June 4, 1963 R. LEROUX 3,092,063

CONSTRUCTION OF LIQUEFIED GAS CARRIERS

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FIG. 1A

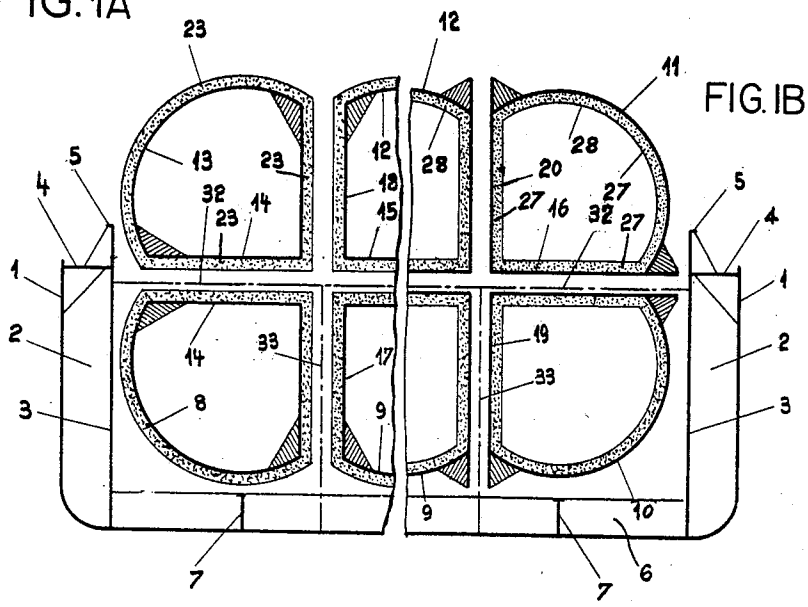

FIG. 1B

FIG. 2A

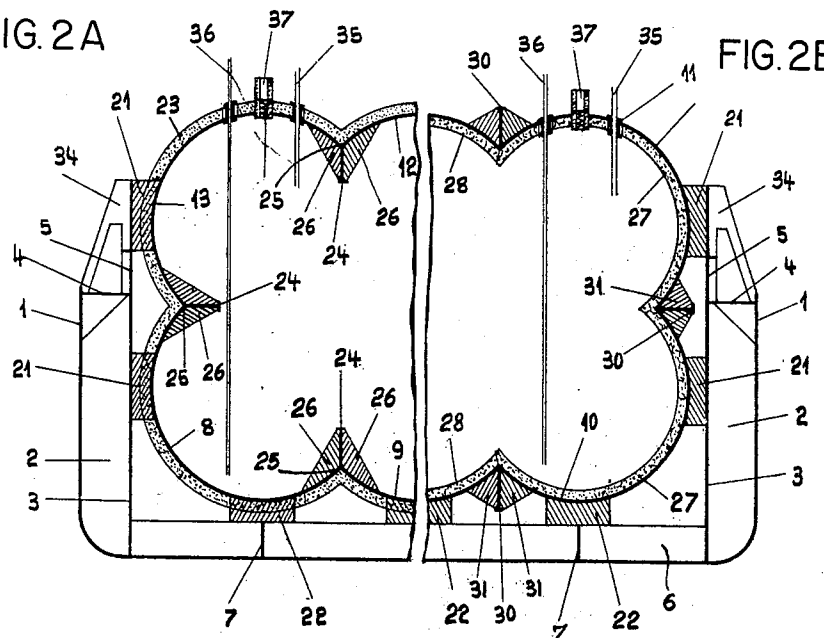

FIG. 2B

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FIG. 3

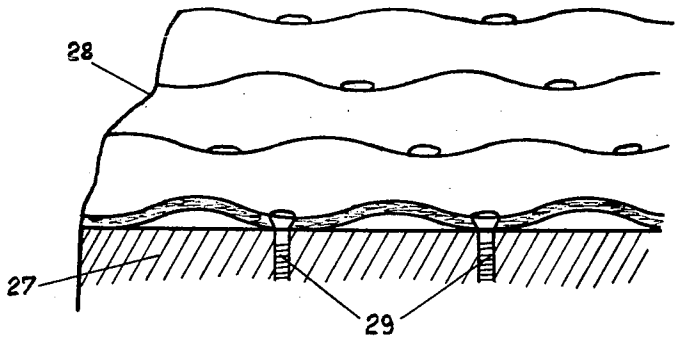

FIG: 5

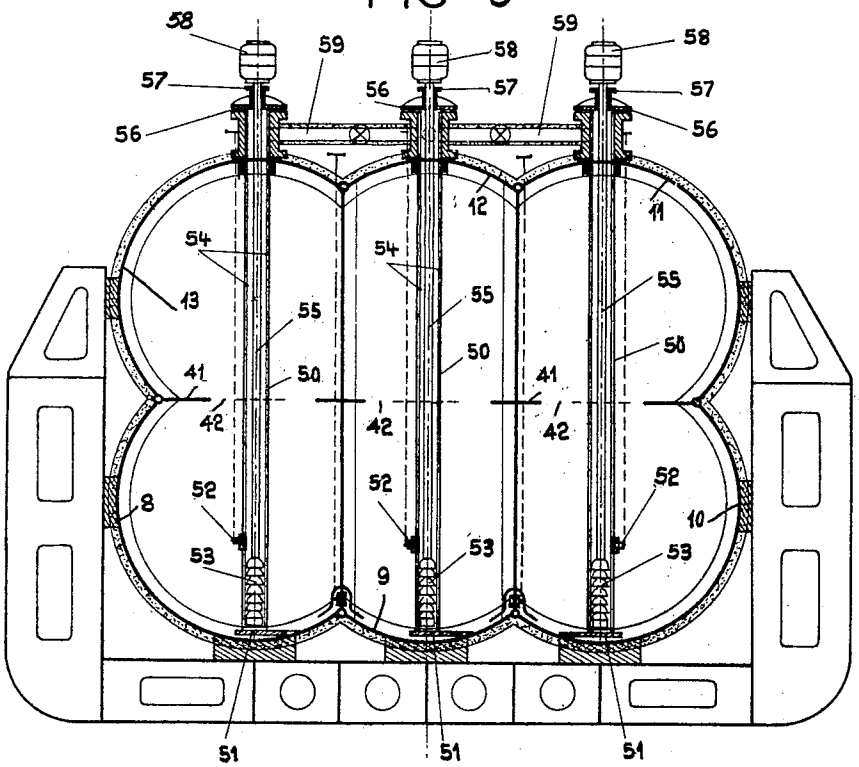

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FIG:4

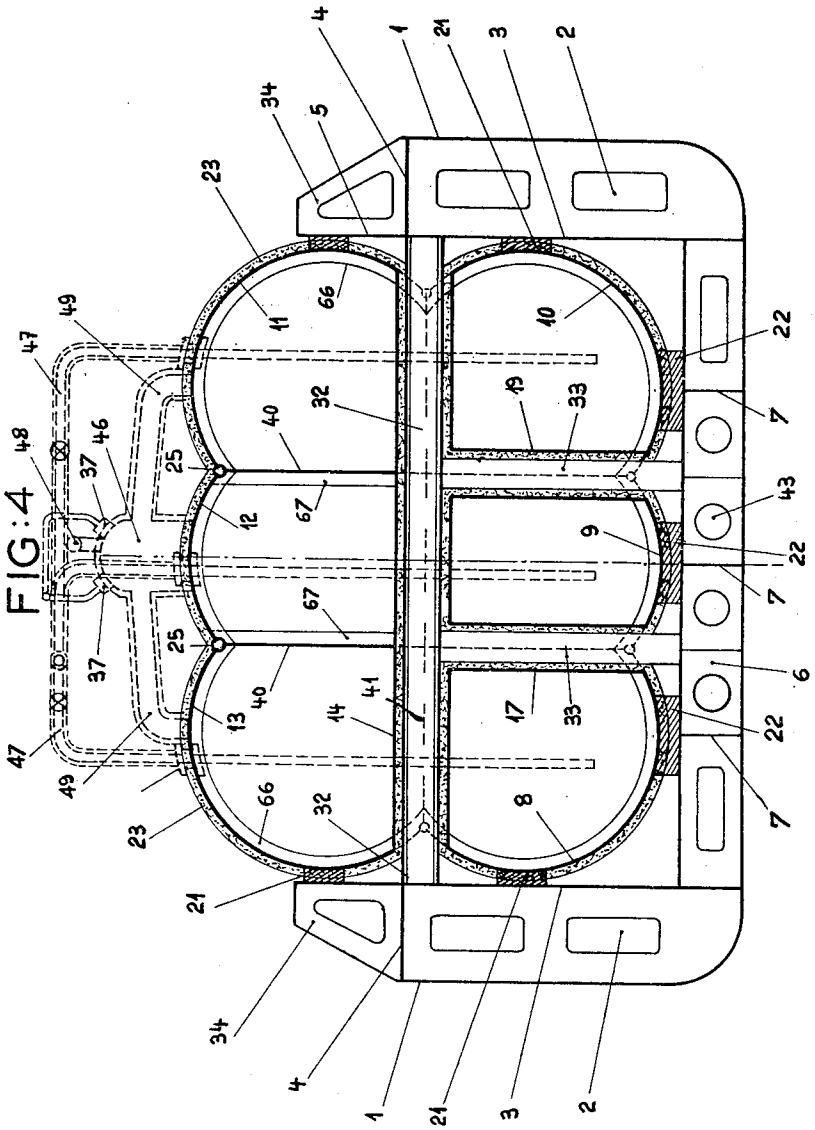

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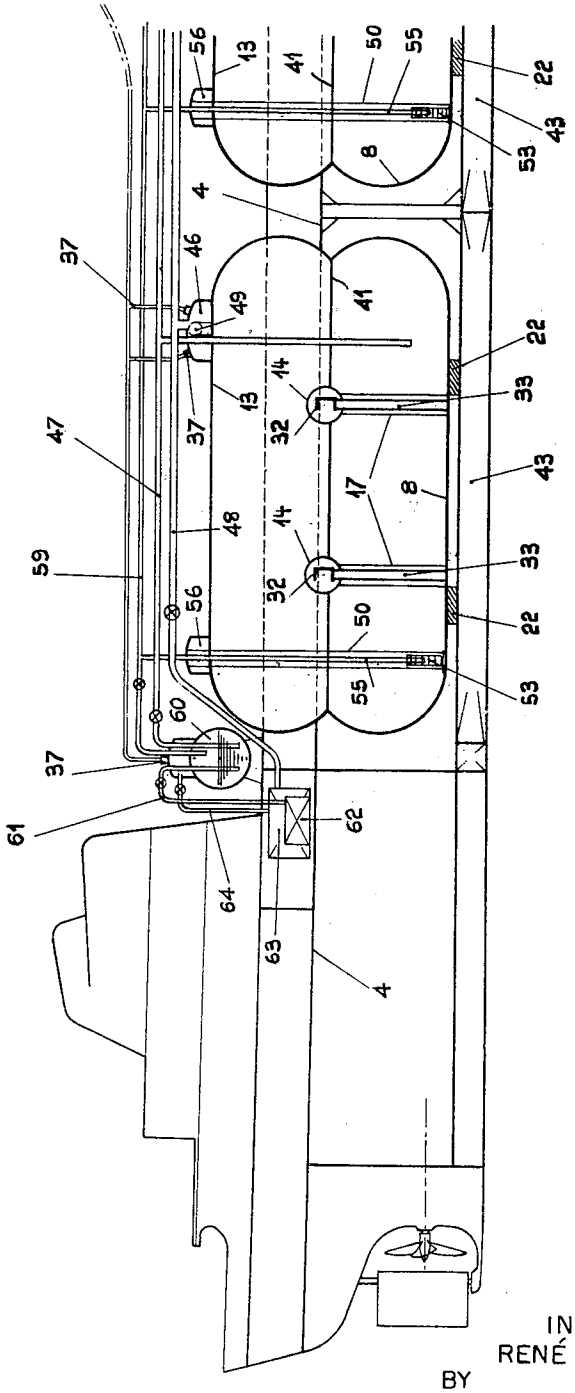
FIG:6



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CONSTRUCTION OF LIQUEFIED GAS CARRIERS

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FIG:7

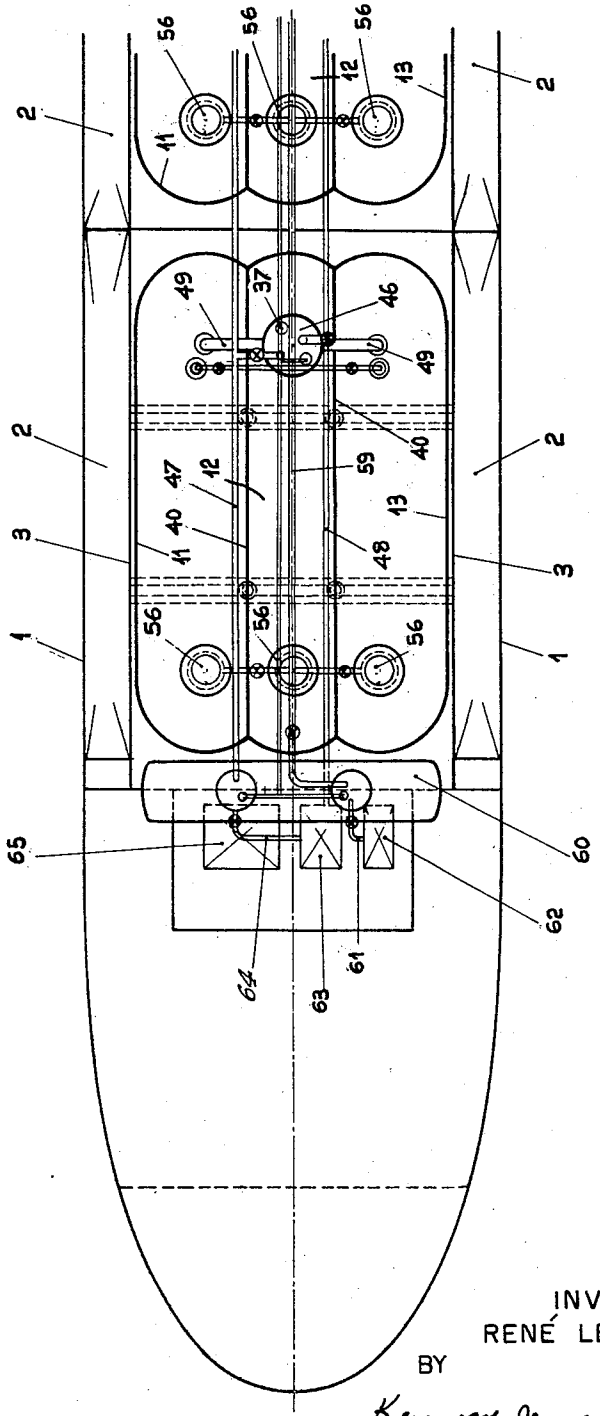

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FIG. 8

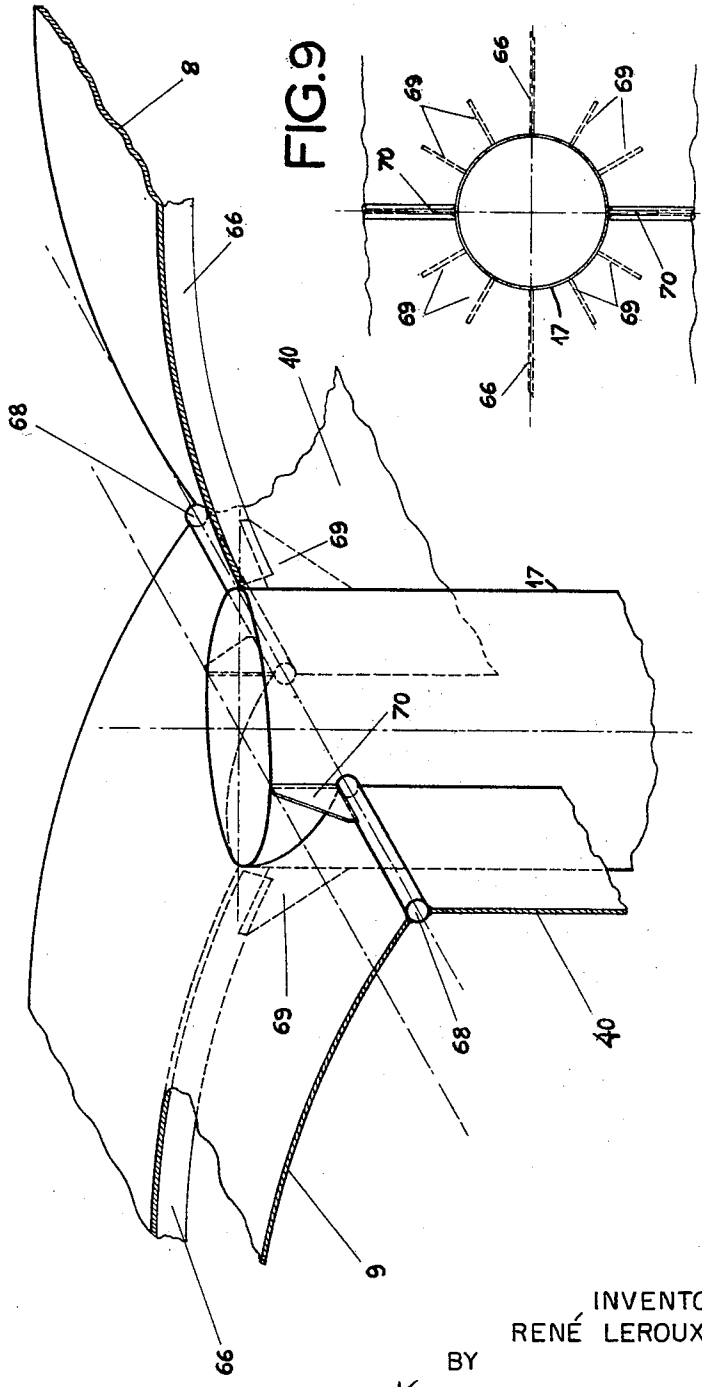

FIG. 9

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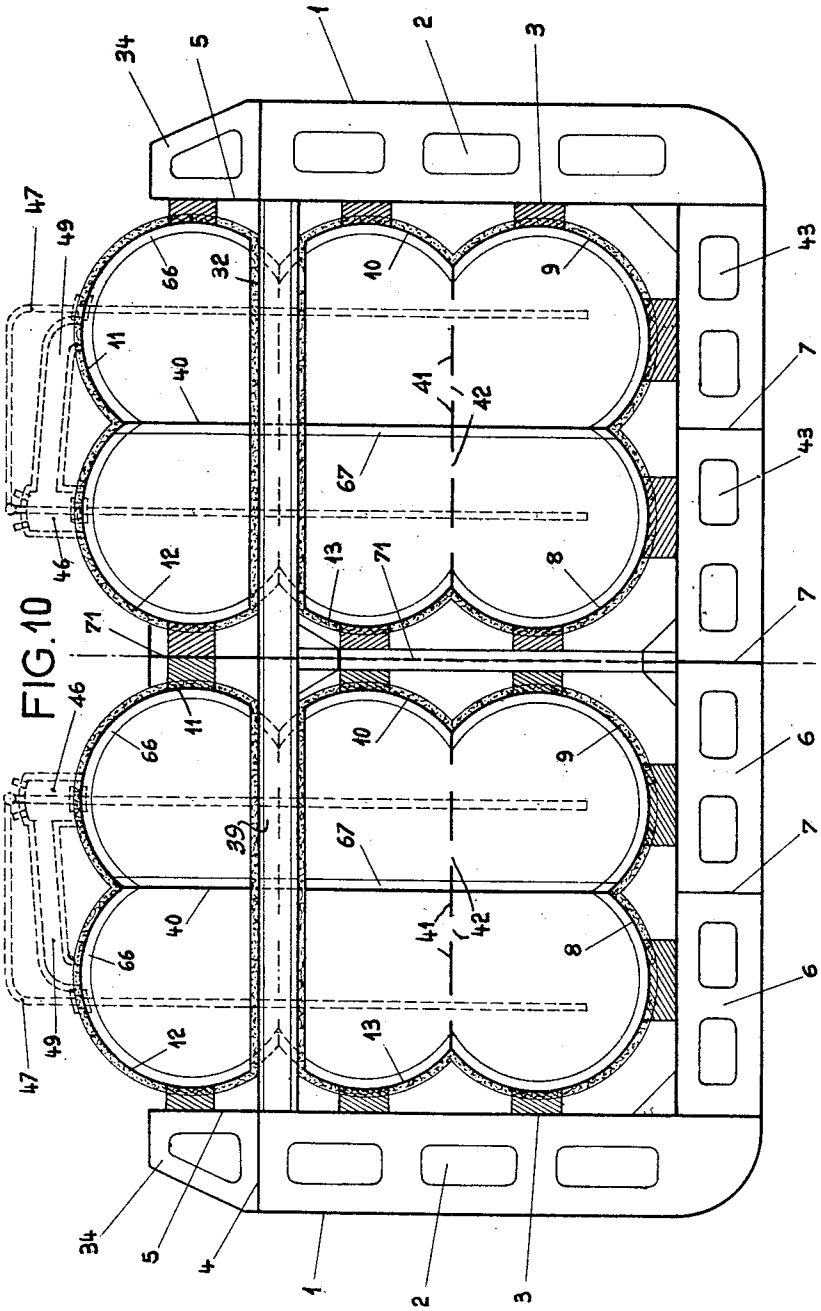

FIG. 10

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United States Patent Office

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CONSTRUCTION OF LIQUEFIED GAS CARRIERS

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Claims priority, application France Oct. 5, 1960
4 Claims. (Cl. 114—74)

The present invention concerns the design of vessels for the transportation of liquefied gases, and in particular the design of such vessels comprising cylindrical tanks which are inter-connected with each other.

It is known to build such vessels in which the longitudinal bulkheads which are located in the planes of intersection of said cylinders and in the interior of said cylinders are intersected, or replaced, partly or completely, by hollow tie-rods the inside of which is in free communication with the atmosphere. Such a design has advantages which are known, but it has the following severe disadvantage: it is always desirable to put the largest possible tanks on a vessel, and such large tanks force the designer to provide large cut-outs in the deck which reduce its strength; it is then necessary to make the vessel wider in order to maintain a gutter, i.e., a strake which covers the deck along the entire length of the vessel and which has sufficient strength and rigidity. It is also necessary to reinforce the sheer strake, i.e., the upper vertical strake of the shell which bounds the main deck throughout the entire length of the ship. Both these requirements increase the weight and the cost of the hull.

The primary object of this invention is to eliminate this serious inconvenience in the design of vessels carrying inter-connected cylindrical tanks. For this purpose the invention provides hollow stay tubes which serve as passageways for structural members of the hull, such as girders and stanchions. The structural elements of the hull thus pass through the tanks instead of going around them which permits substantial savings in weight and costs.

The invention has the additional object of permitting the design of vessels in which the tanks are higher than the deck, even with a substantial part of their capacity, for example with half their capacity; thus, the structural elements of the deck pass, according to the invention, through the hollow stay tubes in the tanks and remain at normal temperature.

Another object of the invention is to give the interconnected tanks strength against internal vacuum which occurs, in practice, when there is a change in the type of liquefied gas which is being carried.

The tank consists preferably of several sections (lobes) and includes hollow stay tubes which permit the passage of the girders and of the stanchions of the hull; but it also has horizontal and vertical bulkheads as means of joining the cylinders. These bulkheads are welded to the intersections formed by the generatrices of the cylinders and also to one of the generatrices of the hollow stay, which makes the entire structure particularly rigid. The six-part tank with its bulkheads represents a beam which rests on two supports and shows only very slight deformation.

It is also possible to adapt the tank system described above to existing vessels which are not specially built for this purpose. It is sufficient in order for this conversion to be advantageous, that the vessel under consideration has already a substantial ballast space. It is thus possible to convert certain freighters, tankers, or ore carriers, by rebuilding of the deck and the bulkheads.

Certain embodiments of the invention and the advantages thereof will be seen more clearly from the description below, which refers to FIGS. 1 to 10 of the drawings in which:

FIG. 1A is a fragmentary cross sectional view of a vessel taken through a section of the vessel in which the hollow stay tubes of the present invention are located.

FIG. 1B is similar to FIG. 1A but shows the tank insulation on the inner surface of the tank.

FIG. 2A is a cross sectional view of the vessel shown in FIG. 1A taken through the section of the vessel in which the supports for the tank are located.

FIG. 2B is similar to FIG. 2A but shows the tank insulation on the inner surface of the tank.

FIG. 3 is an enlarged fragmentary cross sectional view showing the thermal insulation used on the inner surface of the tanks illustrated in FIGS. 1B and 2B.

FIG. 4 is a cross sectional view of a vessel embodying the present invention, including portions of its pumping and cooling systems.

FIG. 5 is similar to FIG. 4 but is taken through the section of the vessel in which the pumps are located.

FIG. 6 is a side elevation view of a portion of a vessel embodying the present invention, some of the parts being removed to show details of construction.

FIG. 7 is a top plan view of a portion of a vessel embodying the present invention, some of the parts being removed to show details of construction.

FIG. 8 is an enlarged fragmentary perspective view illustrating details of construction.

FIG. 9 is an enlarged fragmentary top plan view of the parts shown in FIG. 8.

FIG. 10 is a cross sectional view illustrating another embodiment of the invention.

Referring to the drawings, the hull **1** comprises two side ballast compartments **2** enclosed by two lateral bulkheads **3** and a deck **4** reinforced by two lateral binding strakes **5**. The bottom is supported by floor frames **6** and by longitudinal supports **7**. The tank consists of six cylinders **8, 9, 10, 11, 12, 13** held together by seven hollow stay tubes **14, 15, 16, 17, 18, 19, 20** and rests on lateral supports **21** and horizontal supports **22**. For transportation of gas at moderately low temperature, as shown in FIGS. 1A and 2A, thermal insulation **23** is provided on the outside of the cylinders and the inside of the hollow stay tubes; strakes **24** inside the tanks are welded to the joints **25** and provided with gussets **26**. For a vessel transporting gas at very low temperature, as shown in FIGS. 1B and 2B, the thermal insulation **27** is applied to the inside of the cylinders and the outside of the hollow stay tubes, it is separated from the liquid by a thin sheet **28**, preferably embossed and held by studs **29** with heads that are welded tight. The strakes **30** and their gussets **31** are on the outside of the tanks. According to the invention the longitudinal and transverse bulkheads of the hull are eliminated and replaced by reinforced girders **32** and stanchions **33** which run freely through the inside of the hollow stay tubes **14** to **20** (the girders and stanchions are represented by dot-dash lines indicating their center lines in order not to overcrowd the drawings). Reinforcements **34** hold the upper parts of the tanks. It will be noticed that the volume of the tanks is greater than the volume of the hull which is particularly desirable. The drawings indicate schematically the loading pipes **35**, the unloading pipes **36** and the safety valves **37**.

An application of the invention will be described with reference to FIGS. 4 to 9 which show a vessel with a six-part tank for the transportation of liquefied gas under pressure, at normal temperature, such as butane, isobutane, butadiene, propane, isopropane, or of compounds, such as ammonia and its derivatives.

FIGS. 4 and 5 show multi-lobed tanks consisting of six sections having the shape of partial cylinders **8, 9, 10,**

11, 12, 13, of vertical bulkheads 40 without openings and horizontal bulkheads 41 with openings 42, and of hollow stay tubes 14, 17 and 19 inside of which are the griders 32 and the stanchions 33. The entire structure is covered with a layer of insulating material 23 on the outside of the cylinders and on the inside of the hollow stay tubes. The insulation thus forms a continuous surface which completely surrounds the tank. The tank is supported within the hull 1 by lateral cradles 21, and also the bottom cradles 22 which overlie the lower ballast tanks 43. Certain of these cradles are slidable in order to permit slight deformations of the tanks under the action of pressure or of temperature.

A dome 46 is located on the forward section of the tanks. Pipes 47 through which the liquefied gas arrives, pipes 48 for the compressed gas that drains the liquid from the tank and the pipes 49 for equalizing the pressure between the cylinders, all lead to this dome. The dome also carries the safety valves 37 provided in accordance with the applicable regulations.

The liquefied gas is drawn from the rear section of each cylinder through pipes 50 which bring it to the top of the tanks. These pipes are equipped with flap-type valves 51 at their lower end which can be actuated from the deck, a valve 52 located on the side, a submersible pump 53 moving on slides 54, a drive shaft 55 for the pump, an hermetically sealed closing plate 56, a stuffing box 57, and, on top, a motor 58 which can, for example, be operated by oil or compressed air (FIGS. 5, 6 and 7).

The liquid then flows through an exhaust pipe 59 which brings it to an intermediate tank 60; from there it flows through a pipe 61 to the unloading pump 62 which discharges it to the outside.

The compressor 63 draws gas from the dome of the auxiliary tank through pipe 64 and discharges the compressed gas into the main tanks through pipe 48.

For loading, the liquid arrives directly in the auxiliary tank 60 where it is cooled if its temperature is too high and from where it is transferred to the tanks through loading pipe 47.

Other pipes are not shown, for instance the pipes for the elimination of gas bubbles which may occur in the liquid, pipes for removing gas from the tanks, and pipes for fighting fires. There is also provided a collecting device for escaping gas which collects all gas escaping from the safety valves 37 and discharges it aloft in the forward section.

The cooling machinery is indicated in the drawings at 65. The drawings show, in addition, at 66 the ribs which permit the tanks to withstand a vacuum and at 67 the struts installed for the same purpose.

FIGS. 8 and 9 show in detail the method used for joining the tanks and the hollow stay tubes in these tanks. They show the welding seams 68 protected by longitudinal bulkheads 40, by ribs 66 and by the added gussets 69 and 70.

FIG. 10 shows a very large vessel in which the volume of each tank should not be excessive. Each of the tanks is placed in one of the two sections into which hull 1 has been divided by a longitudinal bulkhead 71. The other arrangements are those described above. The girder 39 rests on the ballast tanks 2 through the intermediary of bulkheads 3, and on the longitudinal bulkhead in the center.

What I claim is:

1. In a vessel designed for the transport of liquefied gases, in combination a hull including beams and stanchions as resistant structural elements and at least one tank composed of several horizontal cylinders with circular sections and axis parallel to ship's line, said cylinders intersecting one another, hollow stay tubes connecting said cylinders and situated in the planes of intersection of said cylinders, the inner part of said hollow stay tubes being in free communication with the atmosphere, said beams and said stanchions running freely through the said hollow stay tubes of the tanks.

2. In a vessel designed for the transport of liquefied gases, in combination a hull including beams and stanchions as resistant structural elements and at least one tank composed of several horizontal cylinders with circular sections and axis parallel to ship's line, said cylinders intersecting one another, hollow stay tubes connecting said cylinders and situated in the planes of intersection of said cylinders, the inner part of said hollow stay tubes being in free communication with the atmosphere, said beams and said stanchions running freely through the said hollow stay tubes of the tanks, thermal insulation covering the outer surface of said cylinders and the inner surface of said hollow stay tubes without any connection either with said beams or with said stanchions.

3. In a vessel designed for the transport of liquefied gases, in combination a hull including beams and stanchions as resistant structural elements, and at least one tank composed of several horizontal cylinders with circular sections and axis parallel to ship's line, said cylinders intersecting one another, and hollow stay tubes connecting said cylinders and situated in the planes of intersection of said cylinders, the inner part of said hollow stay tubes being in free communication with the atmosphere, said beams and said stanchions running freely through said hollow stay tubes of the tanks, thermal insulation covering the inner surface of said cylinders and the outer surface of said hollow stay tubes to insulate said tank, a thin corrugated metal sheet being secured over said insulation to protect it from the contents of the tank.

4. In a vessel designed for the transport of liquefied gases, in combination a hull including beams and stanchions as resistant structural elements and at least one tank composed of several horizontal cylinders with circular sections and axis parallel to ship's line, said cylinders intersecting one another, longitudinal bulkheads and hollow stay tubes interconnecting said cylinders and situated in the planes of intersection of said cylinders, a thermal insulation covering the outer surface of said cylinders and the inner surface of said hollow stay tubes without any connection either with said beams or with said stanchions, the inner part of said hollow stay tubes being in free communication with the atmosphere, said beams and said stanchions running freely through the said hollow stay tubes of the tanks, said cylinders and said bulkheads and said stay tubes being connected by welding, some of said bulkheads being vertical and liquid-tight and others being horizontal and provided with communication openings.

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