

PATENT SPECIFICATION

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(54) MARINE VESSELS

(71) I, ALFRED ALPHONSE YEE, a Citizen of the United States of America, of 1441 Kapiolani Boulevard, Honolulu, Hawaii, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to marine vessels.

According to one aspect of this invention a marine vessel for storage, support or transportation of material comprises continuous rigid peripheral wall, a generally horizontal continuous rigid bottom wall extending across the area bounded by the lower portion of said peripheral wall to define an enclosure a plurality of rigid walls defining a closed periphery in horizontal section and rigidly connected to and extending axially upward from said bottom wall to define a plurality of compartments separate from each other, a generally horizontal rigid top wall extending over the enclosure at least one intermediate wall generally paralleling said top and bottom walls and being disposed in adjacent spaced relation to one of said top and bottom walls and further rigid walls defining a closed periphery in horizontal section and extending from the or each intermediate wall to the adjacent top or bottom wall, and defining a plurality of compartments separate from each other, said rigid and further rigid walls, peripheral wall, top and bottom walls and intermediate wall or walls being of integral cementitious construction with the rigid walls being rigidly connected with each other, and the further walls being rigidly connected with each other.

According to another aspect of the invention a concrete marine vessel comprises a concrete marine vessel comprising a generally horizontal monolithic bottom wall, upstanding side walls and end walls extending from the bottom wall and a generally

horizontal top wall extending from the side and end walls to define an enclosure, an intermediate cargo deck spaced above the bottom wall, a plurality of cylindrical walls extending from the bottom wall and intermediate deck, said intermediate deck having less horizontal dimensions than the bottom wall and top wall, vertically extending walls inter-connecting the bottom wall and top wall outwardly of the intermediate deck with certain of the walls and interconnecting webs outwardly of the intermediate deck constituting a partition wall for a cargo hold in which the intermediate deck forms the bottom wall.

Embodiments of the invention may have a hull of the open deck or closed deck type and a plurality of vertical annular walls extend between the decks but are not necessarily continuous between the top and bottom decks but rather, the vertical walls may extend between the bottom deck and an intermediate deck or between the top deck and an intermediate deck or between intermediate decks with the entire structure being of one piece concrete construction thus enabling the vessel to be constructed with cargo receiving holds, tanks and the like.

The invention may be performed in various ways and some specific embodiments will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1 is a perspective view of a marine vessel in the form of a light barge having a plurality of longitudinally spaced holds therein;

Figure 2 is a top plan view of the construction of Figure 1 illustrating further structural details of the marine vessel illustrated in Figure 1 with portions of the top deck broken away;

Figure 3 is a longitudinal vertical sectional view taken substantially upon a plane pas-

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sing along section line 3-3 of Figure 2 illustrating further structural details of this embodiment of the invention;

5 Figure 4 is a transverse, sectional view, on an enlarged scale, taken substantially upon a plane passing along section line 4-4 of Figure 3 illustrating further structural details of the decks, partition walls and vertical annular walls;

10 Figure 5 is a perspective view of a storage barge illustrating continuous top and bottom decks but compartments therein;

15 Figure 6 is a top plan view of the construction of Figure 5 illustrating the internal structural details of the barge with portions of the top deck being broken away for that purpose;

20 Figure 7 is a transverse, sectional view taken substantially upon a plane passing along section line 7-7, on an enlarged scale, illustrating further structural details of this embodiment of the invention;

25 Figure 8 is a perspective view of a river barge illustrating a continuous cargo hold extending substantially throughout the length of the barge;

30 Figure 9 is a top plan view of the embodiment of the invention illustrated in Figure 8 with portions of the top deck and cargo deck being broken away to illustrate the structure of the vertical annular walls;

35 Figure 10 is a longitudinal vertical sectional view taken substantially upon a plane passing along section line 10-10 on Figure 9 illustrating further structural details of this embodiment of the invention; and

40 Figure 11 is a transverse, sectional view taken substantially upon a plane passing along section line 11-11 on Figure 10 illustrating further structural details of this embodiment of the invention.

Referring now specifically to Figures 1-4 of the drawings, a marina vessel in the form of a barge is generally designed by reference numeral 20 and includes a bottom 22, a top deck 24, substantially vertical peripheral side walls 26, a bow 28 that tapers inwardly and curves upwardly as illustrated in Figures 1-3 and a stern provided with a rudder 30 depending below the upwardly slanted bottom 24 with the stern of the barge also having a notch 32 and 34 therein.

55 Spaced above the bottom 24 is an intermediate deck or cargo deck 36 which generally parallels the bottom and terminates at the bow section and slightly beyond the upwardly slanted rear portion of the bottom 24 as illustrated in Figure 3. The top deck 24 is provided with a plurality of openings 38 therein which give access to a plurality of longitudinally spaced cargo receiving holds 40 in which the openings 38 has a smaller dimension than the interior dimensions of the cargo space or hold 40 and is defined by a vertical wall or flanges 42 which extends

both above and below the top deck 24 for a short distance as illustrated in Figure 4. Each of the side walls of each of the holds 40 or cargo receiving areas is constituted by a partition wall 44 that extends from the top deck 24 to the bottom 22 in intersecting relation to the cargo deck 36 and slightly inclined from top to bottom with the loer end being inwardly of the upper end as illustrated in Figure 4. The partition wall 44 may also be oriented in a vertical position when desired. The two end walls of each of the holds 40 are constituted by a plurality of vertical annular walls 46 of cylindrical configuration which are interconnected by webs 48 centrally located and radially extending therefrom as illustrated in Figure 2. The portions of the top deck 24, between the partition walls 44 and the openings 38 and the partition wall 48 and the openings 38, are provided with reinforcing gussets 50 which have a depth so that the inner edges thereof are flush with the bottom edges of the flange 42 defining the openings 38 with the depth of the reinforcing gussets increasing toward the outer ends thereof.

Disposed between the bottom 22 and the intermediate deck 36 is a plurality of vertical partition walls 52 which extend radially from centrally disposed vertical annular walls of cylindrical configuration designated by numeral 54 integral therewith as illustrated in Figures 2 and 4. The bow and stern of the barge are provided with partition walls or reinforcement walls 56 extending radially from vertical annular cylindrical walls 58 as illustrated in Figures 2 and 3. As illustrated in Figure 4, the inclined partition walls 44 have semi-cylindrical buttress walls 60 extending along the outer surfaces thereof and the side walls 26 are also provided with semi-cylindrical buttress walls 62 integral therewith. The semi-cylindrical walls are interconnected by radial partition walls 64 with all of the walls outside of the cargo holds 40 including access openings 66, ventilation openings 68 and limber notches or holes 70 at the bottom edges where they join with the deck.

The top deck 24 is also provided with reinforcing gussets 72 for the flange 42 for the cargo hold openings 38 with the flanges 42 serving as hatch coamings which may be provided with any suitable type of closure if desired or necessary. The entire structure of the vessel as described is constructed of concrete or other cementitious material with the vertical cylindrical or semi-cylindrical walls defining a plurality of compartments which strengthen the vessel and enable it to withstand wave action and the like. In actual practice, the vessel may have an over-all length of 523 feet, a beam of 105 feet, a total height of 56 feet, 6 inches and be provided with five holds of receiving any type

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of cargo with the vertical dimension between the bottom 22 and the intermediate deck or cargo deck 36 being 13 feet.

Referring now specifically to Figures 5-7, another embodiment of the marine vessel is illustrated and generally designated by reference numeral 80 which structure is useful as a storage barge as well as a facility for LNG liquifaction with this structure including a bottom 82 with an intermediate deck 84 spaced closely therefrom and a top deck 86 with an under deck 88 spaced closely therefrom as illustrated in Figure 7. Interconnecting the peripheries of the top deck and bottom are exterior side and stern walls 90 each end having an interior side wall 92 closely spaced in relation thereto. A portion of the length of the vessel is provided with a plurality of compartments 94 which are separated from each other by spaced partition walls 96 and 98.

Disposed between the bottom and deck 82 and 84 and between the decks 86 and 88 is a plurality of partition walls 100 having vertical cylindrical walls 102 incorporated therein in which they cylindrical walls 102 have the partition walls 100 projecting radially therefrom in the form of connecting webs between the cylindrical walls 102 with both the cylindrical walls 102 and the partition walls 100 extending vertically. Disposed between the exterior and interior side and stern walls 90 and 92 and between the partition walls 96 and 98 is a plurality of semi-cylindrical walls 104 having the free edges thereof integral with the respective side, stern or partition walls, and having the arcuate portions thereof tangentially connected as at 106 as illustrated in Figure 6. Also disposed between the walls 90 and 92 and the walls 96 and 98 is a plurality of horizontal partition plates or walls 108 which are vertically spaced and define vertical compartments between the walls 90 and 92 and between the walls 96 and 98 as illustrated in Figure 7. The forward portion of the vessel 80 is tapered into a bow as at 110 as illustrated in Figures 5 and 6 and this entire area may be provided with a plurality of vertical cylindrical walls 112 interconnected by webs or partitions 114 with these cylindrical walls being continuous between the bottom and top deck or provided with horizontal partitions if desired. The various cylindrical annular walls and semi-cylindrical walls may be provided with vent holes 116 and any desired facilities 118 for connecting a tug or other towing vehicle to tow the barge or to provide anchoring connection with the barge as well as provide communication with the interior holds or compartments 94 which are specifically adapted to receive various types of fluids including liquified gases and the like. In a typical construction, the size of this barge

may be larger than that illustrated in Figures 1-4 with a substantial portion of the barge being below water when used for storage or liquefaction of gases.

Figures 8-11 illustrate another embodiment of the marine vessel generally designated by numeral 120 and which includes an elongate cargo hold 122 to which access is given by a large hatch opening 124. In this embodiment of the invention, a bottom 126 is provided along with a top deck 128, a bow a stern, and interconnecting side walls 130. An intermediate or cargo deck 132 is provided as a bottom for the cargo hold 122 and is closely spaced in relation to the bottom 126. The periphery of the hatch opening 124 is constituted by an upstanding flange 134 and the ends of the hold 122 are constituted by a plurality of cylindrical vertical walls 136 interconnected by webs or partition walls 138. The sides of the hold 122 are constituted by the side walls 130 and semi-cylindrical vertical walls 140 connected thereto in which the horizontal deck 132 extends completely to the side walls 130 but terminates at the forward and rear partitions constituted by the vertical cylindrical walls 136 and the connecting webs 138.

The cargo deck 132 and the bottom 126 are interconnected by cylindrical walls 142 throughout their extent with the cylindrical walls 142 being interconnected by partitions or webs 144 as illustrated in Figure 9. The whole of each side wall 130 and also the bow and the stern are provided with the semi-cylindrical vertical walls 140 which extend from top to bottom of the vessel with the side walls being further reinforced by the cargo deck 132 extending all of the way to the side walls 130. The bow of the vessel includes an upwardly curved forward portion on the bottom as indicated by numeral 146 and an upwardly slanted portion 148 on the top deck 128. As illustrated in Figure 9, the side walls 130 also converge slightly as at 150 to provide a bow suitable for a river barge or the like. Typical dimensions of this embodiment of the invention would be an over-all length of 205 feet and a beam width of 42 feet with a hatch opening of 168 feet by 30 feet.

In each of the described embodiments a honeycomb sandwich panel system is utilized with this system being applied to either open deck or closed deck vessels including a single cargo hold or multiple holds or compartments. These compartments, holds or tanks may be utilized for storage or transportation of various products and materials including dry materials, liquid materials or gaseous materials with appropriate facilities being provided for storing such materials and conveying the materials to and from the storage holds, compartments or tanks. The marine vessel may also be employed as a

floating vessel or partially submerged and in some instances completely submerged if desired thus enabling underwater storage of products. The marine vessel may be constructed of reinforced concrete or prestressed concrete. The vessel is primarily intended for use in areas that are not subject to extreme wave action or rough water but the mobility of the vessel enables storage facilities to be relocated when desired in order to obtain optimum use of such facilities. The annular walls, preferably, but not necessarily, cylindrical in shape, are interconnected by webs or partitions or oriented tangentially with the wall structures including the annular walls being integral. Thus, the annular walls combined with the webs and partition walls as well as external walls define a continuous, honey-comb-like network extending between the bottom and intermediate deck or completely to the top deck thereby providing a more versatile arrangement of cargo receiving space with the honeycomb network greatly enhancing the over-all strength of the structure.

Each annular wall defining a closed periphery in horizontal section or cylindrical wall serves as a vertical shear wall between a lower wall or deck and an upper or higher wall or deck. Also, the spaces or compartments defined by the walls defining closed peripheries in horizontal section may be filled with flowable material with the walls serving as baffles to reduce movement of such flowable materials with the cylindrical walls also enabling equalization of pressure on the inner and outer surfaces of the cylindrical walls. The vertical shear walls defined by the annular walls and the interconnecting webs resist shear in both the longitudinal and transverse directions with the combination of these walls with the horizontal decks and peripheral walls serving to provide a rigid hull structure resistant to shear, bending and flexing due to wave action and the like.

WHAT I CLAIM IS:-

1. A marine vessel for storage, support or transportation of material and comprising continuous rigid peripheral wall, a generally horizontal continuous rigid bottom wall extending across the area bounded by the lower portion of said peripheral wall to define an enclosure, a plurality of rigid walls, defining a closed periphery in horizontal section and rigidly connected to an extending axially upward from said bottom wall to define a plurality of compartments separate from each other, a generally horizontal rigid top wall extending over the enclosure at least one intermediate wall generally paralleling said top and bottom walls and being disposed in adjacent spaced relation to one of said top and bottom walls and further rigid walls defining a closed periphery in horizontal section and extending from the or

each intermediate wall to the adjacent top or bottom wall, and defining a plurality of compartments separate from each other, said rigid and further rigid walls, peripheral wall, top and bottom walls and intermediate wall or walls being of integral cementitious construction with the rigid walls being rigidly connected with each other and the further walls being rigidly connected with each other.

2. A marine vessel as defined in claim 1, wherein said walls are cylindrical.

3. A marine vessel as defined in claim 2, wherein said cylindrical walls are interconnected by interconnecting radial partition walls.

4. A marine vessel as defined in claim 1, wherein said further walls are semi-cylindrical in configuration and tangentially connected.

5. A marine vessel as defined in claim 1, including a vertical partition wall, said partition wall extending upwardly from a lower one of the intermediate walls, this intermediate wall being disposed adjacent to the bottom wall, and an upper one of the intermediate walls adjacent to but below the top wall with the partition wall extending between these intermediate walls.

6. A marine vessel as defined in claim 5 in which said partition wall is buttressed by semi-cylindrical walls rigid therewith.

7. A marine vessel as defined in claim 5, wherein said top wall and top intermediate wall are continuous.

8. A marine vessel as defined in claim 1, wherein said top wall has therein a single hatch opening, the intermediate wall being disposed adjacent the bottom wall and extending laterally to side portions of the peripheral wall, the side portions of the peripheral wall having semi-cylindrical walls rigid therewith and extending from the top wall to the bottom wall.

9. A marine vessel as defined in claim 1, wherein said top wall has a plurality of hatch openings therein, a plurality of transverse partitions and longitudinal partitions associated with the intermediate wall disposed adjacent to the bottom wall thereby defining a plurality of holds, the partitions at the sides of each hold being smooth and the transverse partitions being constituted by cylindrical annular members interconnected by webs.

10. A marine vessel as defined in claim 1, having a tapering bow, said annular walls having openings therein to provide communication between the compartments defined thereby.

11. A concrete marine vessel comprising a generally horizontal monolithic bottom wall, upstanding side walls and end walls extending from the bottom wall and a generally horizontal top wall extending from the

floating vessel or partially submerged and in some instances completely submerged if desired thus enabling underwater storage of products. The marine vessel may be constructed of reinforced concrete or prestressed concrete. The vessel is primarily intended for use in areas that are not subject to extreme wave action or rough water but the mobility of the vessel enables storage facilities to be relocated when desired in order to obtain optimum use of such facilities. The annular walls, preferably, but not necessarily, cylindrical in shape, are interconnected by webs or partitions or oriented tangentially with the wall structures including the annular walls being integral. Thus, the annular walls combined with the webs and partition walls as well as external walls define a continuous, honey-comb-like network extending between the bottom and intermediate deck or completely to the top deck thereby providing a more versatile arrangement of cargo receiving space with the honeycomb network greatly enhancing the over-all strength of the structure.

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each intermediate wall to the adjacent top or bottom wall, and defining a plurality of compartments separate from each other, said rigid and further rigid walls, peripheral wall, top and bottom walls and intermediate wall or walls being of integral cementitious construction with the rigid walls being rigidly connected with each other and the further walls being rigidly connected with each other.

2. A marine vessel as defined in claim 1, wherein said walls are cylindrical.

3. A marine vessel as defined in claim 2, wherein said cylindrical walls are interconnected by interconnecting radial partition walls.

4. A marine vessel as defined in claim 1, wherein said further walls are semi-cylindrical in configuration and tangentially connected.

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6. A marine vessel as defined in claim 5 in which said partition wall is buttressed by semi-cylindrical walls rigid therewith.

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11. A concrete marine vessel comprising a generally horizontal monolithic bottom wall, upstanding side walls and end walls extending from the bottom wall and a generally horizontal top wall extending from the



side and end walls to define an enclosure, an intermediate cargo deck spaced above the bottom wall, a plurality of cylindrical walls extending from the bottom wall and intermediate deck, said intermediate deck having less horizontal dimensions than the bottom wall and top wall, vertically extending walls inter-connecting the bottom wall and top wall outwardly of the intermediate deck with certain of the walls and interconnecting webs outwardly of the intermediate deck constituting a partition wall for a cargo hold

in which the intermediate deck forms the bottom wall.

12. A marine vessel substantially as hereinbefore described with reference to and as shown in Figures 1 to 4, Figures 5 to 7, or Figures 8 to 11, of the accompanying drawings.

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