United States Patent

Phelps

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[54] MULTICYLINDER VESSEL FOR TRANSPORTATION OF FLUIDS

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[73] Assignee: **Warren Petroleum Corporation**, Tulsa, Okla.

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[52] **U.S. Cl.** ..... **114/16 R**, 114/74 A

[51] **Int. Cl.** **B63b 25/16**, B63g 8/00

[58] **Field of Search** ..... 114/74 A, 65, 16 R; 220/15

[56] **References Cited**

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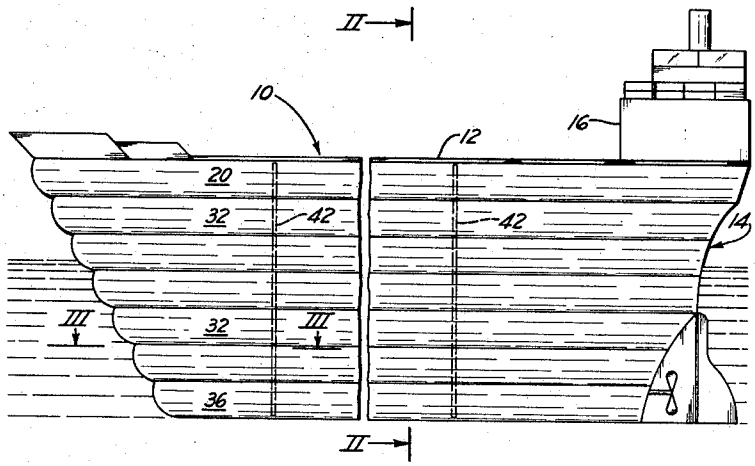
[57] **ABSTRACT**

Surface vessels and submarines for the transportation of large volumes of fluids are constructed of a plurality of cylindrical segments joined along their edges. The cylindrical segments serve both as the wall of the storage tanks in which the fluids transported are contained and the skin of the vessel. Webs joined to the junctures of the cylindrical segments extend across the interior of the vessel and are joined to junctures of cylindrical segments on the opposite side of the vessel.

9 Claims, 6 Drawing Figures



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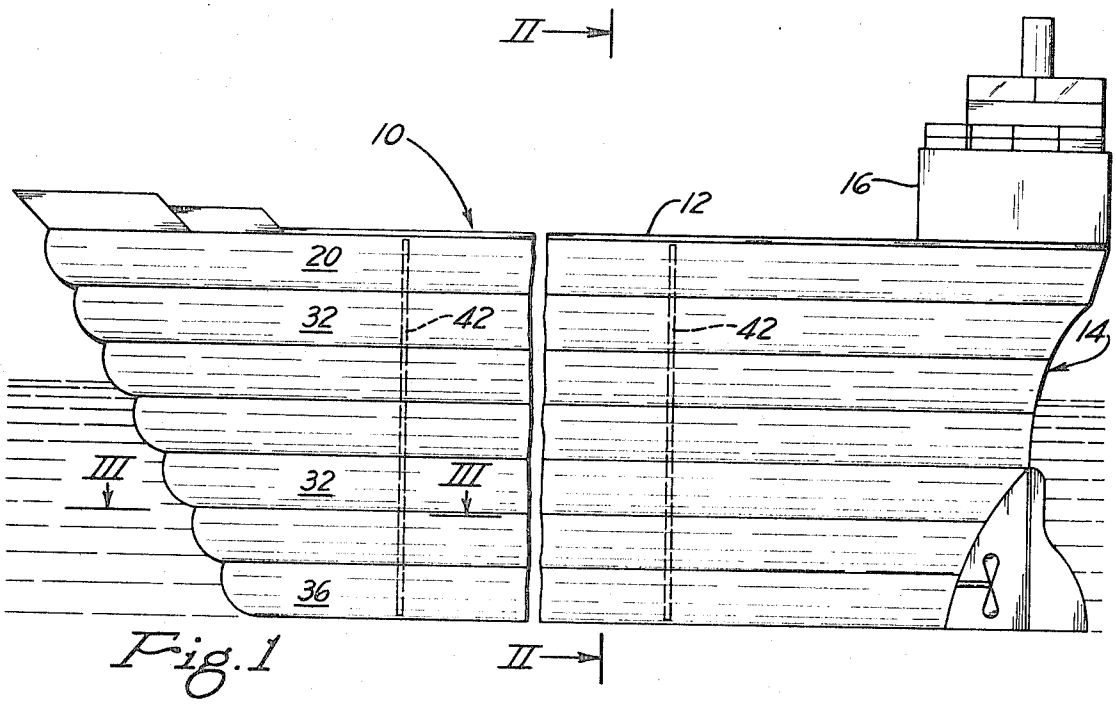

Fig. 1

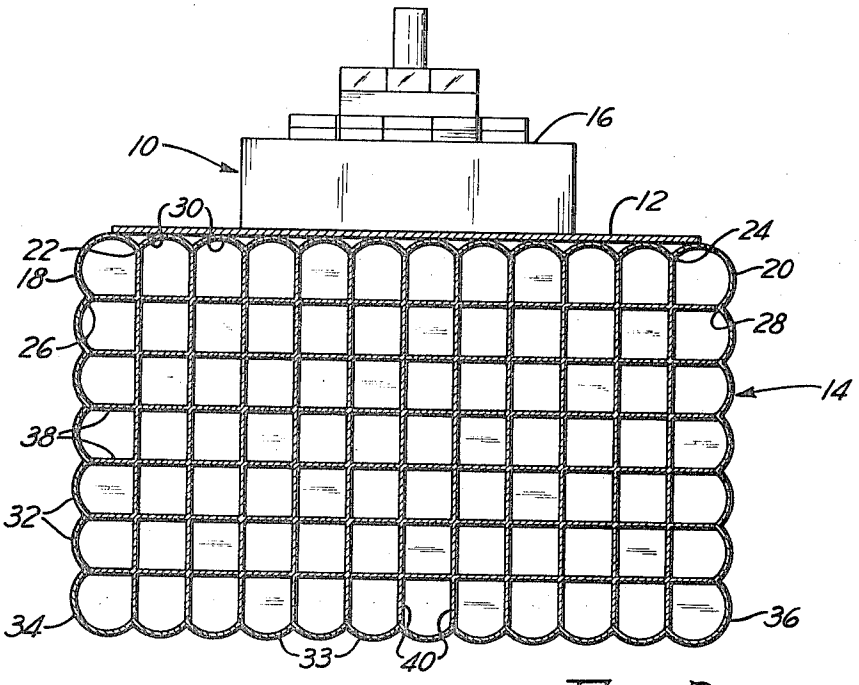

Fig. 2

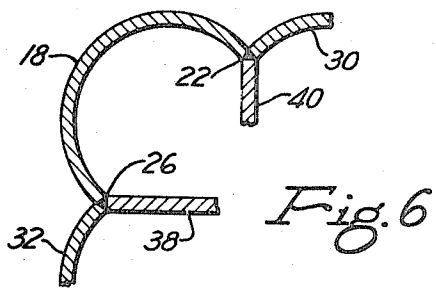

Fig. 6

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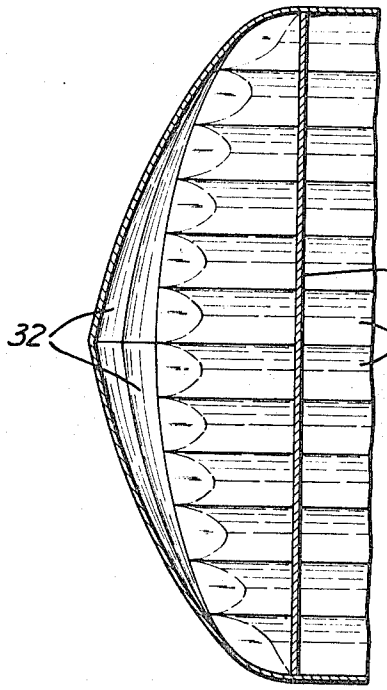

Fig. 3

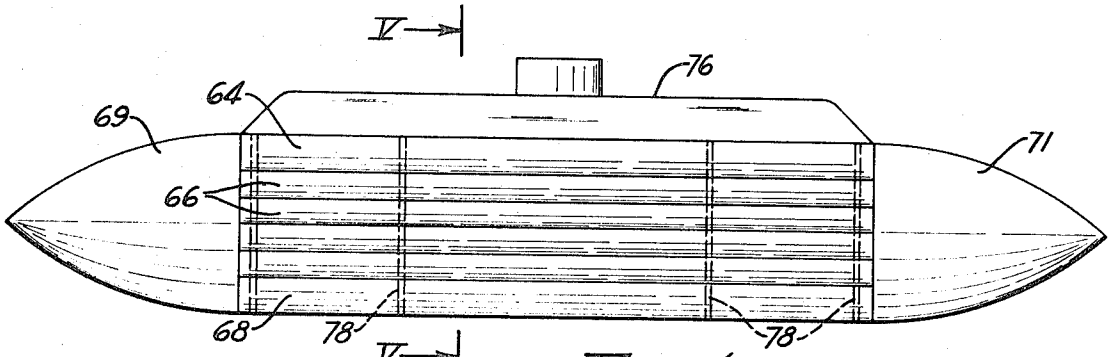

Fig. 4

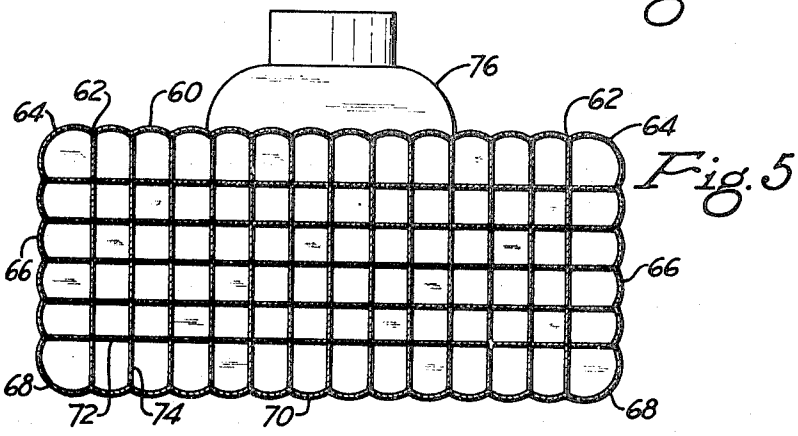

Fig. 5

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MULTICYLINDER VESSEL FOR TRANSPORTATION OF FLUIDS

This invention relates to the transportation of liquids and more particularly to a vessel for the transportation of liquids under a superatmospheric pressure.

During the last 10 or 15 years there have been discoveries of large subsurface oil reservoirs in countries such as Libya and Nigeria where the consumption of oil and other petroleum products is low. During the same period there has been a large increase in the consumption of oil and other petroleum products, including LPG and natural gas, in Europe. The production of oil at rates adequate to meet the increased demand has resulted in a concurrent increase in the production of hydrocarbon gases and gas liquids. While the recently constructed supertankers are suitable for the transportation of large amounts of crude oil, such tankers are not suitable for transportation of more volatile petroleum products of high vapor pressure such as LPG.

One of the remote areas in which petroleum will be produced in large quantities is the North Slope of Alaska. One method that has been suggested for the transportation of crude oil produced at the North Slope has been in submarine tankers, preferably driven by nuclear power, capable of transporting the oil under the ice in the Northwest Passage. Traditionally, the transverse sectional shape of a submarine is substantially circular. The depth of water in channels through which submarine tankers would pass limits the capacity of such tankers if they are of circular cross section to a small, uneconomical size.

This invention resides in a vessel for transporting fluids under superatmospheric pressure in which the hull is formed by a plurality of cylindrical segments substantially horizontally arranged and longitudinally joined together. A web extends across the interior of the hull from each juncture along which cylindrical segments are joined to another juncture. The cylindrical segments form both the wall of the containers in which the fluids are stored under pressure and the skin of the vessel.

In the drawings:

FIG. 1 is a elevational view of a tanker constructed in accordance with this invention.

FIG. 2 is a transverse sectional view taken along section line II—II in FIG. 1.

FIG. 3 is a fragmentary horizontal sectional view taken along section line III—III in FIG. 1 with the webs not shown.

FIG. 4 is an elevational view of a submarine constructed in accordance with this invention.

FIG. 5 is a transverse sectional view taken along section line V—V in FIG. 4.

FIG. 6 is an expanded sectional view of a juncture of cylindrical segments and a web.

Referring to FIG. 1, a tanker indicated generally by reference numeral **10** is illustrated having a hull **14**, over which there may be a deck **12**, and a pilot house **16** at the aft end of the tanker. As is best shown in FIG. 2, the hull **14** includes a pair of spaced apart, substantially horizontal corner cylindrical segments **18** and **20** at the upper and outer corners of the hull. The concave surfaces of the corner cylindrical segments **18** and **20** face downwardly and inwardly in the general direction of the center of the hull **14** to place their inner edges **22** and **24** extending toward each other a short distance below the deck **12**. The cylindrical segments **18** and **20** include an arc preferably in the range of 120° to 180° whereby the segment extends toward the center of the vessel beyond the vertical line through the center of curvature of the segment. The lower lateral edge **26** of corner segment **18** and lateral edge **28** of segment **20** extend downwardly below a horizontal line through the center of curvature of those two corner segments.

A series of upper cylindrical segments **30** are joined together along their lateral edges to form an upper closure for the hull **14**. The series of cylindrical segments **30** extend from lateral edge **22** of corner cylindrical segment **18** to lateral edge **24** of corner cylindrical segment **20** and are joined to those lateral edges by welding or other suitable means. If desired, the deck **12** may be omitted, and the upper surface of cylinders **30** will then serve as the deck.

Other series of longitudinally intersecting and joined cylindrical segments **32** form the sidewalls. Cylindrical segments **33** form the bottom and thereby close the hull **14**. In the embodiment of the invention illustrated in FIGS. **1** and **2**, the vessel is of generally overall rectangular shape in transverse section, and the interconnected cylindrical segments extending from the lower edge **26** to the lower edge **28** include lower corner cylindrical segments **34** and **36**. In the embodiment illustrated in FIGS. **1** and **2**, it is preferred that the cylindrical segments **30**, **32** and **33** include an arc equal to the arc by which the corner cylindrical segments **18**, **20**, **30** and **32** exceed 90° whereby the segments **30** and **32** and the corner cylindrical segments **18** and **20** have common tangents and the cylindrical segments **32** and **33** and the corner cylindrical segments **34** and **36** have common tangents. In the vessel illustrated in FIGS. **1**, **2**, and **3**, the cylindrical segments **30** across the top and segments **33** across the bottom of the hull are suitably shaped at their forward end, as indicated by the shading of segments **33** in FIG. **3**, to fit tightly along the edges of the corner segments to close the hull. Such structure is not essential to this invention, however, as the cylindrical segments may not extend the full length of the vessel and the vessel may be equipped with a conventional bow and stern.

Joined to each juncture of cylindrical segments are webs that extend across the interior of the hull **14** to another juncture of cylindrical segments on the opposite side of the hull. In the embodiment of the invention in FIGS. **1** and **2**, horizontal webs **38** extend laterally across the hull from junctures of cylindrical segments in a sidewall to junctures cylindrical segments in the opposite sidewall, and vertical webs **40** extend downwardly from junctures of cylindrical segments closing the top of the hull to junctures of cylindrical segments **33** forming the bottom of the vessel.

The webs **38** and **40** extend for the full length of the vessel. It is apparent that the webs **38**, for example, may be constructed of a series of plates welded in alignment to and between webs **40** or, vice versa, webs **40** may be a series of aligned plates welded to and between webs **38**. As indicated by broken lines in FIG. **1**, bulkheads **42** extend transversely across the vessel to divide the space within the hull of the vessel into the desired number of compartments. Webs **38** and **40** have holes to permit draining; however, some of the webs may be imperforate and serve, preferably with additional bracing, as bulkheads dividing the space within the hull **14** into the desired arrangement of storage compartments.

It is an advantage of the invention that the cylindrical segments serve both as a wall of a storage container and the skin of the vessel. The small radius of curvature of the cylindrical segments increases the rigidity of the resultant structure. The webs extending across the hull of the vessel carry much of the load forcing the sidewalls apart and thereby reduce the thickness of the cylindrical segments necessary to withstand the pressure in the storage compartments. Volatile liquids such as LPG, natural gasoline of high vapor pressure, or crude oil "spiked" with propane can be shipped under pressure in the vessel illustrated in FIGS. **1** and **2**. The vessel structure utilizing this invention combines efficient utilization of steel with maximum structural competence to successfully and safely combat the variable and complex combinations of internal and external pressures, bending moments, torques and thrusts to which both submersible and surface vessels are subjected.

The vessel construction of this invention is particularly advantageous in submarines for the transportation of crude oil as well as more volatile hydrocarbons beneath the ice in arctic regions. Such vessels must be able to withstand pressure from outside the vessel when submerged. If the submarine is used to transport volatile hydrocarbons, the vessel must withstand superatmospheric pressures within the compartments. When the submarine surfaces, the direction of the pressure differential across the skin of the vessel may be opposite that existing when the vessel is submerged. The multicylinder construction has the intrinsic ability to withstand both internal and external pressures to which a submarine is subjected.

Referring to FIGS. 4 and 5, the submarine is diagrammatically illustrated having a generally rectangular shape in transverse section to provide a submarine tanker of large capacity able to submerge in water of minimum depth. It is an advantage of this invention that a vessel of any reasonable ratio of width to height can be constructed. The submarine is constructed of a series of horizontal longitudinal cylindrical segments **60** joined along their lateral edges to form the upper surface of the submarine hull. The free edge **62** of each of the end cylindrical segments **60** in the series is joined to the edge of a corner cylindrical segment **64**. Similarly, the sidewalls of the hull of the submarine consist of a series of longitudinally intersecting and joined cylindrical segments **66** which extend from the lower edge of the corner segments **64** of the upper edge of lower corner segments **68**. The bottom of the submarine consists of a series of cylindrical segments **70** extending from the inner edge of one of the corner segments **68** to the inner edge of the opposite corner segment **68**. In the submarine illustrated in FIG. **5**, the cylindrical segments **70** extend over the middle portion of the vessel and are connected at their forward and aft ends to a conventional bow **69** and stern **71**, respectively.

Webs **72** extend across the hull of the submarine from the juncture of cylindrical segments **66** in one sidewall to the juncture of cylindrical segments **66** in the opposite sidewall. Vertical webs **74** extend from the juncture of cylindrical segments **60** in the top of the hull to the juncture of cylindrical segments **70** in the bottom of the hull.

In the embodiment illustrated in FIGS. **5** and **6** of the drawings, a cylindrical segment **76** of larger diameter than the other segments extends longitudinally along the upper surface of the vessel to provide space for living quarters for the crew, pipes and pumps for loading or unloading the submarine and other necessary equipment. As indicated by broken lines in FIG. **5**, the submarine is divided into compartments by bulkheads **78**.

The multicylinder hull structure of this invention can be used for tankers, barges and submarines for the transportation of fluids under superatmospheric pressure. The single wall thickness serving both as a wall of the pressure container and the skin of the vessel provides an important saving in steel and increase in the storage capacity of the vessel. The ability of the multicylinder vessel to withstand pressure allows a blanket of inert gas such as nitrogen or hydrocarbon gas to be maintained at superatmospheric pressure over liquid in the storage compartments to prevent air entering the storage compartment and thereby to eliminate any possibility of an explosive mixture forming in the storage compartments. The elimination of air from the storage compartments also greatly reduces corrosion of the cylindrical segments.

I claim:

1. A vessel for the transportation of liquids under superatmospheric pressures having a hull comprising a pair of substantially horizontal, spaced-apart, corner cylindrical segments extending longitudinally of the vessel, said corner cylindrical segments including an arc of approximately 120° to 180° and having their concave surfaces facing inwardly and downwardly, the inner lateral edge of the two corner cylindrical segments being at the same elevation and the lower lateral edge of the two corner cylindrical segments being at the same elevation, a first series of a plurality of horizontal cylindrical segments joined longitudinally along lateral edges thereof extending between and joined to the inner lateral edges of the two corner cylindrical segments to form the upper surface of the hull of the vessel, a second series of a plurality of cylindrical segments joined along their lateral edges, said second series extending between and joined to the lower lateral edges of the two corner cylindrical segments to form the sides and the lower surface of the hull of the vessel, means closing the forward and aft ends of the hull of the vessel, the cylindrical segments forming the skin of the vessel and a wall of pressure storage compartments within the vessel, and a web extending across the interior of the hull from each juncture of two cylindrical segments to a nonadjacent junction of two other cylindrical segments.

2. A vessel as set forth in claim **1** in which the cylindrical segments in the first series and the corner segments have a common tangent.

3. A vessel as set forth in claim **1** in which some of the webs are imperforate to form bulkheads dividing the hull of the vessel into compartments.

4. A vessel as set forth in claim **1** in which walls extend tranversely of the hull to form bulkheads dividing the hull into compartments.

5. A vessel as set forth in claim **1** in which the second series of cylindrical segments includes two spaced-apart corner segments of 120° to 180° substantially directly below the other corner segments whereby the hull has an overall generally rectangular shape in transverse section.

6. The invention as set forth in claim **1** in which the vessel is a submarine.

7. The invention as set forth in claim **1** in which the vessel is a submarine having a hull of substantially greater width than height.

8. A vessel for the transportation of liquids under superatmospheric pressures having a hull comprising a pair of substantially horizontal, spaced-apart, corner cylindrical segments extending longitudinally of the vessel, said corner cylindrical segments including an arc of approximately 120° to 180° and having their concave surfaces facing inwardly and downwardly, the inner lateral edge of the two corner cylindrical segments being at the same elevation and the lower lateral edge of the two corner cylindrical segments being at the same elevation, a first series of a plurality of cylindrical segments joined longitudinally along lateral edges thereof extending between and joined to the inner lateral edges of the two corner cylindrical segments to form the upper surface of the hull of the vessel, a second series of a plurality of cylindrical segments joined along their lateral edges, said second series extending between and joined to the lower lateral edges of the two corner cylindrical segments to form the sides and lower surface of the hull of the vessel, said cylindrical segments being shaped at their forward and aft ends to close the hull of the vessel, the cylindrical segments forming the skin of the vessel and a wall of pressure storage compartments within the vessel, and a web extending across the interior of the hull from each juncture of two cylindrical segments to a nonadjacent juncture of two other cylindrical segments.

9. A vessel as set forth in claim **1** wherein the corner cylindrical segments and the cylindrical segments in the first and second series have substantially the same radius of curvature.

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