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COLD CARGO SHIP AND CONSTRUCTION

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FIG. 1

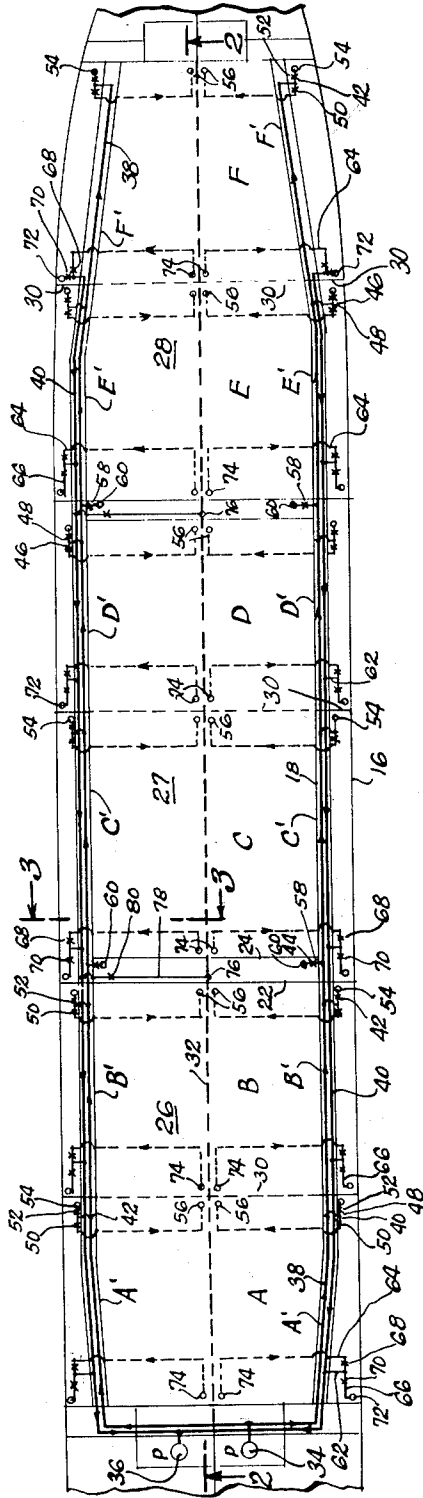
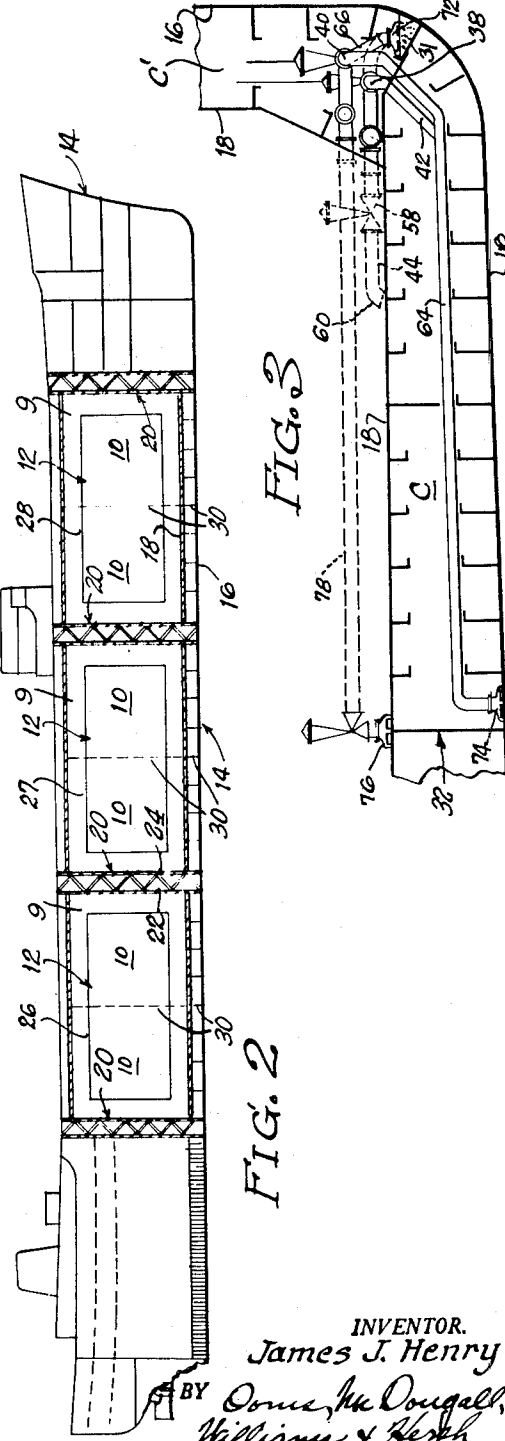


FIG. 2



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COLD CARGO SHIP AND CONSTRUCTION

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This invention relates to the transportation of a liquid cargo which needs to be maintained at extremely low temperature, and it relates more particularly to the construction and operation of a ship in which the cold cargo is transported by water from a source of plentiful supply to an area where a deficiency exists.

This invention will be described with reference to the transportation of natural gas in a liquefied state from the source of plentiful supply, where it is liquefied for about a 600-fold reduction in volume, to an area where a deficiency exists, where the liquefied gas is re-formed into the gaseous state for use. For this purpose, the liquefied gas is housed at about atmospheric pressure in large tanks which are mounted within the hold space of a ship. Methane, which has a critical boiling point at about -258° F. at atmospheric pressure, constitutes the principal component of natural gas. As a result, the temperature of the liquid cargo must be maintained below the boiling point temperature of the liquefied gas or at a temperature below about -240° F., depending greatly upon the amount of heavier hydrocarbons in the liquid.

Ordinary steels such as are employed in the steel plates used in the fabrication of the ship's hull or used in the manufacture of conservation and storage tanks, cannot be employed in the construction of the storage tanks for liquefied natural gas because of the inability of steel to retain its ductility under the temperature conditions existing. Thus, in practice, the liquid cargo storage tanks are preferably formed of aluminum, alloys of aluminum, copper, stainless steel or other metals capable of retaining their ductility and strength at the low temperature of the liquid.

It is for this same reason that the cold of the liquid should not be permitted to reach the main hull of the vessel. Thus it is desirable to make use of a ship constructed with a double skin, hereinafter referred to as an inner and outer hull, with the inner hull spaced from the outer hull by a distance which may range from 1-4 or more feet but which are interconnected by steel webs and web frames for stiffening and support.

To protect the steel walls of the inner and outer hulls and to minimize the transfer of heat into the liquid housed in the storage tanks, the inner face of the inner hull is lined with a relatively thick layer of a thermal insulating material to define a well-insulated hold space in which the tanks are located.

It is desirable to provide still further protection to the ship's hulls and to embody means to enable use to be made of a water ballast notwithstanding the presence of the cold cargo filling the hold space.

Thus it is an object of this invention to provide means in a ship for accomplishing the same.

More specifically, it is an object of this invention to produce a ship for the storage and transportation of a cargo which has to be maintained at extremely low temperature; which embodies means for enabling use of a water ballast for proper navigation of the ship; which embodies means for enabling control of the temperature of the metal walls of the ship to prevent excessive reductions in temperature, and which embodies means for preventing the formation of cold spots on the walls of the ship such as might result from failure of insulation or failure of tanks housing the cold liquid cargo.

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These and other objects and advantages of this invention will hereinafter appear and for purposes of illustration, but not of limitation, an embodiment of the invention is shown in the accompanying drawings, in which—

FIGURE 1 is a top plan view schematically setting forth the arrangement of elements in the construction of a ship embodying the features of this invention;

FIGURE 2 is a schematic sectional elevational view taken substantially along the line 2-2 of FIGURE 1; and

FIGURE 3 is a vertical sectional view of a portion of the ship's structure taken substantially along the line 3-3 of FIGURE 1.

While the invention will hereinafter be described with reference to the transportation of a liquefied natural gas housed within tanks 10 stationed within the ship's hold 12 substantially to fill the hold space, it will be understood that the concepts described will have application to the construction of a ship 14 employed for the transportation of other materials which may need to be maintained at a temperature differing widely from ambient temperature.

This application is a continuation-in-part of my copending application Ser. No. 582,965, filed May 7, 1956, and entitled "Ship" now Patent No. 3,021,808. In the aforementioned copending application, description is made of a ship 14 formed with a double skin about the hold space and identified as an outer main hull 16 and an inner hull 18 which is spaced a short distance inwardly from the outer hull including sides and bottom and reinforced and supported by webs and interconnecting web frames. The inner surface of the inner hull is used as a support for insulation panels 9 arranged in end-to-end and in side-by-side relation substantially completely to line the wall and to provide an insulated hold space, as described in the copending application of Dosker, Serial No. 646,001, filed March 14, 1957. The insulated hold space is substantially completely filled with the aluminum tanks of large capacity (30 x 60 x 100 feet) adapted to be filled with a liquefied natural gas at about atmospheric pressure and at a temperature of about -250° F.

The hold space may be subdivided lengthwise into hold sections such as 26, 27 and 28 by cofferdams 20 extending crosswise of the ship in longitudinally spaced-apart relation, with each cofferdam being formed of a pair of spaced parallel walls 22 and 24. At least one of these walls, e.g., 22, must extend crosswise the entire width of the ship, that is, from outer hull to outer hull. The other wall may likewise extend the entire width of the ship (corresponding to the cross-sectional view of FIG. 2), or it may be situated between the inner hulls only (as in FIG. 1, line 24). The so-formed cofferdams define a compartment across the width of the ship through which water may be circulated for ballast and/or for temperature control. Also, the surfaces of the cofferdam walls facing toward the hold space are lined with the panels of insulation 9 to insulate the subdivided hold space in the same fashion as the inner walls of the inner hull. A bulkhead partition 30 may also be utilized for lengthwise subdivision.

The space between the inner and outer hulls 18 and 16, respectively, is further subdivided by a bulkhead 32 which extends lengthwise along the central portion of the ship between the hulls and by horizontally displaced bulkheads 31 which subdivide the space between the side and bottom of the ship to provide separate wing tanks A', B', C', D', E' and F' extending downwardly along each of the sides of the ship and tanks A, B, C, D, E and F, also hereinafter referred to as wing tanks, on each side of the bulkhead 32 under the hold. The number of wing tanks, including the tanks under the hold, can be varied depending upon the number of bulkheads and the arrange-

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ment of the bulkheads employed in the construction of the ship.

Water is generally employed as ballast in ship operation. However, because of the cold cargo filling the ship's hold, a number of problems are raised in the use of a water ballast. For example, in the event of failure of a part of the insulation, the cold of the liquid would be capable of transmission to the wall forming the inner hull and possibly even to the wall forming the outer hull, unless means are employed to conduct the cold away or to effect immediate and substantially complete dissipation of the cold. Water in contact with the wall of the inner hull might initially be able to dissipate some of this cold. Eventually, however, the water could be caused to solidify by freezing on the surface of the cold spot, thereby to reduce the heat transfer characteristics to the extent that the metal wall might possibly be reduced in temperature to an undesirable level. This situation could be further aggravated by additional solidification of the water by freezing to the point where natural expansions upon solidification would induce stresses that might lead to damage of the ship's walls or structure.

In accordance with the concepts of this invention, means are provided in the construction and operation of the ship not only to avoid the development of such conditions but also to enhance the use of the ship as a transportation means for such cold liquid cargo.

As schematically illustrated in the drawings, power-driven pumping means 34 and 36 are provided in the aft of the ship for use in effecting the flow of water to the separated groups of wing tanks on each side of the ship. Use may be made of a single pumping means for communication with all of the wing tanks, but it is preferred to make use of separate power-actuated pumps interconnected one to the other so as to provide for fluid flow in the event of failure of any one. The pumps have one inlet in communication with the sea water for taking water from the sea, and the pumps also have an outlet connected through valves to a main water header 38 running the length of the ship on the opposite sides thereof in alignment with the space between the inner and outer hulls. The pump also has an inlet connected through valves to water mains 40 also running lengthwise on opposite sides of the ship in alignment with the space between the inner and outer hulls, and the pump is provided with an outlet for returning the water to the sea.

Branch pipes 42 communicate the main header 38 with each of the longitudinally spaced wing tanks on opposite sides of the ship and below the hold. Branch pipes 44 communicate the main header 38 with each of the cofferdams. Each of the branch pipes 42 are further branched into pipes 46 and 48 fitted with valves 50 and 52, respectively, for the control of flow of fluid to their outlets 54 and 56. One of the outlets 54 is located in alignment with the space between the inner and outer hulls in the forward end portion of the respective side wing tanks A', etc. The other outlet 56 is positioned in the central portion of the ship adjacent the bulkhead 32 in the corresponding forward end portion of the wing tanks A', etc. below the hold. Each of the branch pipes 44 is also provided with a control valve 58 for controlling the flow of water to the outlet 60 located within the cofferdams adjacent the outer side thereof. The return mains 40 are also provided with branch pipes 62 for communication with each of the wing tanks. The branch pipes are further branched into units 64 and 66 with valve members 68 and 70 for the control of the flow of water from separated inlets. One of the inlets 72 is located in the bottom corner of the side wing tanks A', etc. between the inner and outer hulls, while the other inlet 74 is located in the central portion of the ship adjacent the bulkhead and in the rearward portion of the wing tanks A', etc. below the hold.

The water main 40 also communicates with the inlets 76 located in each of the cofferdams adjacent the bot-

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tom wall and in the central portion thereof. Each of the inlets 76 is separately connected to the main 40 through the pipe 78 provided with a valve 80.

The inlets and outlets may be of conventional construction, including pipes having open ends, but it is preferred to form the inlets with a ball suction valve and to provide the outlets with a ball discharge valve. The former operates to unseat the ball in response to suction, while the latter operates to unseat the ball in response to pressure to provide the desired flow of fluids in the desired direction.

Thus, water can be introduced into the wing tanks as ballast and returned to the sea by the pumping means 34 and 36. When proper water ballast has been established, development of a supercooled condition on the walls of the inner hull can be minimized by opening the valves to the inlets and to the outlets, whereby water from the wing tanks and from the cofferdams can be caused to circulate through the wing tanks by flow into the inlets 74, 72 and 76 for return through the outlets 56, 54 and 60. Thus a continuous circulation of water can be maintained in the wing tanks to maintain the proper ballast while providing the necessary turbulence and fluid flow to conduct cold away from the walls of the inner hull. Thus the temperature of the walls of the inner hull can be protected and the temperature of the walls of the outer hull can also be protected to prevent undesirable reduction in temperature. In the event that the amount of cold absorbed by the water ballast tends to cause excessive cooling of the water, solidification can be prevented by effecting circulation through the sea by connecting the inlets 74, 72 and 76 to the pump for delivery to the sea, while the outlets 54, 56 and 60 can be connected through the pump to the inlet from the sea. Circulation through the sea can be maintained indefinitely, if desired, but it will be preferred to achieve such circulation only for such lengths of time or in such amounts as to achieve proper control of the temperature of the ballast water.

For control of the level of water ballast in the wing tanks, the latter can be provided with vents at certain levels for overflow of water into the sea while water for ballast and for temperature control is introduced through the outlets for effective movement and circulation of the water.

Thus the water ballast can be continuously or intermittently circulated to maintain complete control of temperature existing on the metal walls of the inner and outer hulls and of the cofferdams.

Circulation through all or selected cofferdams or wing tanks may be effected to meet existing conditions or to prevent the development of cold spots in the event of failure of insulation in all or any section. For this purpose, the valves previously described are provided for controlling the circulation of water from the main water header 38 or into water main 40. The controls for the valves are adapted to extend beyond the deck for their selective operation in control of flow.

The ability to achieve rapid movement and interchange of ballast water in any one or all of the sections provides for efficient and effective removal of cold before any solidification can occur, and it also provides for the maintenance of temperature of the metal well within safe levels.

The introduction of ballast water further provides means for maintaining uniformity in temperature about the walls of the insulated space, thereby to achieve better control of heat transfer and means for charting the history of the insulation, particularly when temperature differentials are employed as a means for indicating possible breakdowns in portions of the insulation. Temperature control can be effectively achieved when the outlets 54 and 60 are positioned to wet down the outer surfaces of the walls forming the inner hull and the cofferdams.

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It will be apparent from the foregoing that I have provided means enabling the use of ballast water not only to achieve the desired ballast in a ship but to achieve distribution and equalization of temperature, whereby the formation of cold spots on the walls of the ship can effectively be avoided. Such equalization in temperature, as effected by water control, can be employed to achieve uniformity in the temperature of the insulated walls so as to provide for better control and also to enable use of temperature differentials to indicate the history of the insulation.

It will be understood that changes may be made in the details of construction, arrangement and operation without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. In the transportation of a cargo which needs to be maintained at a temperature differing widely from ambient temperature, a ship having an outer hull and an inner hull in closely spaced-apart relation with the outer hull and defining a hold space, a relatively thick layer of insulation on the inner surface of the inner hull to provide an insulated space, bulkheads extending crosswise and lengthwise of the ship between the inner and outer hulls to subdivide the space into a plurality of separated wing tanks, inlets and outlets contained in spaced-apart relation within each of said wing tanks, a pumping means, a connection between said pumping means and the inlets in each of said wing tanks, another connection between said pumping means and the outlet in each of said wing tanks and a connection between said pumping means and a source of ballast fluid to be introduced into said wing tanks whereby said ballast fluid can be circulated through said wing tanks.

2. A system as defined in claim 1 in which the inlets in the wing tanks are located at the lowest points of their respective compartments.

3. A system as defined in claim 1 in which the inlets in the horizontally disposed wing tanks are positioned closest to the sides of the ship while the outlets are positioned farthest from the sides of the ship.

4. A system as claimed in claim 1 which includes fluid flow control means in connection with each of said inlets and outlets for regulating the rate of flow of fluid there-through.

5. A system as claimed in claim 1 in which the ballast fluid is water and in which the connection between said pumping means and a source of ballast fluid comprises a connection with the sea.

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6. A system as claimed in claim 1 which includes cofferdams extending crosswise of the ship to subdivide the hold space into separated sections lengthwise of the ship, said cofferdams comprising a pair of spaced walls to provide a fluid-tight space therebetween, inlets and outlets in spaced-apart relation within said cofferdams, and means communicating the inlets and outlets with said pumping means.

7. A system as claimed in claim 6 in which the outlets are in the sides of the cofferdam and the inlets are in the center of the cofferdam.

8. In a cold cargo ship having inner and outer hulls spaced one from the other to define an insulated hold space and a relatively thick layer of insulation material on the walls of the hold space to insulate the hold, bulkheads extending crosswise and lengthwise of the ship between the inner and outer hulls to subdivide the spaced into a plurality of separated wing tanks, inlets and outlets within each of the wing tanks and arranged in spaced-apart relation therein, a pumping means having a pump inlet and a pump outlet, a header extending lengthwise of the ship, a main extending lengthwise of the ship, means communicating each of the tank inlets with the header, means communicating each of the tank outlets with the main, means communicating the main with the inlet of the pumping means and means communicating the header with the outlet of the pumping means, means communicating the pumping means with a source of ballast fluid whereby the pumping means can introduce ballast fluid into the wing tanks and circulate ballast fluid through the wing tanks.

9. A system as claimed in claim 8 in which the ballast fluid is sea water.

10. A system as claimed in claim 8 in which one bulkhead extends lengthwise of the ship through the central portion thereof and other bulkheads extend crosswise of the ship in longitudinally spaced relation to subdivide the space between the inner and outer hulls into wing tanks.

References Cited in the file of this patent

UNITED STATES PATENTS

886,621	Mehrtens	May 5, 1908
1,239,999	Yarrow	Sept. 11, 1917
1,779,786	Unzue	Oct. 28, 1930
2,738,749	Macy et al.	Mar. 20, 1956
2,798,364	Morrison	July 9, 1957
2,807,143	Schnellhardt	Sept. 24, 1957
2,810,265	Beckwith	Oct. 22, 1957