United States Patent

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[54] **STRUCTURAL ARRANGEMENT OF LARGE TANKERS**
8 Claims, 6 Drawing Figs.

[52] U.S. Cl. 114/125, 114/74
[51] Int. Cl. B36b 43/06, B63b 25/08
[50] Field of Search 114/125, 74

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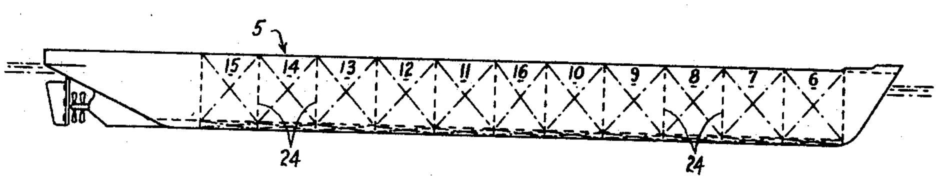
ABSTRACT: A cargo vessel whose hull is provided with a series of transverse bulkheads to form a series of cargo holds or tanks, and two longitudinal bulkheads to form one central and two side holds or tanks, the side tanks having a transverse width of between one tenth and one twelfth of the transverse width of the central holds or tanks, and a central longitudinal partial bulkhead extending through the center holds or tanks and extending downwards from the deck of the vessel a distance about one-third the depth of the center holds or tanks, the central partial bulkhead having a series of air openings therethrough adjacent the connection of the bulkhead with the deck of the vessel.



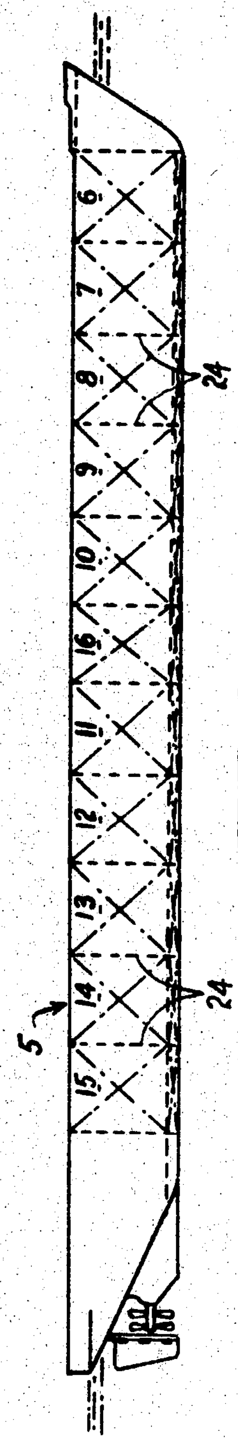


Fig. 1

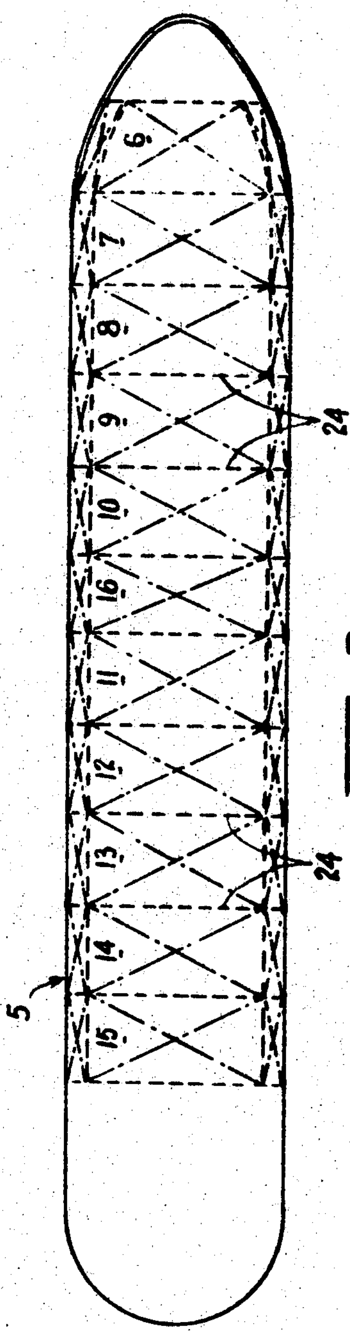


Fig. 2

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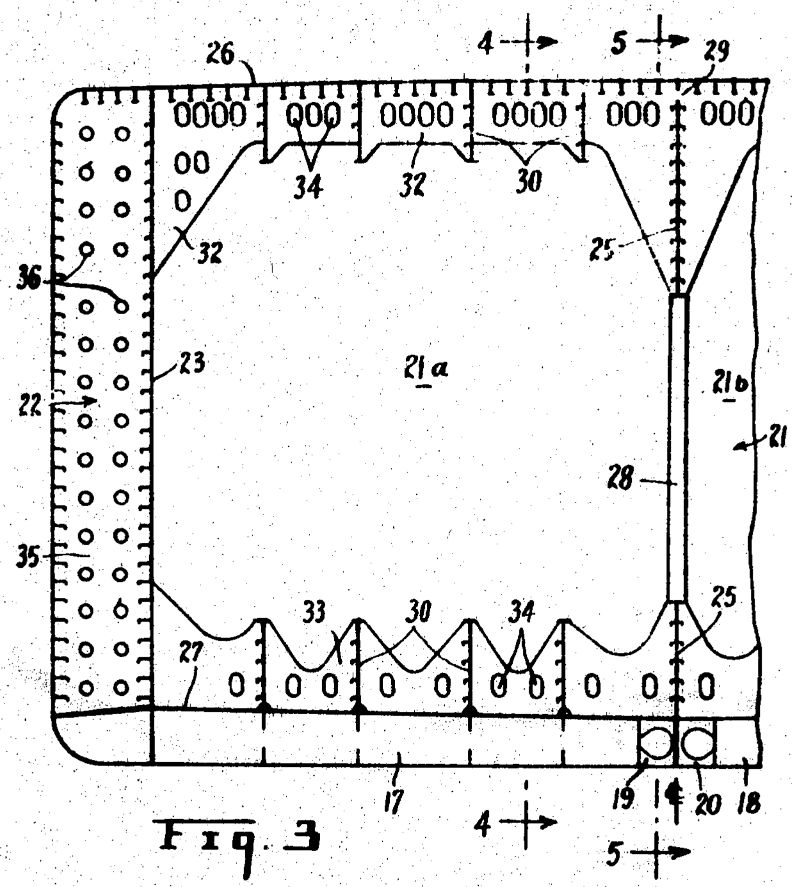

Fig. 3

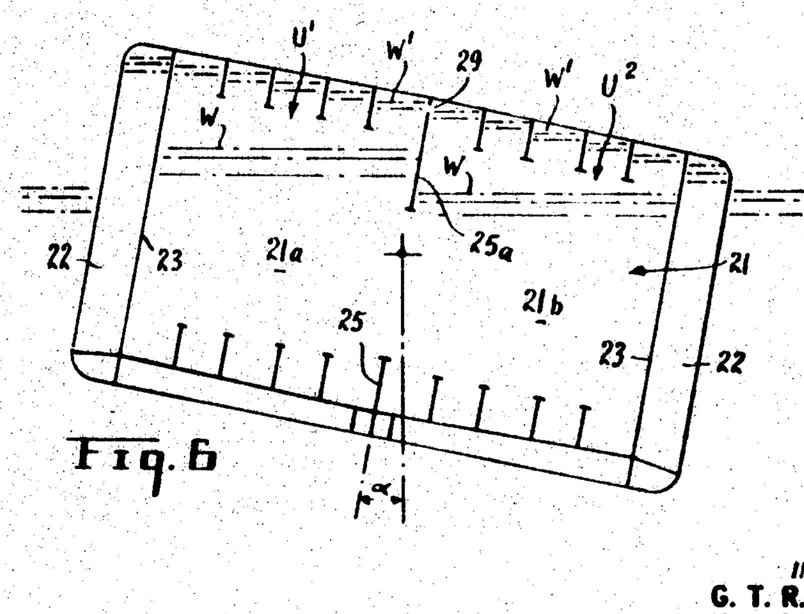

Fig. 6

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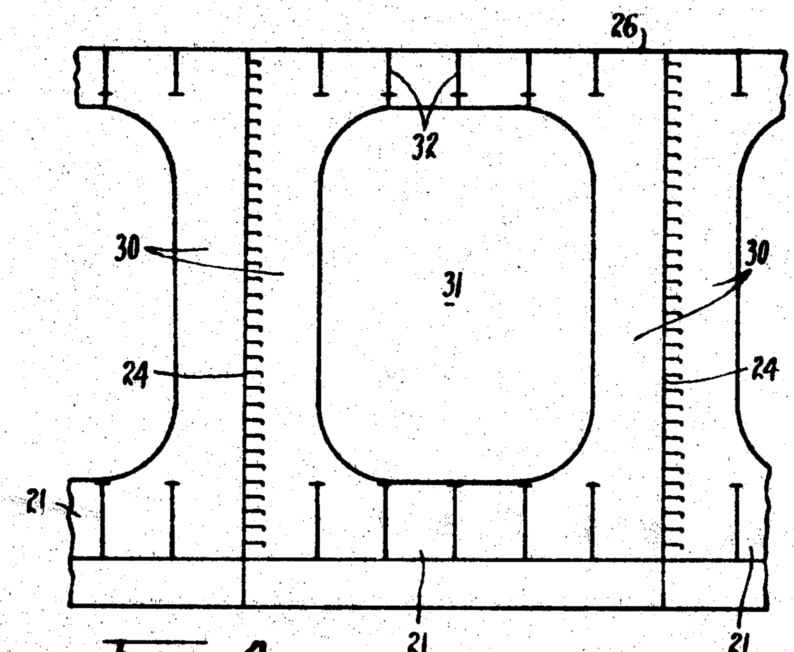

Fig. 4

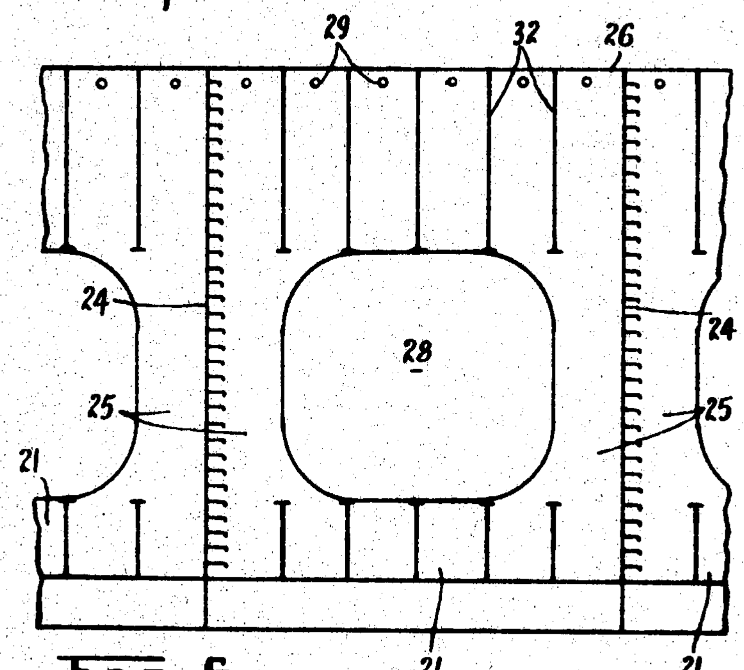

Fig. 5

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STRUCTURAL ARRANGEMENT OF LARGE TANKERS

This invention relates to large sea-going vessels and particularly to the construction of tanker vessels of 500,000 deadweight tonnage.

Recent studies have been undertaken by various regulating bodies on the feasibility of constructing 500,000 d.w.t. tankers. These studies have resulted in establishing the following overall particulars of a vessel of this size.

TABLE A

Length (between perpendiculars)	1, 246′, 9″
Breadth (moulded)	218′, 2¼″
Depth (moulded)	106′, 7½″
Draft (moulded)	87′, 0″
Block coefficient	0. 84
Displacement (long tons)	568, 529
Light ship weight (long tons)	68, 529
Deadweight (long tons)	500, 000

Such a vessel would be designed to have a single skin hull and have three tanks transversely, with the side tanks being approximately half the width of the center tank and all tanks having an approximate length of 192 feet. The center tank would then have a capacity of approximately 50,000 long tons of oil, while the side tanks would have a capacity of 25,000 long tons of oil.

With such a single skin vessel, in the event of even a simple grounding of the vessel and rupturing the bottom shell of even one tank, a large volume of oil would be discharged to the sea causing a serious pollution problem. Further a collision could damage the shell in way of the side tanks resulting in the discharge to the sea of a large amount of oil. Another important point to be considered with such a single shell vessel is that on impact, while berthing, a fire in the oil cargo can be started resulting in great damage to the vessel and to the port facilities, also due to the large volume of oil exposed by damage to one or more side tanks.

The present inventions relates to an improved design of a vessel having the above overall characteristics but which will overcome the drawbacks above outlined, except that the moulded depth has been increased to 114 feet, 9,6 inches. The two longitudinal bulkheads dividing the hull transversely into three cargo tanks are located further outboard than in the above described vessel in order to provide a relatively wide central tank and two relatively narrow side tanks. In way of the wide center tank there is provided a cellular double bottom which is to be used for clean ballast and for bunkers. With the additional 8.18 feet greater moulded depth, in the present vessel the cubic capacity of the cargo oil tanks in both vessels will be substantially equal.

The following table B gives the comparable characteristics of the vessel constructed according to the present invention.

TABLE B

Length (between perpendiculars)	1, 246′, 9″
Breadth (moulded)	218′, 2¼″
Depth (moulded)	114′, 9. 6″
Draft (moulded)	93′, 0″
Block coefficient	0. 78
Displacement (long tons)	563. 212
Lightship weight (long tons)	63. 212
Deadweight (long tons)	500. 000

On table B it will be observed that the lightship weight of the tanker, according to the present invention, is 63.212 long tons in comparison with the lightship weight of 68.529 long tons in table A. This difference in weight is attributed to a difference of 1.55 tons which obtains in the weight of steel per foot run in favour of the vessel in table B, plus the absence of large bore cargo oil pipes and the smaller amount of heating grid surface area in the cargo-oil tanks.

The inclusion of a cellular double bottom in the vessel of the

present invention gives to the vessel a large "KM" which is the vertical distance above the keel at which the transverse metacenter occurs, and investigations have established that the "GM," the vertical distance from the center of gravity to the metacenter, which will obtain, after free surface correction is made for the liquid contained in all the cargo-oil tanks in the vessel which, in a loaded condition will be about 6.00 feet, which is more than adequate to ensure complete safety under all conditions likely to be encountered in service.

Due to the greater width of the center oil tanks a novel roll stabilization system has been designed to minimize on the structure of the cargo-oil tanks, damage caused by the dynamic effect of the liquid at its free surface. This includes a combination of a longitudinal partial bulkheads and transverse girders.

The primary object of the invention is the construction of large oil tanker vessels having built-in safety features against large scale pollution of waters through large scale discharge of oil caused by accidents to the vessel.

A further object of the invention is to provide a large oil tanker having built-in roll stabilization features to counteract damage by the dynamic effect of the liquid at its free surface.

A further object of the invention is to provide a large tanker vessel having a cellular double bottom and a center and side oil-cargo tanks, the side tanks having a width approximately one-tenth the transverse width of the center tank and of limited oil capacity to reduce oil pollution if the hull is breached.

These and other objects of the invention will be apparent from the following detailed specification and the accompanying drawings, in which:

FIG. 1 is a side elevation of a large tanker vessel according to the present invention, showing the tank division.

FIG. 2 is a plan view of the vessel shown in FIG. 1.

FIG. 3 is a half transverse section through one of the groups of tanks of the vessel.

FIG. 4 is a longitudinal section taken on the line 4–4 of FIG. 3.

FIG. 5 is a longitudinal section taken on the line 5–5 of FIG. 3.

FIG. 6 is a diagram showing a transverse section of the vessel and the roll stabilization effect when the vessel rolls.

Referring to the drawings the vessel 5 shown in FIGS. 1 and 2 is proportioned to the dimensions given in table B and is divided into ten groups of three tanks each, numbered 6 to 15 inclusive. A midship tank, space 16, is provided and suitably divided for use as a pump room.

A cellular double bottom forms suitable fuel oil and clean ballast tanks 17 and 18 disposed on either side of the two central longitudinal trunks 19 and 20 provided for the purpose of loading and unloading the tanks 17 and 18 as fully described in our Canadian Pat. No. 719.890 issued Feb. 16, 1965. These trunks 19 and 20 are directly connected to the pumps in the pump room 16.

In FIG. 3 there is shown a typical half transverse section through any one of the tank groups 6 to 15 and shows a central tank 21 and one of the side tanks 22, separated by the longitudinal bulkhead 23.

The central tank 21 and the side tanks 22 of each of the groups 6 to 15 and the tank or pump room 16 are separated from each other by transverse bulkheads 24.

A central longitudinal partial bulkhead 25 in the form of a plate girder extends downwards from the deck 26 a distance of approximately one third the height of the tank, fore and aft from the transverse bulkheads 24 and upwards from the tank top 27 to define a large opening 28.

Unlike conventional swash bulkheads, the partial bulkhead 25 does not have opening trepanned through the plate above the large opening 28 except for a series of air holes 29 located close to the deck 26, the purpose of which will be explained later.

Similar longitudinal plate girders 30 spaced apart between the central partial bulkhead 25 and the longitudinal bulkheads

23 define openings 31 which extend upwards to a greater height and closer to the deck 26 than to the openings 28.

The central longitudinal partial bulkhead 25 and the plate girders 30 are supported by transverse gussets 32 under the deck 26 and gussets 33 above the tank top 27. These gussets 32 and 33 have openings 34.

Each of the side tanks 22 are provided with a series of swash plates 35 each have openings 36. These swash plates 35 extend the full width and height of the tanks 22 and are equal in number and are transversely aligned with the gussets 32 and 33 to provide adequate stiffening across the full width of the vessel.

In FIG. 6 of the drawings there is shown a transverse section of the vessel above described. The opening 28 as shown in FIGS. 3 and 5 in effect convert the width of the central tank 21 into a "U tube" with the legs of the U defined by the two sides 21*a* and 21*b* of the tank 21 and the upper portion 25*a* of the partial bulkhead separating the two legs of the U tube.

For the purpose of illustrating the "U tube" effect, the vessel is shown rolled over to one side to an angle of α of approximately 10°.

The period of the transverse moment induced in the liquid within the tanks 21 is rendered out-of-phase with the natural rolling period of the vessel to produce a roll-damping effect. The degree of out-of-phase between the liquid and the vessel is controlled by the air holes 29, of appropriate size, located in the upper portion 25*a* of the partial bulkhead 25, close to the underside of the main deck 26.

The optimum ullage on each side of the portion 25*a* of the bulkhead can be established in association with a given area of the air holes 29, to produce the necessary out-of-phase righting moment to prevent rolling of the vessel to large angles of the keel. By adjusting the ullage in any two center cargo-oil tanks 21, the out-of-phase transverse moment in the liquid will provide an efficient roll-stabilizing system for the vessel of the size described.

This, combined with the fact that a tanker vessel of 500.000 deadweight having a cellular double bottom and a length/broadth ratio of 5.7: 1 ensures that the vessel will have a large "KM" (vertical distance above the keel at which the transverse metacenter occurs) and a "GM" (vertical distance of the center of gravity to the metacenter) which will, after free surface correction is made for the liquid contained in all the cargo tanks of this vessel, will be about 6.00 feet, which is more than adequate to ensure complete safety under all conditions likely to be encountered in service.

In FIG. 6 the ullage (the amount of which the two sides 21*a* and 21*b* of the tank 21 lack of being full) is indicated at U^1 and U^2. The liquid level W is shown below normal full load conditions for illustrative purposes. The normal full load W^1 will be located closer to the level of the air holes 29 and the air trapped above the liquid level will provide the necessary reaction to effect efficient roll-stabilization, first in one direction and than in the other.

With the above-described tank construction, combined with a cellular double bottom and having a moulded draft of 93 feet, 0 inches, there is a considerable saving in weight of steel over a vessel having a single skin and relatively wide side tanks and a moulded draft of 87 feet, 0 inches as in table A.

The comparable weight per foot run over a 90 foot length (length of one group of tanks) is shown in the following table.

TABLE C

	Weight per group of tanks, tons	Weight per foot run, tons
Vessel Table A	5252.13	58.36
Vessel Table B	5112.69	56.81

This difference in weight is achieved by the use of lighter shell plating due to the added strength of the cellular double bottom and the added strength given by the narrow side tanks and, in addition, by the elimination of large bore pipes throughout the length of the vessel brought about by utilizing the trunk 19 and 20 in the double bottom as connections between the pump room 16 and the various sections of the double bottom used for fuel oil or ballast.

While the invention has been described as being applied to tanker vessels for the transportation of oil or other liquid cargoes, it should be realized that it is equally applicable to vessels used for the transportation of bulk dry cargoes, particularly free flowing materials such as grain, etc. In this connection the area of the air holes 29 would be calculated to provide the optimum ullage on each side of the portion 25*a* of the bulkhead for the cargo being carried.

We claim:

1. A cargo vessel having an outer shell forming the deck, sides and bottom of the vessel and having a cellular double bottom, a series of main transverse bulkheads within the said shell above the said double bottom and spaced lengthwise of the vessel to form groups of cargo storage tanks in excess of 90 feet in length, two longitudinal bulkheads spaced inwardly of the sides of the vessel to define in each group of cargo tanks, one central and two side tanks to each group, the said side tanks having a transverse width of between one tenth and one twelfth the transverse width of said central tank, and a central longitudinal partial bulkhead extending through each group of center tanks and extending downwards from the deck of the vessel a distance of about one third the depth of the central tank, the said partial bulkhead having a series of small air openings therethrough adjacent the connection of the bulkhead with the deck.

2. A cargo vessel as set forth in claim 1 in which the said central longitudinal partial bulkhead converts the said central tank to a U tube disposed transversely of the vessel, the air holes in the said partial bulkhead permitting a controlled flow of trapped air between the upper ends of the legs of the U tube on rolling of the vessel to render the transverse moment induced in the cargo out-of-phase with the natural rolling period of the vessel.

3. A cargo vessel as set forth in claim 2 in which the said central longitudinal partial bulkhead is in the form of a plate girder extending along the underside of the deck and downwards along opposite transverse bulkheads to limit the area connecting the two legs of the U tube.

4. A cargo vessel as set forth in claim 2 in which the central longitudinal partial bulkhead is in the form of a plate girder extending inwardly from the adjacent deck, transverse bulkheads and cellular double bottom to define the area connecting the two legs of the U tube.

5. A cargo vessel as set forth in claim 1 in which a series of longitudinal girders are disposed under the deck and above the cellular double bottom and spaced at intervals between the said central longitudinal partial bulkhead and the longitudinal bulkheads at the sides of the central tank, and gussets disposed transversely between the said longitudinal girders, adjacent longitudinal bulkheads and the longitudinal partial bulkhead, strengthen the said longitudinal partial bulkhead against the out-of-phase effect of the cargo on either side of the partial bulkhead on rolling of the vessel.

6. A cargo vessel as set forth in claim 5 in which the said gussets are arranged at spaced intervals lengthwise of the vessel between transverse bulkheads, and swash bulkheads in each of the side tanks are located in alignment with the said gussets.

7. A cargo vessel as set forth in claim 5 in which a series of swash bulkheads are located transversely in each of the said side cargo tanks, the said swash bulkheads extending over the whole cross-sectional area of the tanks and having a series of openings therethrough.

8. A cargo vessel as set forth in claim 5 in which the series of longitudinal girders are in the form of plate girders extending inwardly from the adjacent deck, transverse bulkheads and cellular double bottom to define large area communication openings at spaced intervals across the transverse width of the central tanks.