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R. RIGBY ET AL  
SHIPPING LIQUEFIED GASES

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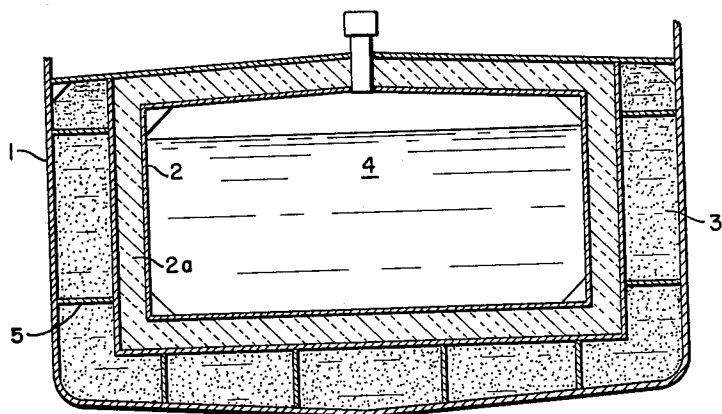


FIG. I

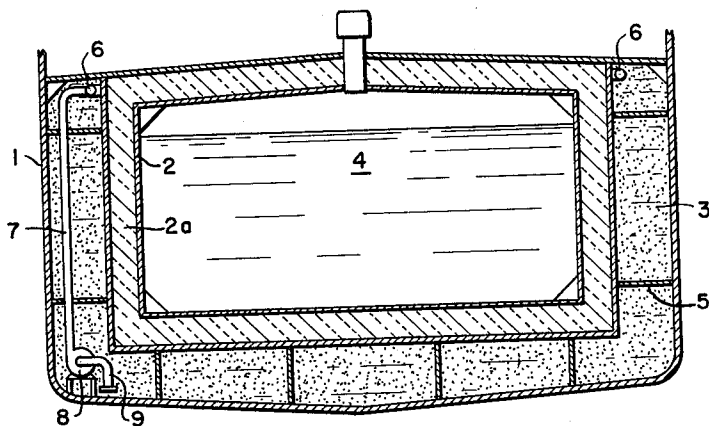


FIG. II

INVENTORS:  
R. RIGBY  
R.G. JACKSON

BY: *A. D. Basch*

THEIR ATTORNEY

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## SHIPPING LIQUEFIED GASES

Richard Rigby and Robert Glover Jackson, Wirral, England, assignors to Shell Oil Company, New York, N.Y., a corporation of Delaware

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9 Claims. (Cl. 62-45)

The invention concerns a tanker for the transport of low-temperature liquid cargoes; e.g., liquefied natural gas, methane, ethane, ethylene and mixtures thereof.

Such liquids are usually carried in heat-insulated tanks made of a suitable material, for example, aluminum or stainless steel, mounted in what amounts to the hold of the ship. The hold and the ship's structure are, for reasons of cost, constructed of a normal steel. Such normal steel becomes brittle, however, if exposed to temperatures below  $-70^{\circ}\text{C}$ . ( $-100^{\circ}\text{F}$ .); for example, those of liquefied natural gas, which is transported at temperatures below  $-150^{\circ}\text{C}$ . ( $-240^{\circ}\text{F}$ .). Since such brittleness would endanger the ship, some protection for the ship's structure must be provided if the ship is to be safe in the event one or more of the tanks containing the low temperature liquid should fail.

To this end, according to the invention, the hold of the tanker is internally lined with a lining, which comprises a porous material and a fluid having a freezing point below ambient temperature and above the temperature of the liquid to be transported. This fluid may be water, a hydrocarbon or another suitable liquid.

According to a preferred embodiment of the invention means are provided for circulating the fluid through the lining. These means preferably comprise a pump, the suction line of which communicates with a drain in the lower portion of the lining, and the pressure line of which is arranged for feeding fluid to the top portion of the lining.

The invention is now described in more detail by reference to the accompanying drawing, in which FIG. I and FIG. II are cross-sectional elevations of different embodiments of a tanker according to the invention.

The FIGS. I and II show the hull wall 1 of a tanker, the hold of which is provided with a heat-insulated tank 2 (with heat insulation 2A) containing liquefied natural gas 4 at a temperature of  $-150^{\circ}\text{C}$ . ( $-240^{\circ}\text{F}$ .), the pressure in the tank above the liquid being slightly in excess of atmospheric pressure.

The inner side of the wall 1 is provided with a lining 3, which consists of a porous filler material and a sealing fluid. The filler material may be wood flour, cork, mineral, foamed plastic (for example, foamed polyvinyl chloride or foamed polystyrene) or another suitable porous insulating material not affected chemically by the sealing fluid. If desired, the porous material may be held in place by shuttering.

The sealing fluid has a freezing point below ambient temperature and above the temperature of the liquid in the tank 2. This sealing fluid may suitably be water or a hydrocarbon; for example, a heavy fuel oil fraction.

A plurality of anchoring means or spacers 5 are provided for supporting the tank 2 in proper space relationship to the whole wall 1 of the tanker.

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In the embodiment shown in FIG. I, the sealing fluid fills substantially all the open pores within the lining. The hydrostatic pressure of the sealing fluid causes an upward buoyancy force on the tank 2, which will be counteracted by the anchoring means 5.

In the embodiment shown in FIG. II, a pump 8 is provided, the pressure line 7 of which feeds distributors 6 in the top portion of the lining 3. Sealing fluid may be continually supplied by the distributors 6 to the lining 3, through which it drains downwardly to the lower portion of the lining where drains 9 are provided. These drains 9 communicate with the suction line of the pump 8, which may continually withdraw sealing fluid from the lining. Thus, the sealing fluid circulates through the lining and no substantial hydrostatic pressure will develop within the lining.

Under normal conditions, i.e., when the heat insulated tank 2 is intact, the sealing fluid in the lining will be in the liquid phase. If desired, the lining 3 may be provided with heating elements; so as to prevent freezing of the sealing fluid under normal conditions.

If a leak in the tank 2 should occur, the escaping cold liquid or gas will come into contact, or near contact, with the lining 3 and freeze the fluid therein near the leak; thereby forming a frozen plug which provides an effective seal between the tank 2 and the wall 1 and prevents the cold liquid or gas 4 from coming into contact with the wall 1. The porous material in the lining 3 will trap the frozen plug in its proper location opposite the leak and will retain the plug at this location in spite of forces tending to dislodge the plug. Once the leak has been sealed, any further necessary safety measures can then be taken; for example, pumping the liquid 4 in the tank 2 overboard.

It will be clear that the protection afforded by the lining 3 must last for sufficient time for the remedial measures to be taken. To this end, the lining 3 does not necessarily have to be an extremely effective heat insulant, but rather should have a high thermal inertia; i.e. it should require a substantial outflow of heat to be cooled. In this respect, the use of water as a sealing fluid is advantageous, in view of the great heat of fusion of water.

Apart from the hull wall of the tanker, other load carrying members of the hull in the vicinity of a tank 2 may be similarly protected.

We claim as our invention:

1. Apparatus for storing low temperature liquids comprising: an outer container; an inner heat insulated container wherein said low temperature liquid is stored; means for anchoring said inner container in a spaced relationship with said outer container; a porous filler material filling the space between said inner and said outer containers; and, a fluid having a freezing point below ambient temperature and above the temperature of said stored liquid filling the pores in said filler material.

2. The apparatus of claim 1 wherein said outer container is the hull of a ship.

3. The apparatus of claim 1, in which the fluid is water.

4. The apparatus of claim 1, in which the fluid is a hydrocarbon.

5. The apparatus of claim 1, in which means are provided for circulating the fluid through the filler material.

6. The apparatus of claim 5, in which the means for

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circulating the fluid through the filler material comprise a pump, the suction line of which communicates with a drain in the lower portion of the filler material, and the pressure line of which is arranged for feeding fluid to the top portion of the filler material.

7. Method of storing a low temperature liquid comprising: placing said low temperature liquid in a heat insulated storage tank; maintaining about said insulated storage tank a porous filler material containing a fluid having a freezing point below ambient temperature and above the temperature of the stored liquid; and, con-

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tinuously circulating said fluid through said porous lining.

8. The method of claim 7 wherein said fluid is water.

9. The method of claim 7 wherein the fluid is a hydrocarbon.

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