April 30, 1963 H. L. LORENTZEN 3,087,454

TANK VESSEL

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FIG. 1.

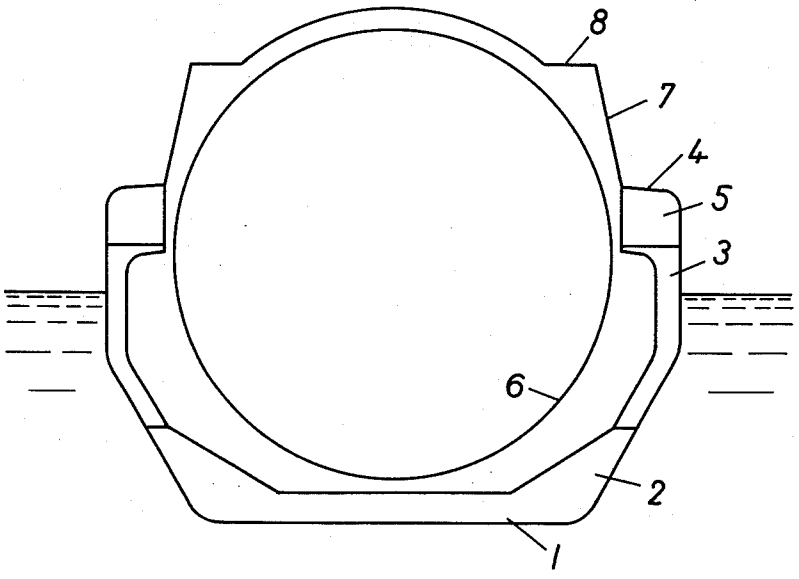

FIG. 2.

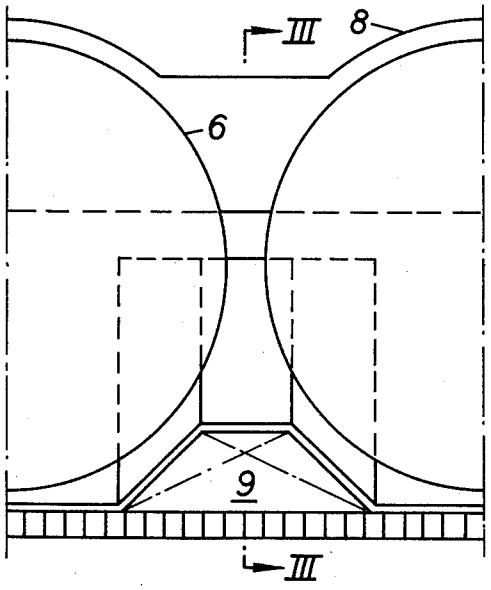

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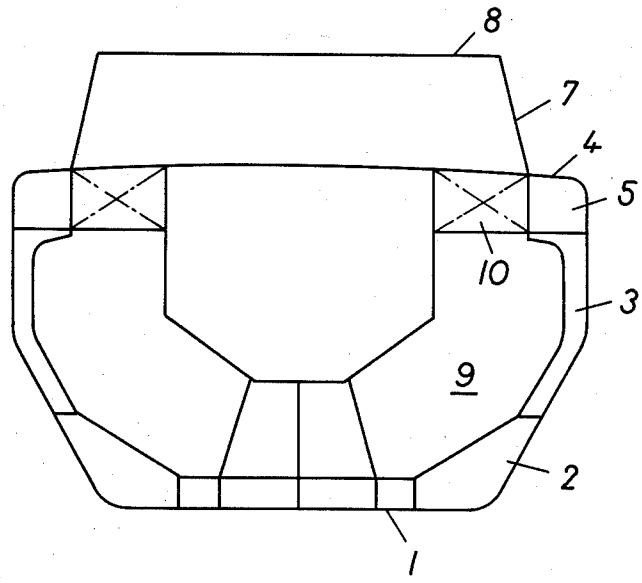
FIG. 3.



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TANK VESSEL

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1 Claim. (Cl. 114—74)

The present invention relates to improvements in the construction of tank vessels having tanks which are adapted for the transportation of liquids and which are built into the hull.

The cubic capacity of the tanks depends upon the specific weight of the liquid to be transported. If the specific weight of the liquid is small, such as in the case of condensed propane or methane, the tanks must be so big as to extend to a rather great height in the associated vessel in order that the carrying capacity of the vessel be optimally utilized. Thus if the tanks are designed to resist a high pressure and, consequently, are rather heavy, it may be difficult to maintain a sufficient stability for the vessel.

In cases in which the tanks are intended for the transport of condensed gas and, for the purpose of facilitating heat insulation, are made spherical or cylindrical, the conventional hull shape is encumbered with certain disadvantages. For example, the conventional transverse cross section of substantially rectangular shape with a slight curvature at the bilge leaves a superfluous space or displacement between such tanks and the ship's side at the bilge with the result that the center of gravity of the total displacement is situated at a relatively low level, a fact which is unfavorable to stability.

It has been suggested to build such tank vessels with a transverse shape which over a substantial part of the length of the ship is more or less adapted to the cross sectional shape of the tanks, i.e. more or less shaped in circle arcs or approximately circle arcs. Such a vessel would, however, be encumbered with the disadvantage that the distribution of the material in the hull is unfavorable to the fore-and-aft strength of the vessel, and that the seagoing qualities of the vessel, i.e. the stability characteristics and the rolling movements of the same become less satisfactory unless relatively big bilge keels are provided.

For the purpose of providing sufficient stability, it has also been suggested to provide fore-and-aft bulkheads in the tanks, but this is complicated and entails increased weight and costs. The construction of particular ballast tanks for the purpose of securing stability has also been suggested, but is also an unnecessary complication. An increase of the width of the vessel sufficient to provide a positive stability would result in a shape of the vessel which would be unfavorable both with regard to the utilization of space, the seagoing qualities and the speed.

An object of the present invention is accordingly to provide a hull shape having improved stability compared with the hull shapes referred to above, and providing also a material distribution in the hull which is more favorable to the fore-and-aft strength of the vessel.

According to the invention, a hull is provided, over a substantial part of its length or in that part of the hull in which the tanks are located, with a transverse shape which departs from the conventional shape referred to above in that instead of having a slight curvature at the bilge, a greater cross sectional area is cut off in that region. As a result, the displacement center of gravity is shifted to a higher level and the stability increased. The area of the remaining part of the transverse section, required to provide for the desired stability or metacentric height of the vessel, essentially depends upon the specific weight of the liquid to be transported. When the specific weight of the liquid is small and the tanks

consequently relatively big and high, it may be necessary to cut off such a sectional area that the remaining sectional area up to the deep load line is merely about 75 percent of the same area when no portion is cut away. When, on the other hand, the specific weight of the liquid is greater, it may be sufficient to cut off only so much as to leave an area amounting to about 90 to 95 percent of the un-cut area.

Conveniently, the line defining the cut off portion is a straight or approximately straight line extending at an angle of about 45° or preferably somewhat steeper to the horizontal, to the effect that the width of the bottom of the vessel is considerably less than that of vessels of a conventional shape. The said line should be so positioned that the usually vertical part of the ship's side above the cut off portion extends downwardly to about the level of the draught line of the vessel under empty or ballast conditions, whereby the vessel at all draughts may lay steadily alongside a quay.

Conveniently, the hull is made so high relatively to the tanks that the top of the hull is situated at a slightly higher level than that of the center of the tank cross section and, preferably, a main deck is also laid at that level. A lighter superstructure with a deck may be placed above the main deck, possibly provided with expansion means for covering the tanks.

The fore-and-aft space between succeeding tanks of spherical shape, or having bottoms shaped as sphere segments, conveniently is utilized to locate a tank which, in the transverse plane, is of a U-shaped cross section and which may be extended somewhat upwardly along the ship's sides and formed as a frame structure.

The accompanying drawings schematically illustrate a vessel structure according to one embodiment of the invention, the vessel having built-in spherical tanks.

In the drawing: FIGURE 1 is a cross sectional view of the hull and one tank; FIGURE 2 is a fore-and-aft sectional view of a portion of the hull with two tanks; and FIGURE 3 is a cross sectional view of the hull taken along line III—III of FIGURE 2.

In FIGURE 1, **1** is the bottom of the vessel, shown in the form of a double bottom. The width of the bottom is substantially less than conventional in vessels of a similar total width, and the cross section consists, according to the invention, in a straight or approximately straight oblique portion **2** and an upper essentially vertically extending portion **3** at the top end of which the main deck **4** is located. For purposes of strength, the connection between the deck **4** and the frame forming the portions **2, 3** is made in the form of a box structure **5**, which conveniently may serve as a pipe channel. **6** is a tank, the top portion of which projects above the level of the main deck **4**. All tanks in the vessel are covered by a superstructure **7** provided with a deck **8**, the superstructure **7** being located on the main deck **4** and preferably being of a light construction. As shown in FIGURES 1 and 2, the deck **8** may follow the shape of the tank tops.

As shown in FIGURES 2 and 3 a tank **9** is accommodated between adjacent tanks in the fore-and-aft direction, such tanks being of a U-shaped cross section in the transverse direction and extending, as indicated with dash lines in FIGURE 2, upwardly along the sides of the vessel, while being in the fore-and-aft direction shaped approximately according to the shape of the adjacent tank surfaces. The portions of the intermediate tanks extending upwardly are, suitably, in the form of a frame structure. The tanks **9** do not extend to the main deck and the space **10** situated between the top of the tank and the deck may be utilized as service rooms, such as pump rooms.

In the drawings, spherical tanks are shown, such shape being the most favorable with regard to heat transfer and

strength. Horizontally extending tanks may have a circular transverse cross section, but the lower portion of the tank may also be made with a shape other than precisely circular but which is generally circular, such as a polygon, preferably more or less adapted to the hull of the vessel, whereby the tank capacity may be increased at the same time as the position of the center of gravity of the load is lowered. The top portion of the tank should maintain a circle shape or be of otherwise upwardly restricted cross sectional area for the purpose of reducing the area of the free surface of the liquid in the tank.

What is claimed is:

A vessel comprising an elongated hull having a bottom, sides and a main deck level and including a portion of substantially rectangular cross-section extending downwardly from said main deck level and a portion of inverted trapezoidal shape extending downwardly from the first said portion, said portions having a junction defining a maximum width of said vessel transverse to said hull, said trapezoidal portion providing a vessel bottom of reduced with, a plurality of tanks longitudinally disposed in said hull and adapted for storing liquefied gas therein, each said tank having a substantially circular cross-section with a width substantially equal to that of said vessel and projecting above said main deck level, a U-shaped tank between and adjacent the first said tanks below said main deck level and supported on the vehicle bottom and

extending upwardly along the vehicle sides; said vessel being adapted, in loaded condition, to assume a level in the water defining a deep draft line delimiting a vessel portion which is submerged when the vessel is loaded, said vessel portion including said trapezoidal portion and having an area between about 75 to 95 percent of the area of a rectangle having sides corresponding to said maximum width and the distance between said deep draft line and the bottom of the vessel thereby providing stability for said vessel.

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