United States Patent

Manuel

[15] **3,686,869**

[45] **Aug. 29, 1972**

[54] **BUOYANT BARRIER AND METHOD FOR INSTALLING THE SAME**

[72] Inventor: **James E. Manuel,** Belle Terre, N.Y.

[73] Assignee: **Versatech Corporation,** Nesconset, N.Y.

[22] Filed: **March 5, 1971**

[21] Appl. No.: **121,275**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 857,792, Sept. 15, 1969.

[52] **U.S. Cl.** ..... **61/1 F**

[51] **Int. Cl.** **E02b 15/04**

[58] **Field of Search** 61/1, 5; 210/121, 242

[56] **References Cited**

UNITED STATES PATENTS

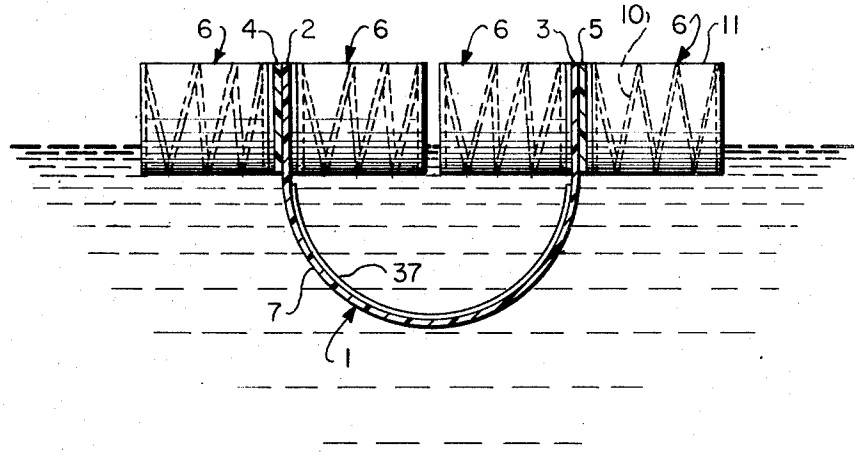
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Primary Examiner—Jacob Shapiro
Attorney—Roylance, Abrams, Berdo and Kaul

[57] **ABSTRACT**

A buoyant barrier, for confining oil spills and the like, comprises an elongated sheet of flexible material and a plurality of resiliently collapsible air chambers secured to the sheet and arranged in two series each extending along a different side edge portion thereof, the arrangement being such that the barrier can be flattened and wound on a reel, for storage and transport, and unwound from the reel and deployed on the surface of a body of water when in use. When the barrier is deployed, the inflated air chambers afford buoyant support, and the sheet extends in trough-like fashion to define a water chamber.

5 Claims, 7 Drawing Figures



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SHEET 1 OF 2

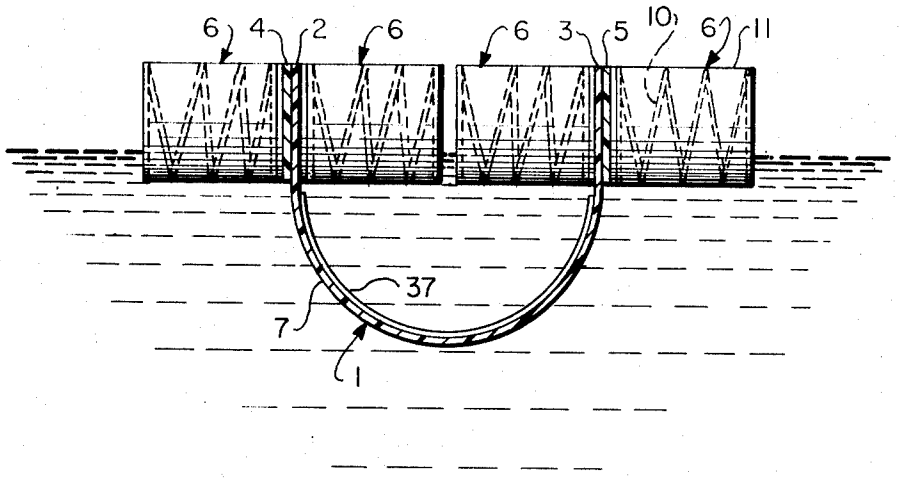


FIG. 1

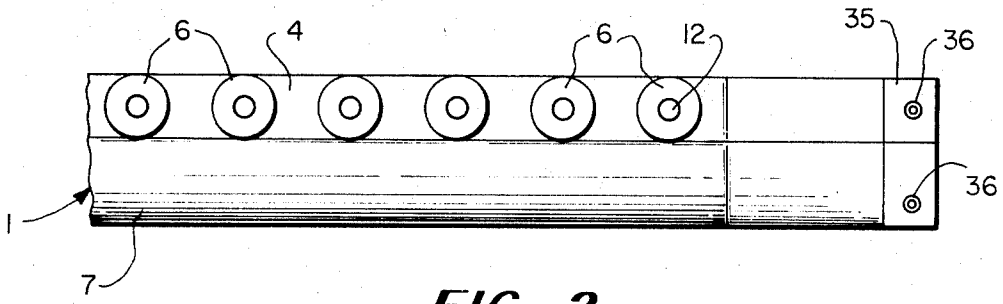
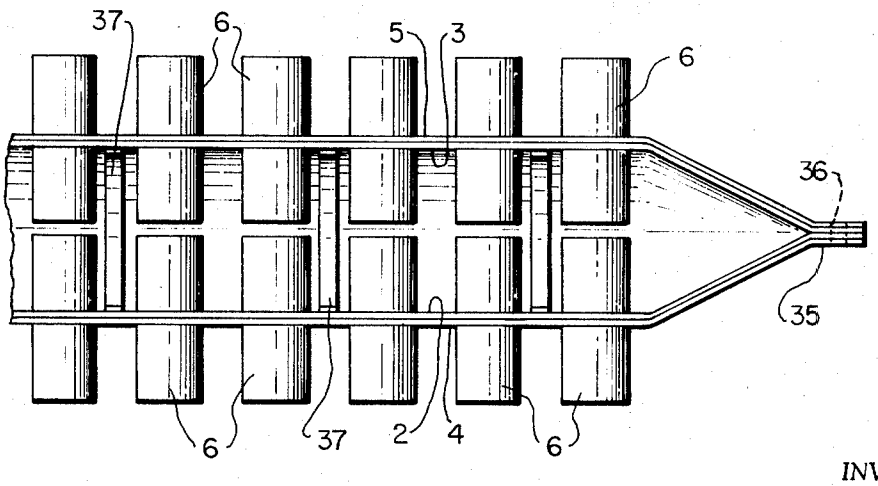


FIG. 2



INVENTOR
JAMES E. MANUEL

FIG. 3

BY Roylance, Abrams, Berdo & Kaul

ATTORNEYS

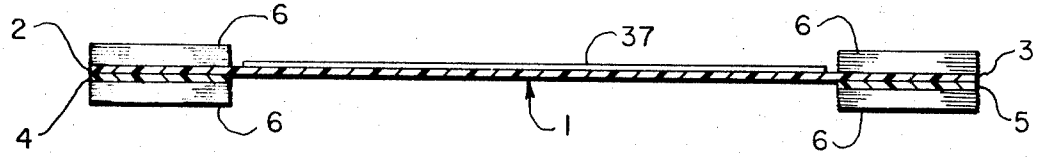


FIG. 4

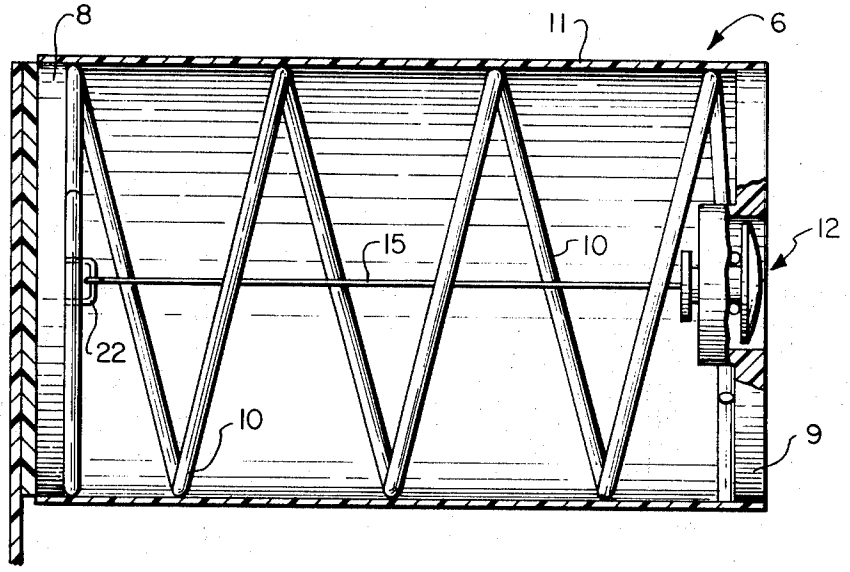


FIG. 5

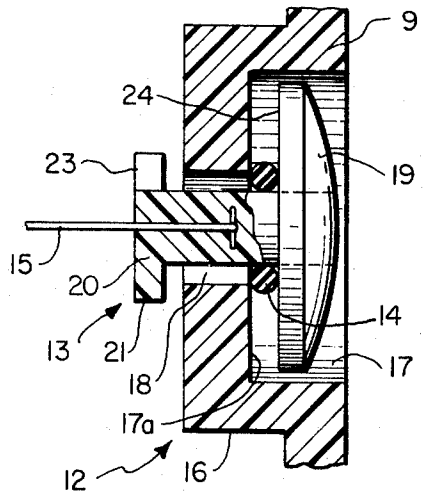


FIG. 6

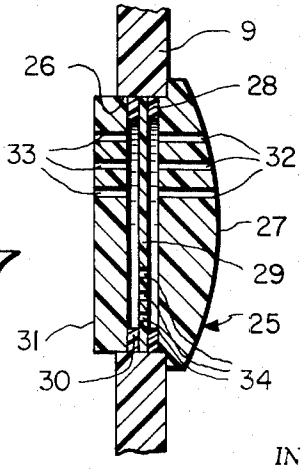


FIG. 7

INVENTOR
JAMES E. MANUEL

BY Lyon, Lyon, Abrams, Burkhart

ATTORNEYS

BUOYANT BARRIER AND METHOD FOR INSTALLING THE SAME

This application is a continuation-in-part of my copending application Ser. No. 857,792, filed Sept. 15, 1969.

This invention relates to buoyant barriers and methods for installing them. Though the invention is of broader utility, it offers particular advantage in the containment of floating pollutants, typically spilled oil.

In recent years, there has been a rapidly increasing need for an effective way to contain flowable pollutant materials spilled on the surface of a body of water. The problem is particularly critical with respect to oil spills which can occur, for example, at offshore wells or from tankers, refueling buoys, dock installations, and the like. Prior-art workers have proposed to employ for this purpose various kinds of buoyant enclosures, the enclosure usually being made up of a series of floats, typically of foamed polymeric material, with the floats each being provided with a skirt which depends into the water for a significant distance, the combination of float bodies and skirts combining to present a confining surface of considerable area. It has also been proposed to make the floats in the form of an inflatable structure fabricated from flexible sheet material. In such prior-art proposals, weight means is provided along the skirt, with the weight means having a specific gravity greater than that of water, to hold the skirt in its dependent position and to stabilize the overall structure. While such proposals have received considerable attention, and are frequently employed under those conditions where lengthy transport of the structure is not involved (as in the case of the problem of enclosing a tanker at dockside), the structures hereinbefore proposed have not been capable of being quickly and easily transported for long distances and then speedily installed at the point of use.

A general object of the invention is accordingly to devise a buoyant barrier, especially suitable for use in containing oil spills, which employs only structure and equipment which can be quickly transported, as by aircraft, delivered to the point of installation, and then quickly deployed on the surface of a body of water to contain the floating pollutant or other material.

Another object is to provide an elongated barrier structure which can be supplied in a single, lightweight package and which does not embody any weight means of a character which must be transported therewith.

A further object is to provide a buoyant barrier structure which is fabricated from flexible sheet material and can be deployed more quickly than has heretofore been possible.

Stated generally, buoyant barriers according to the invention comprise a flexible sheet having two generally parallel side edge portions, and a plurality of resiliently collapsible air chambers arranged in two series with the air chambers of each series secured to and extending along a different one of the two side edge portions of the sheet. Typically, each air chamber can be formed of flexible sheet material enclosing a helical compression spring, the air chambers being arranged with the axes of the springs perpendicular to the plane of the sheet to which the chambers are attached. The air chambers are provided with passage means, to allow inflow of air during inflation and outflow of air as the chambers are collapsed, and automatic valves are advantageously employed to close the passage means when the chambers are in inflated condition. The overall barrier structure is of such flexibility that it can be wound on a reel, with the air chambers collapsing in directions radial to the axis of the reel, and unwound from the reel for deployment, with the air chambers expanding resiliently for inflation as the barrier is unwound. When the barrier is deployed on the surface of a body of water, the inflated air chambers provide buoyant support, and the flexible sheet depends therefrom in through-like fashion to define a water chamber which stabilizes the floating barrier.

In order that the manner in which the foregoing and other objects are achieved according to the invention can be understood in detail, particularly advantageous embodiments thereof will be described with reference to the accompanying drawings, which form a part of the original disclosure of this application, and wherein:

FIG. 1 is a transverse sectional view of a buoyant barrier structure according to one particularly advantageous embodiment of the invention, with buoyancy chambers inflated and the structure illustrated in typical position on the surface of a body of water;

FIG. 2 is a side elevational view of an end portion of the barrier structure of FIG. 1;

FIG. 3 is a top plan view of the structure illustrated in FIG. 2;

FIG. 4 is a transverse sectional view of the barrier structure of FIG. 1, but with the structure in the collapsed and folded condition in which the same is stored;

FIG. 5 is a longitudinal sectional view of one of the air chambers employed in the barrier of FIGS. 1–4;

FIG. 6 is an enlarged longitudinal sectional view of a valve employed in the air chamber shown in FIG. 5; and

FIG. 7 is a view, similar to FIG. 6, illustrating a baffled air passage device useful as an alternative to the valve of FIG. 6.

Referring to the drawings in detail, FIGS. 1–6 illustrate a buoyant barrier according to one embodiment of the invention, with the barrier shown in deployed condition in FIGS. 1–3. The barrier comprises an elongated flexible water impervious sheet 1 having parallel side edge portions 2 and 3 to which reinforcing strips 4 and 5, respectively, are secured throughout the length of the sheet.

A plurality of resiliently collapsible air chambers, indicated generally at 6 and shown in detail in FIG. 5, are provided, air chambers 6 being arranged in pairs with each pair being secured to one of the edge portions 2, 3. The air chambers 6 of each pair carried by edge portion 2 of sheet 1 are opposed to each other, one end of one air chamber 6 being secured directly to edge portion 2 and projecting therefrom, the like end of the other air chamber being secured directly to strip 4 and projecting therefrom, and the pairs of air chambers being spaced along edge portion 2 throughout essentially the entire length of the edge portion, so that edge portion 2 thus carries two series of the air chambers. The air chambers 6 carried by edge portion 3 are arranged in the same fashion just described for those carried by edge portion 2.

The main body of sheet 1 extends as a greatly elongated rectangle. The combination of sheet 1 and air chambers 6 can be flattened and wound on a reel in the fashion described in my copending application Ser. No. 857,792, the winding operation causing the air chambers 6 to collapse to the condition shown in FIG. 4, so that a relatively great length of the barrier can be wound on a single reel. When the barrier is unwound from the reel, for deployment onto the body of water, air chambers 6 expand to inflated condition, as described in detail hereinafter, as soon as the restraint resulting from the wound configuration is removed.

The transverse width of sheet 1 between edge portions 2 and 3 is substantial. Accordingly, when the barrier has been deployed, the main body portion of the sheet can depend in trough-like fashion from the inflated air chambers, so that body portion defines a water chamber 7 for stabilizing the buoy. Water chamber 7 can be filled by pumping water into the trough as the buoy is deployed, or simply by immersing the barrier briefly in the body of water during deployment, such immersion being accomplished, for example, by running the barrier under an inflated buoyant roller disposed on the surface of the body of water and carried by the deploying vessel on which the reel is mounted.

Advantageously, air chambers 6 are all identical, constructed as shown in FIGS. 5 and 6. Each chamber includes a flat end member 8 of circular plan, an opposite end member 9 which is also generally flat and of circular plan, equal in diameter to member 8, a helical compression spring 10, an enclosing wall 11 of relatively thin flexible sheet material, and an automatic air valve indicated generally at 12. End member 8 is imperforate and is fixed to the exposed face of the corresponding reinforcing strip 2, 3, as by adhesive. The enclosing wall 11 can be a piece of extruded tubular sheet or film with the diameter of the tubular piece equal to the diameter of members 8 and 9, the end portions of the tubular piece each embracing the periphery of a different one of members 8 and 9 and being secured thereto, as by adhesive, in fluid-tight fashion. The spring 10 has one end engaged with the inner face of member 8 and the other end engaged with the inner face of member 9. Accordingly, spring 10 urges the device to its fully inflated condition, seen in FIG. 5, with wall 11 taut between end members 8 and 9, the spring 10 still being under light compression when the wall 11 is taut. Spring 10 and the flexible nature of wall 11 allows the chamber 6 to be collapsed axially to the condition shown in FIG. 4, with bellows action, under axial forces applied to the end members. Valve 12 allows atmospheric air to enter the chamber during inflation, and to exhaust therefrom, during collapsing, and excludes entry of water when the chamber is inflated.

As seen in FIG. 6, valve 12 comprises end member 9, as a fixed valve member, a movable valve member 13, a sealing ring 14, and a stop line 15. Member 9 is provided at its center with an axially offset portion 16 defining a circular recess 17 which opens through the outer face of member 9. Member 9 also includes a central bore 18 of circular transverse cross section. Movable valve member 13 includes a circular head 19, a cylindrical stem 20, and an end flange 21, stem 20 being initially separate from head 19, the head having a bore in which the stem is inserted and rigidly secured during assembly. Head 19 has a flat rear face 24 lying in a plane at right angles to the axis of stem 20 in the assembled device. One end of stop line 15 is secured to stem 20, as by being molded in place. The other end of the stop line is secured to end member 8, as by a suitable clip 22, FIG. 5, rigidly attached to the end member. Valve 12 is assembled, before application of wall 11, by inserting stem 20 through bore 18, applying sealing ring 14, inserting the tip of the stem into the bore in head 19, and securing the stem to the head.

When air chamber 6 is in the inflated condition shown in FIG. 5, line 15 is taut, holding head 19 in a position, relative to end member 9, such that ring 14 is compressed between face 24 of head 19 and surface 17*a* of recess 17. With the air chamber and valve in this condition, water cannot enter the chamber via the valve and the buoyancy afforded by the chamber is thus preserved even if the air chamber should be submerged briefly by wave action. The closing pressure applied to the valve by spring 10 depends upon the effective length of stop line 15 being somewhat shorter than the effective length of the tubular wall 11. Only a small positive closing pressure is required, however, because, should the air chamber be submerged, the hydrostatic head applied to head 19 will act to aid the closing pressure.

Valve 12 provides air passage means, including the space between the wall of bore 18 and the surface of stem 20, via which air can enter the air chamber during inflation and exhaust from the chamber during collapsing of the chamber. During collapsing, the effective pressure within the chamber tends to increase and, since axial collapsing allows stop line 15 to go slack, the valve opens to allow outflow of air. To assure free air passage even though flange 21 engages member 9, the flange can be provided with a plurality of radial slots 23. When the air chamber is free to expand under the action of spring 10, line 15 being slack, valve 12 is open to allow free inflow of air. To assure that ring 14 will not close the valve under the action of inflowing air, the ring can embrace stem 20 with a tight fit, so as to remain in a fixed position adjacent head 19 rather than being free to move along the stem 20. If desired, a light compression spring (not shown) can be inserted between head 19 and surface 17*a*.

From FIGS. 5 and 6, it will be noted that the depth of recess 17 in end member 9 is greater than the combined axial dimensions of head 19 and ring 14. Hence, a force can be applied to member 9 in a direction to collapse the air chamber, as during winding of the barrier, without interfering with operation of the valve.

In the embodiment shown in FIG. 7, valve 12 is replaced by a limited aperture device 25 secured in fluid-tight fashion in a bore 26 in member 9. Member 25 can be a rigid structure laminated from elements formed of a suitable polymeric material, and comprises an outer member 27, a ring 28, a flat plate 29, a ring 30, and an inner member 31. Members 27 and 31 are provided with at least one aperture 32 and 33, respectively, which may be aligned if desired. Intermediate plate 29 is provided with at least one aperture 34, offset laterally relative to apertures 32, 33. The inner diameters of rings 28 and 30 surround the locations of all of the apertures 32, 33 and 34. Accordingly, air can pass

freely through the apertures and the spaces between members 27 and 29 and 29 and 31, but direct inflow of water, as might result from wave action, is precluded.

Returning to FIG. 1, it will be noted that for each pair of the air chambers 6, one air chamber projects laterally away from the barrier, while the other air chamber of each pair projects inwardly to float on the water contained in trough 7. The interiors of the air chambers of each pair are mutually independent. Accordingly, the paired arrangement of the air chambers provides redundancy, assuring adequate buoyancy even though one or more air chambers are damaged.

To aid in deployment, the ends of the structure are folded to provide a flat upright tab 35, FIG. 2, equipped with eyelets 36 for attachment of retaining lines or other fastening means. A plurality of springs 37, FIGS. 1, 3 and 4, are advantageously secured to the main body portion of sheet 1, the springs having the arcuate configuration seen in FIG. 1 when in relaxed, undistorted condition, but being sufficiently resilient to be readily flattened to the condition shown in FIG. 4. The springs 37 extend transversely of sheet 1 and serve to assure that the main body portion of the sheet will assume the arcuate configuration seen in FIG. 1 when the barrier is deployed.

Sheet 1 and walls 11 can be fabricated from various types of commercially available fluid-impervious sheet materials, including extruded polymeric materials and composite fabrics. Extruded polyvinyl chloride sheet with a thickness on the order of 0.006–0.01 in. is particularly useful.

While particularly advantageous embodiments have been described, it will be understood by those skilled in the art that these embodiments are illustrative rather than limiting. Thus, while it is advantageous to have the collapsible air chambers cylindrical and oriented as shown, they can be of noncylindrical form and the invention is not limited to having the direction of collapse and inflation at right angles to the main sheet.

What is claimed is:

1. In a buoyant barrier for confining material, such as spilled oil, floating on the surface of a body of water, the combination of

a sheet of flexible material having two elongated at least generally parallel edge portions; and

a plurality of resiliently collapsible air chambers arranged in two series with each series extending along and attached to a different one of said edge portions,

each of said air chambers being of bellows-like configuration with the axes of the bellows extending perpendicular to the plane of the sheet when said sheet in in flat condition,

each of said chambers being equipped with air passage means arranged to allow air to flow into the chambers, during inflation thereof, and out of said chambers, during collapsing thereof;

the combination of said sheet and said chambers being of such overall flexibility as to be capable of being wound on a reel for storage and transport, with said air chambers collapsed, and also capable of being unwound and deployed on the surface of the body of water, with said air chambers expanding resiliently to inflated condition, when the barrier is in use,

said sheet having a width such that, when said chambers are inflated and the barrier deployed, said sheet depends from said chambers in trough-like fashion to define a water chamber, with the inflated air chambers supporting the barrier and with said edge portions projecting above the surface of the body of water.

2. The combination defined in claim 1, wherein said air chambers of each of said series are arranged in pairs with the air chambers of each pair aligned generally end-to-end with the respective edge portion of said sheet disposed therebetween so that, when the barrier is deployed, one of said air chambers of each pair projects laterally outwardly and the other air chamber of each pair projects inwardly so as to be supported by the water retained by the trough-like deployed configuration of said sheet.

3. The combination defined in claim 2, wherein the air spaces defined by each pair of said air chambers are mutually independent.

4. The combination defined in claim 1, wherein each of said air chambers comprises

wall means formed of a flexible sheet material, and

a helical compression spring contained within said wall means.

5. In a buoyant barrier for confining material, such as spilled oil, floating on the surface of a body of water, the combination of

a sheet of flexible material having two elongated at least generally parallel edge portions; and SHEET OF FLEXIBLE MATERIAL HAVING TWO ELONGATED AT LEAST GENERALLY PARALLEL EDGE PORTIONS: AND

a plurality of resiliently collapsible air chambers arranged in two series with each series extending along and attached to a different one of said edge portions,

each of said chambers being equipped with air passage means arranged to allow air to flow into the chambers, during inflation thereof, and out of said chambers, during collapsing thereof,

each of said chambers comprising automatic valve means operative to close the respective one of said air passage means when the air chamber has been inflated and to open the same as the air chamber is collapsed; EACH OF SAID CHAMBERS BEING EQUIPPED WITH AIR PASSAGE MEANS ARRANGED TO ALLOW AIR TO FLOW INTO THE CHAMBERS, DURING INFLATION THEREOF, AND OUT OF SAID CHAMBERS, DURING COLLAPSING THEREOF, EACH OF SAID CHAMBERS COMPRISING AUTOMATIC VALVE MEANS OPERATIVE TO CLOSE THE RESPECTIVE ONE OF SAID AIR PASSAGE MEANS WHEN THE AIR CHAMBER HAS BEEN INFLATED AND TO OPEN THE SAME AS THE AIR CHAMBER IS COLLAPSED:

the combination of said sheet and said chambers being of such overall flexibility as to be capable of being wound on a reel for storage and transport, with said air chambers collapsed, and also capable of being unwound and deployed on the surface of the body of water, with said air chambers expand-

ing resiliently to inflated condition, when the barrier is in use,

said sheet having a width such that, when said chambers are inflated and the barrier deployed, sad sheet depends from said chambers in trough-like fashion to define a water chamber, with the inflated air chambers supporting the barrier and with said edge portions projecting above the surface of the body of water.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,686,869 Dated August 29, 1972

Inventor(s) James E. Manuel

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, lines 30-33, cancel "SHEET OF FLEXIBLE MATERIAL HAVING TWO ELONGATED AT LEAST GENERALLY PARALLEL EDGE PORTIONS: AND".

Column 6, lines 46-59, cancel "EACH OF SAID CHAMBERS . . . AIR CHAMBER IS COLLAPSED:".

Column 7, line 5, "sad" should read --said--.

Signed and sealed this 6th day of February 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.