conduit communicating the actuators only after the first actuator has sheared its shear wire and moved to a limit position, whereby a time delay is effected between operation of the actuators.

5. Apparatus in accordance with claim 2 including a first spring for initiating opening of said swingable closure to a position in the torpedo slip stream, the slip stream being effective to further open it to its limit position, and a second spring for initiating opening of said buoyant cover, the buoyant cover thereafter adapted to disengage from the torpedo due to its buoyancy and drag in the slip stream.

6. Apparatus in accordance with claim 1 including a screen disposed across the mouth of the bag and releasably secured to same in a manner such that the screen may be ejected from the mouth in event of substantially complete clogging by solid products of reaction, whereby gas pressure within the bag cannot increase sufficiently to rupture the bag.

7. Apparatus in accordance with claim 1 including a removable vent valve in said plug, and a lanyard connecting said vent valve with the torpedo adapted to remove the vent valve when the lanyard is tensioned, whereby water may enter the bag through the vent valve and raise the pressure therein to at least the ambient pressure of the sea, to thereby facilitate removal of said removable plug.

8. Apparatus for recovering a negatively buoyant sinking body, which apparatus becomes operative when the body has sunk to a predetermined depth in the sea and above the floor of same, comprising;

(*a*) an inflatable collapsed flexible bag having a mouth at one end of same,

(*b*) a removable plug closing said mouth,

(*c*) a water reactant material disposed within said bag adapted to produce gas,

(*d*) a cord of fixed length having one end affixed to the body and its other end to the mouth of the bag adapted to drag the bag through the water in constant spaced relation to the body, with the mouth disposed in the direction in which the bag is being dragged so that water may enter the mouth and fill the bag,

(*e*) transfer means for transferring the collapsed bag from the body into the slipstream, when desired, to be dragged by its affixed cord,

(*f*) and means for removing said plug,

(*g*) the construction and arrangement being such that when the plug is removed from the mouth of the bag, water enters the bag filling same and reacting with the water reactant material, producing gas which expels the water from the bag, producing sufficient buoyancy such that the bag may raise the body to the surface of the water gas being expelled through said mouth as the bag and body rise to the surface.

9. Apparatus for recovering a negatively buoyant sinking body, which apparatus becomes operative when the body has sunk to a predetermined depth in the sea and above the floor of same, comprising;

(*a*) an inflatable collapsed flexible bag having a mouth at one end of same,

(*b*) a removable plug closing said mouth,

(*c*) a water reactant material disposed within said bag adapted to produce gas,

(*d*) a cord having one end affixed to the body and its other end to the bag adapted to drag the bag through the water, with the mouth disposed in a position relative to the water such that water may enter the mouth and fill the bag,

(*e*) transfer means for transferring the collapsed bag into the slipstream, when desired, to be dragged by its affixed cord,

(*f*) means for removing said plug,

(*g*) the construction and arrangement being such that when the plug is removed from the mouth of the bag, water enters the bag filling same and reacting with the water reactant material, producing gas which expels the water from the bag, producing sufficient buoyancy such that the bag may raise the body to the surface of the water.

(*h*) a cavity within said body having an opening disposed at the top of same, when the body is moving horizontally, said cavity containing the bag, and

(*i*) a rudder adapted to be actuated prior to operation of the transfer means for turning the body about a horizontal axis to dispose said cavity at the top of the body, in event the body is sinking with its longitudinal axis disposed in a generally vertical position, whereby the bag is transferred to the slipstream during an optimum orientation of the body.

References Cited by the Examiner

FOREIGN PATENTS

372,923 4/07 France.

BENJAMIN A. BORCHELT, *Primary Examiner.*

FRED C. MATTERN, JR., *Examiner.*