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3,016,866

BUOYANT PRESSURE VESSELS FOR GASES

Filed Sept. 12, 1960

2 Sheets-Sheet 1

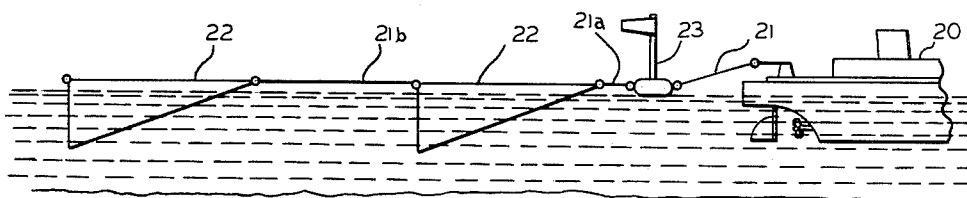


FIG. 1

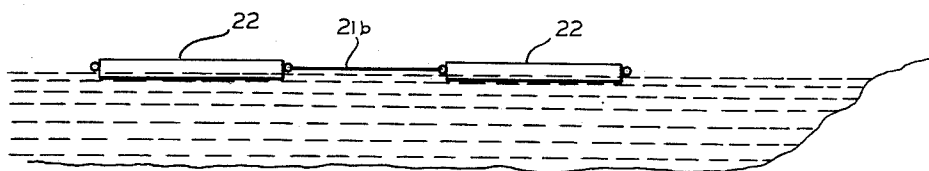


FIG. 2

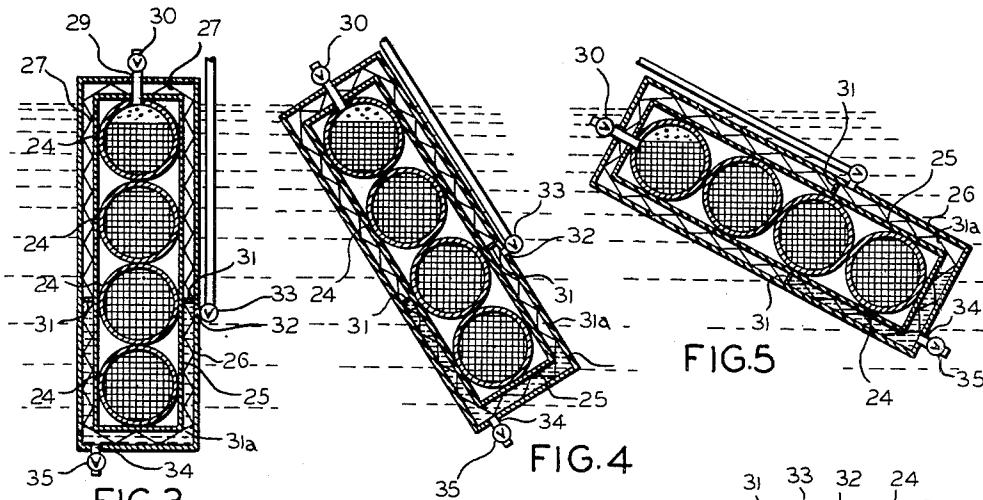


FIG. 3

FIG. 4

FIG. 5

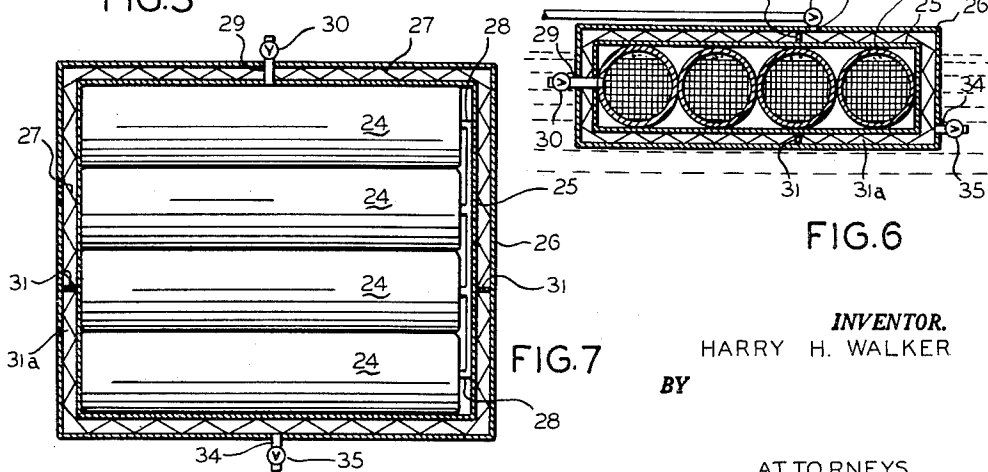


FIG. 6

FIG. 7

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2 Sheets-Sheet 2

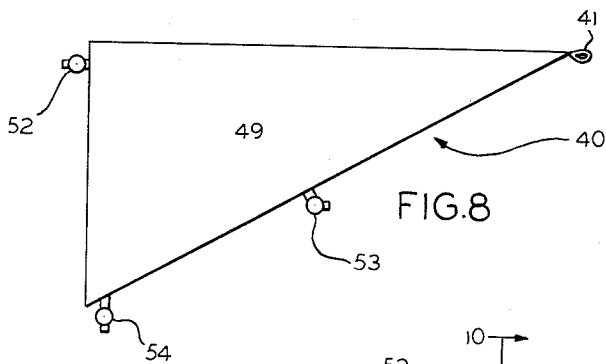


FIG. 8

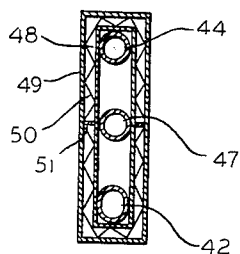


FIG. 10

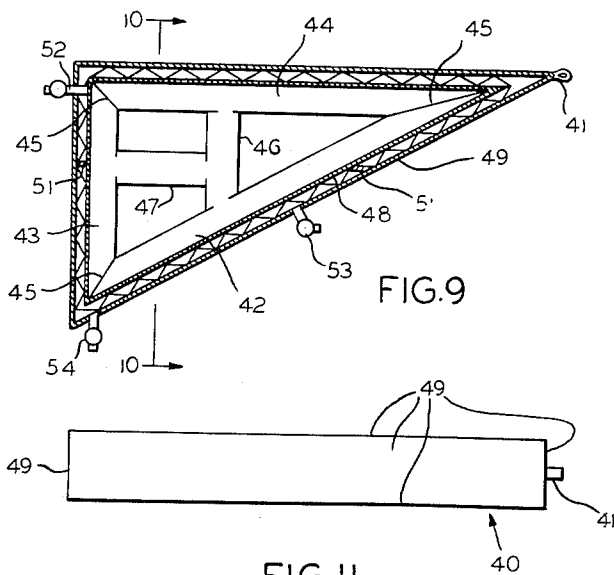


FIG. 11

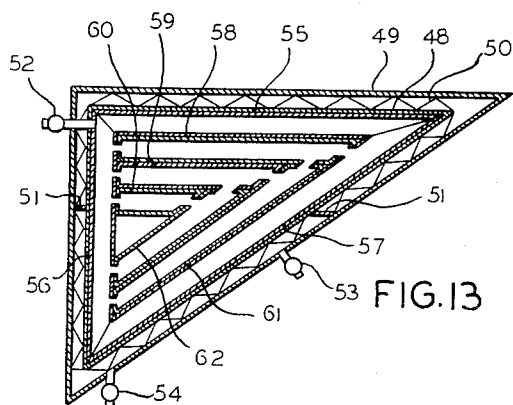


FIG. 13

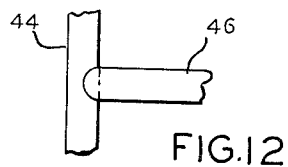


FIG. 12

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BUOYANT PRESSURE VESSELS FOR GASES

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4 Claims. (Cl. 114-74)

The present invention is directed to new and useful improvement in buoyant vessels for the transport of liquid petroleum, gaseous material, or liquified gases.

Present oceangoing tanker constructions have disadvantages in that due to their deep draft, they must be loaded and unloaded from a deep water pier or submarine mooring, which mooring involves running pipelines from the shore to the mooring point situated in deep water. These tankers are also unsuited to carry high vapor pressure liquids, such as liquified petroleum gases. The high vapor pressure of these liquids demands details of construction and handling equipment quite different from those associated with conventional forms of liquid cargo. At the present time these high vapor pressure liquids are usually refrigerated to a point where they have a low vapor pressure and can be transported as a liquid in insulated unpressurized tanks. Often times these high vapor pressure liquids are carried in independent pressure tanks in the customary type of cargo vessel that is fitted and arranged for the handling thereof. Since a major portion of the cost of liquified petroleum gases and liquids in general depends in a large measure on the cost of transport, and the associated cost of handling, it is obviously desirable to reduce these costs to as large an extent as possible.

Accordingly, a major purpose of the present invention is the provision of buoyant pressure vessels that are so formed as to be seagoing in nature and which are also so formed as to enable simple conversion from deep draft vessels to extremely shallow draft vessels, thereby enabling conversion thereof in deep water at a point close to a point of desired landing, at which time the vessels may simply be floated ashore, where they may be picked up and handled by ground equipment.

A related purpose of the invention is the formation of pressure vessels that can be manufactured and used in the transport of liquids or liquified petroleum gases on an economical basis.

Another related purpose of the invention is the provision of improved tank facilities for the transport of liquids or gases, the tanks being so arranged that they are easily towed through the water, converted at will from deep draft vessels to shallow draft vessels, and at the same time being such as to provide an extremely rugged and durable construction with the use of relatively thin walled sections throughout the vessel.

Another related purpose of the invention is the provision of a buoyant air chamber surrounding a vessel for the transport of liquid petroleum, or gases, or liquified gases, the chamber being so arranged that it provides a protective shell for the container proper and at the same time provides a ballast chamber which enables tilting of the vessel and thereby enables conversion of the vessel from a deep draft vessel to a shallow draft vessel.

Other objects and purposes will appear from time to time in the course of the ensuing specification and claims, when taken with the accompanying drawings, in which:

FIGURE 1 is a diagrammatic view of a string of pressure vessels formed in accordance with the present invention and being towed in deep draft position by an oceangoing tug or the like;

FIGURE 2 is a diagrammatic view of the vessels illustrated in FIGURE 1, but illustrating these vessels in shallow draft position;

FIGURE 3 is a cross-sectional view of a typical vessel

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formed in accordance with the present invention and taken along a vertical cross section when the vessel is in its deep draft position;

FIGURE 4 is a cross-sectional view of the vessel illustrated in FIGURE 3, but illustrating another position of the vessel during the tilting action thereof;

FIGURE 5 is a cross-sectional view of the vessel illustrated in FIGURES 3 and 4, but illustrating still another position of the vessel during the tilting thereof;

FIGURE 6 is a cross-sectional view of the vessel illustrated in FIGURES 3, 4 and 5, but illustrating the vessel in a horizontal or shallow draft position;

FIGURE 7 is a side view of the vessel illustrated in FIGURES 3 through 6, inclusive, with certain parts in section for purposes of clarity;

FIGURE 8 is a side view of vessels formed in accordance with the present invention and of the type illustrated in FIGURE 1;

FIGURE 9 is a cross-sectional illustration of the vessel illustrated in FIGURE 8 and taken along a vertical plane extending through the vessel, when the vessel is in a deep draft position;

FIGURE 10 is a sectional view of the vessel illustrated in FIGURES 8 and 9 and looking in the direction of the arrows 10-10 of FIGURE 9;

FIGURE 11 is a top view of the vessel illustrated in FIGURES 8, 9 and 10;

FIGURE 12 is a view illustrating certain details of the construction of cylindrical tubes constituting a portion of the vessel embodying the present invention; and

FIGURE 13 is a cross-sectional illustration of a further form of pressure vessel constituting the present invention. Like elements are designated by like characters throughout the specification and drawings.

With particular reference now to the drawings and in the first instance to FIGURE 1, numeral 20 designates a towing vessel which may be a seagoing tug. The towing vessel 20 includes a towing line 21, extending rearwardly thereof and which is adapted to be connected to several pressure vessels formed in accordance with the present invention, which vessels are designated at 22.

Each of the vessels 22 may be connected, by means of the tow lines 21a and 21b, to a towing support 23, which in turn is connected by means of the towing line 21 to the tug 20. Towing support 23 may form a mooring buoy for the vessels when it is desired to store them close to a shore line.

In accordance with the invention, each of the vessels 22 has a length and overall height greater than their width, so they may be positioned vertically for ease in towing through the water or may be positioned generally horizontally for ease in floating the vessels to a beach or shore line. The vessels may take anyone of several shapes meeting criteria as set out herein.

In FIGURES 3 through 7, for example, the vessels 22 are illustrated as being generally rectangular in side outline, whereas the vessels of FIGURE 1 are generally triangular in outline shape. In FIGURES 3 through 7, the vessels are shown as including a plurality of elongated cylindrical tanks 24 which are positioned in side by side, abutting relation. Inner and outer plates 25 and 26 surround the cylinders 24 with the inner plates 25 fixed, as by welding, to the cylindrical sides of the tanks 24. The outer plate 26 may be fixed to the inner plate 25 and held in spaced relation thereto as by any suitable braces 27, the showing of which is omitted in FIGURES 3, 5 and 6 for clarity. The inner and outer plates 25 and 26 thus define a protective envelope around the cylindrical vessels 24.

Each of the vessels is adapted for communication with each other as by means of the connecting tubes 28. An inlet for one of the tanks 24 is designated at 29 and may

include a control valve 30 which may be opened for admitting or discharging contents from the tanks 24.

The envelope defined by the plates 25, 26 is divided along the mid-section thereof as by means of barrier plates 31 which divide the envelope into air spaced above and below the barrier plates 31. One side of the vessel is provided with an air inlet fitting 32 which is adapted to be connected to a source of air under pressure. Inlet 32 may include a valve 33 which closes the inlet to the space 31a in the envelope. One side of the envelope may include a discharge fitting 34 which includes a valve 35 adapted to selectively open and close this fitting, which leads into space 31a.

By opening the valve 35, while the valve 33 is closed, water may enter into the ballast space 31a, thus shift the center of gravity of the vessel toward the lower end, as appears in FIGURE 3, and thus holding the vessel in the upright position illustrated in FIGURE 2.

By opening valve 35 and attaching fitting 32 to a source of air pressure, air will enter the space 31a and forcibly eject the water therefrom through the valve 35. When the water has been exhausted from the space 31a, the valve 35 is closed. The center of gravity of the vessel then shifts back towards the mid-point thereof and the vessel will undergo the tilting action illustrated in FIGURES 3 through 6, so as to assume a more or less horizontal disposition in the water.

FIGURE 8 illustrates a vessel having the triangular shape illustrated in FIGURE 1 and so formed as to provide the tilting action described for the form of the invention illustrated in FIGURES 3 through 7, inclusive. In FIGURE 8 a plurality of cylindrical tubes are used to define a triangular shape.

FIGURE 8 illustrates a triangularly shaped vessel 40 with a towing connection 41 at the apex of the triangle at which the longer side and hypotenuse meet. As will be noted from FIGURES 10 and 11, the vessel has an overall length and height substantially greater than its width, which width appears in the top view of FIGURE 11. As will be particularly noted in FIGURE 9, the vessel as defined by a plurality of cylindrical tubes 42, 43 and 44, the tube 42 forming the hypotenuse of the triangle, while the tubes 43 and 44 form the sides of the triangle. The end edges of each of these tubes are inclined to the longitudinal axes thereof as by cutting a normal cylindrical tube along a plane inclined to the axes of these tubes. These end edges 45 are so inclined that they mate with the edges of one another so that they may be welded together, thus forming a triangularly shaped vessel consisting of tubes in communication with one another.

Suitable bracing may be positioned between the tubes as by means of the intermediate cylindrical tube 46 which is welded to the tubes 42 and 44 as by means of a saddle joint which is illustrated in FIGURE 12. An additional bracing tube 47 may extend between the tube 43 defining the short side of the triangle and the bracing tube 46 and fixed to these tubes as by means of the saddle joint illustrated in FIGURE 12. Openings in the side walls of the tubes 42, 43 and 44 afford communication to and from the tubes 46 and 47 and tubes defining the sides of the triangle. These openings should be relatively small in size so as to equalize pressure in the several tubes without materially weakening the walls of the tubes.

It should be noted that the pressure forces in the tubes, which forces tend to separate the tubes at the joints, are exerted over a relatively large welded area due to the fact that the mating edges of the tubes are inclined to the longitudinal axes thereof.

The pressure vessel thus defined is enclosed by a ballast envelope defined by inner and outer plates 48 and 49, respectively, which plates extend completely around the vessel and which define an air and ballast space therein. The inner plates 48 are preferably welded to the side walls of the several tubes enclosed in this envelope. The outer plates 49 may be fixed to the inner plates and held

in spaced relation thereto as by means of bracing elements 50 of the same type illustrated in FIGURES 3 through 7, inclusive.

A barrier 51 is positioned between the inner and outer plates so as to seal off a space in the envelope above the barrier and below the barrier, thus providing an air space above the barrier and a ballast space below the barrier.

The vessel includes a suitable valved inlet fitting 52 for admitting gases or fluids to the several cylindrical tubes, a valved air inlet fitting 53 leading to the ballast space beneath barrier 51, and a valved water inlet and outlet fitting 54 leading to the ballast space.

As is the case with the form of the invention illustrated in FIGURES 3 through 7, inclusive, water may be admitted to the ballast space through fitting 54 when valve fitting 53 is closed, and this then disposes the center of gravity below in the lower region of the vessel. The vessel, or several interconnected vessels, may then be towed through the water in the deep draft position which is illustrated in FIGURE 1. When a landing area is reached, valve fitting 54 is opened and a source of air under pressure is then connected to fitting 53 so as to forcibly eject the water from the ballast space. After ejection, fittings 53 and 54 are closed and the center of gravity of the vessel rises therein and the vessel rolls over on its side, thereby becoming a shallow draft vessel, as illustrated in FIGURE 2, for landing purposes.

FIGURE 13 illustrates a triangularly shaped vessel similar to that illustrated in FIGURES 8 through 12. In FIGURE 13, however, substantially the entire space within the tubes 55, 56 and 57, which define the sides and hypotenuse of the triangle, respectively, are filled with bracing tubes which also carry liquid or gases. In FIGURE 13, for example, several tubes 58, 59 and 60 are positioned in side by side abutting relation and welded to one another, and also welded to one side of tube 55. Tubes 61 and 62 extend parallel to the tube 57 forming the hypotenuse and have their side walls welded to one another and with one of the tubes welded to the side wall of tube 57. All of the tubes in FIGURE 13 have their end edges formed on planes inclined to the longitudinal axes thereof, except for the end edges of the tubes 58, 59 and 60 adjoining the side tube 56. Those end edges of the interior tubes which adjoin the side walls of other tubes may be affixed thereto as by suitable saddle joints of the type illustrated in FIGURE 12.

The pressure vessel structure illustrated in FIGURE 13 also includes a ballast envelope defined by inner and outer plates 48 and 49 with suitable braces 50 and similar in all respects to the protective and ballast envelope defined in FIGURES 8 through 11. The structure also includes inlet and outlet fittings 52, 53 and 54 identical in all respects to the correspondingly numbered fittings in FIGURES 8 through 10.

The triangular shape of the vessels gives a streamlining effect which is advantageous in towing.

The particular triangularly shaped pressure vessels shown herein define a continuous gas or liquid vessel which may have high strength even with relatively thin walled tubes. In this connection, the mating edges of the tubes defining the triangles are so formed that the pressure forces which tend to separate the vessels at the joints are distributed over much larger areas than is the case where the ends of the cylindrical tubes are formed on planes extending perpendicularly to the axes of the tubes. The interior tube network, which may take the style illustrated in FIGURES 9 and 10, or the style illustrated in FIGURE 13, not only provides additional storage space for liquids or gases, but also is so formed as to resist the outward expanding forces that work on the tubes defining the sides of the triangle. It should be noted that since all of the tubes are in communication

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with one another, heavy end plates or castings customarily used with cylindrical vessels are unnecessary. As formed, the tubes, in effect, are endless, thereby attaining some of the advantages of doughnut-shaped pressure vessels in this respect.

All forms of the invention herein described are highly advantageous in the transport of high vapor pressure liquids or other liquids. The vessels are so formed that when the interior tubes are substantially filled with liquid, the vessels are sufficiently buoyant as to assume a riding position in the water on their sides, or in the shallow draft position. The center of gravity of the vessels is then at or near the midpoint thereof. When water is admitted to the ballast space, however, and the ballast space becomes filled with water, the center of gravity shifts so that the vessels assume an upright position in the water. When in the upright position the vessels may be balanced so that only the upper portions thereof extend above the water line, which not only improves the riding qualities of the vessels when towed through the seas, but as a corollary thereto reduces wave action on the vessels and reduces the towing power required.

The outer envelope for the vessels not only provides the air space and buoyant space necessary for conversion thereof from deep draft vessels to shallow draft vessels, but also provides a protective air wall surrounding the vessels, which wall is advantageous from the standpoint of protecting the vessels when they are landed on a beach and thereafter handled.

Groups of vessels of the type herein illustrated and described may be towed together and then moored close to a point of landing and maintained in the deep draft position. When it is desired to land the vessels, a suitable source of air pressure connected to the air inlet fittings easily ejects the water from the ballast spaces to allow the vessels to assume their shallow draft or generally horizontal position for landing.

The forms of vessels herein described are also highly advantageous in terms of requiring relatively low towing power. It is a known fact that a towing vessel expends much power due to the reactive forces between the wash of the propeller and the forward face of the vessel or vessels immediately behind the towing vessel and exposed to the wash. It is also known practice to tow vessels side by side and held apart with about six to eight inches between the sides of the vessel, so that this propeller wash will race between this space between the barges or towed vessels, and thus require less power than is the case where barges are held with their sides in abutting relation.

The herein described invention is highly advantageous in this respect in that the vessels are relatively narrow and when disposed in side by side relation, a large number of them, say eight or ten vessels, create many spaces for the passage of this propeller wash. In other words, where two barges or vessels having considerable width are spaced apart by six or eight inches for the passage of the propeller wash, only a single passage for this wash is provided; while with vessels of the type illustrated

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herein, eight or ten vessels connected side by side and spaced apart from one another may represent the same storage volume as two relatively wide vessels, while creating seven or nine spaces for the passage of the propeller wash. Thus, use of the vessels of the type disclosed herein enables the creation of a large number of spaces for the propeller wash with an attendant reduction of power required of the towing vessel.

Whereas I have shown and described certain operative forms of the invention, it should be understood that this showing and description thereof are to be taken in an illustrative or diagrammatic sense only. There are many modifications to the invention which will fall within the scope and spirit thereof and which will be apparent to those skilled in the art. The scope of the invention should be limited only by the scope of the hereinafter appended claims.

I claim:

1. A vessel for the marine transport of liquid or gaseous cargoes by towing comprising an inner tubular cargo containing structure, an enclosing outer chamber defined by spaced inner and outer skins, a partition horizontally dividing said chamber to define an upper buoyancy compartment and a lower water ballast compartment to cause the vessel to float in an upright position, the overall depth of the vessel being several times greater than its width, means for forcing air under pressure into the ballast compartment to expel the water ballast contained therein to cause the vessel when about to enter shallow waters to turn about a horizontal axis into a horizontal position to very materially reduce its draft, and means for flooding the said ballast compartment with water when it is desired to return the vessel to an upright deep draft position.

2. A vessel as claimed in claim 1 of substantially triangular shape, the vessel being provided at the point of intersection of the hypotenuse with one side, with means for connection with a towing vessel.

3. A vessel as claimed in claim 1, wherein said vessel has an overall rectangular shape and said inner cargo containing structure is defined by a plurality of cylindrical tubes positioned in side by side relation and joined to one another, said tubes being in communication with one another.

4. A vessel as claimed in claim 1, wherein said vessel has an overall triangular shape and said inner cargo containing structure is defined by a plurality of cylindrical tubes positioned in a similar triangular shape and joined to one another, said tubes being in communication with one another.

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