Aug. 20, 1968 N. K. BASILE ETAL 3,397,662

HATCH ARRANGEMENT FOR LIQUEFIED GAS STORAGE TANKS

Filed June 28, 1966 5 Sheets-Sheet 1

FIG. 1.

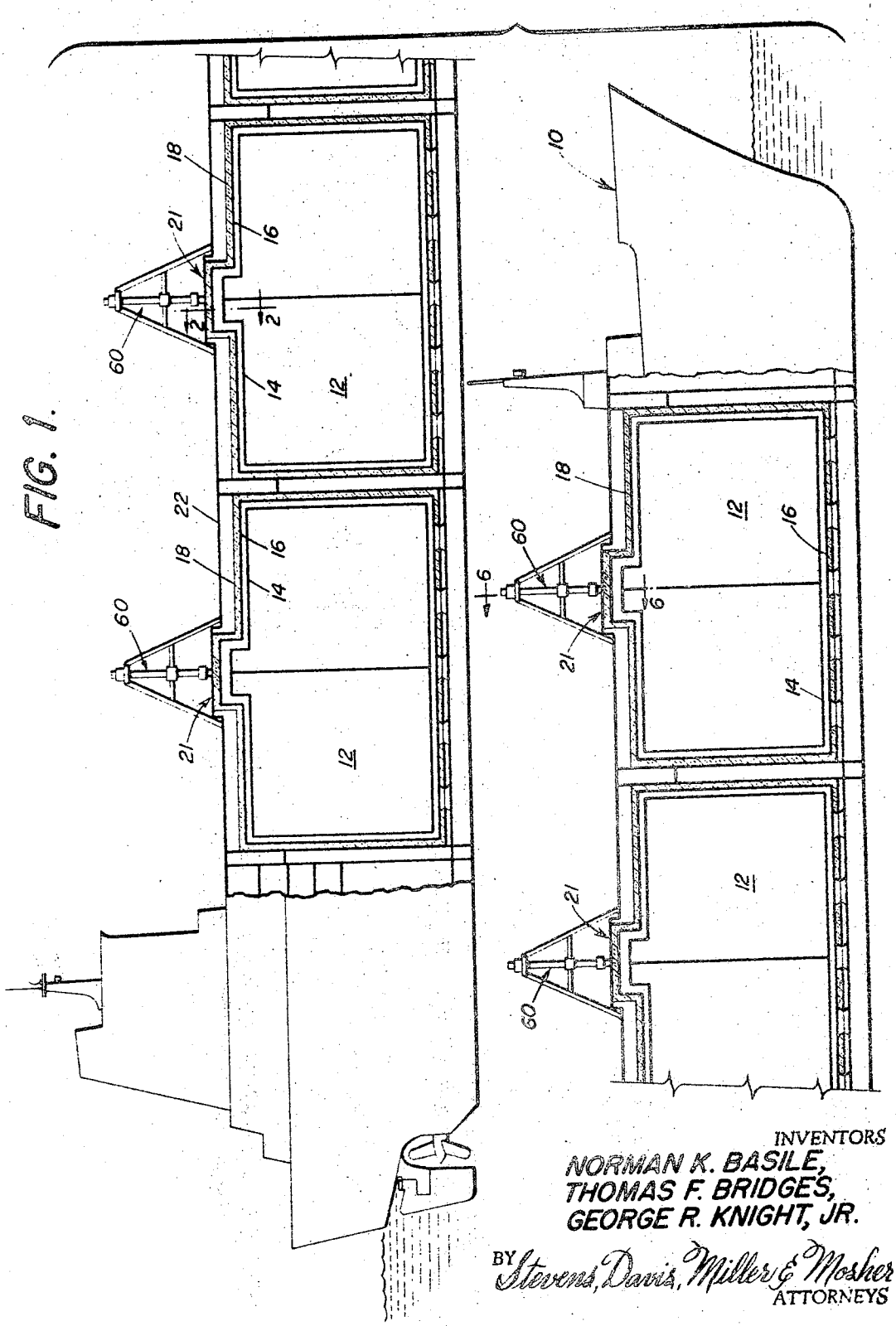

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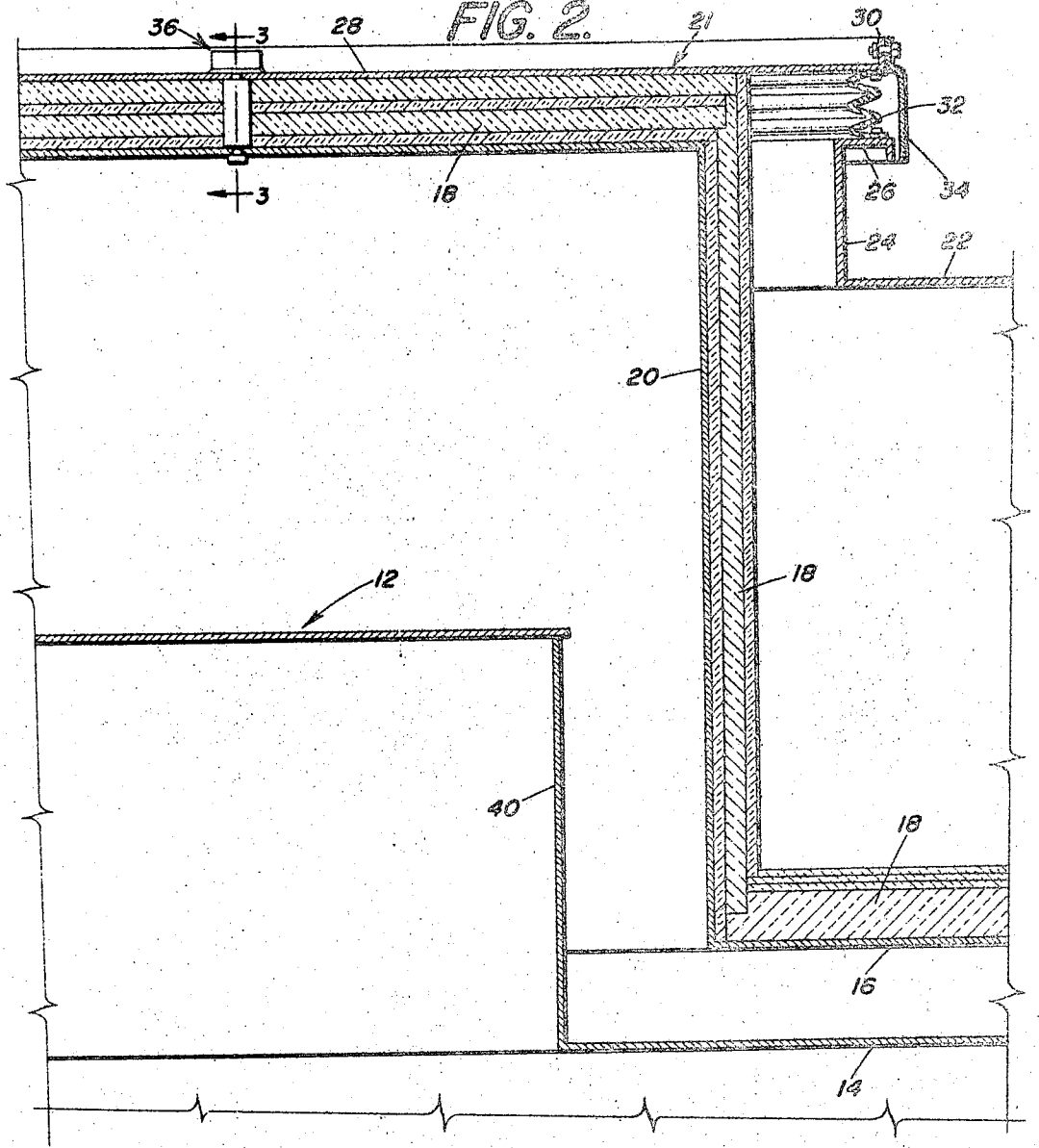
FIG. 2.



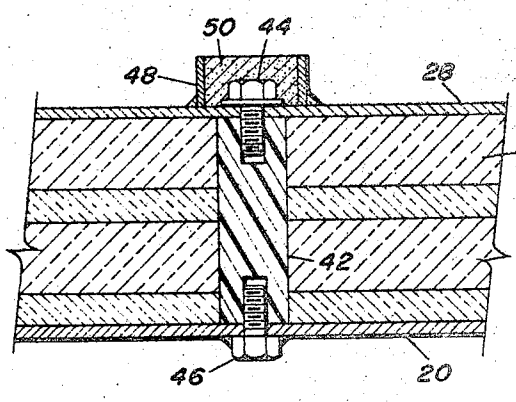


FIG. 3.

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FIG. 4.

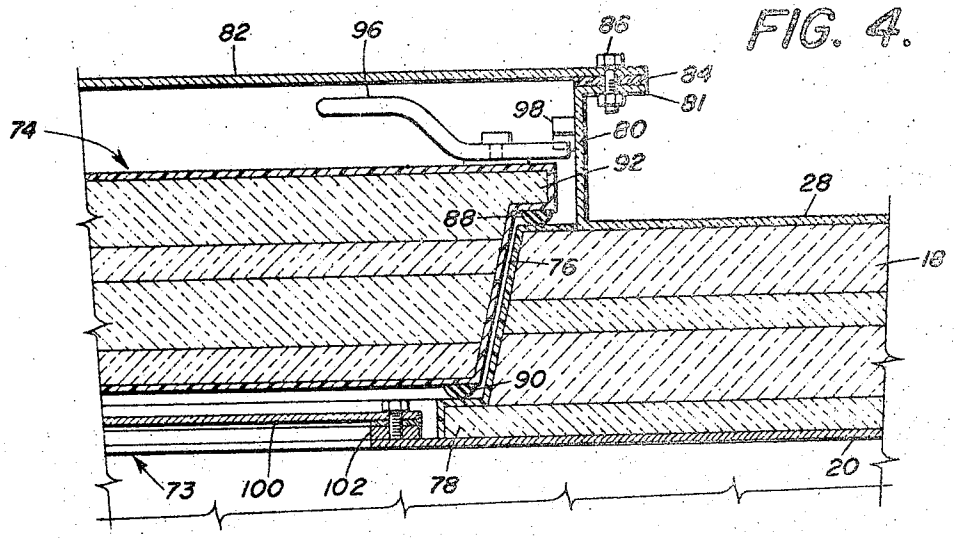

FIG. 7.

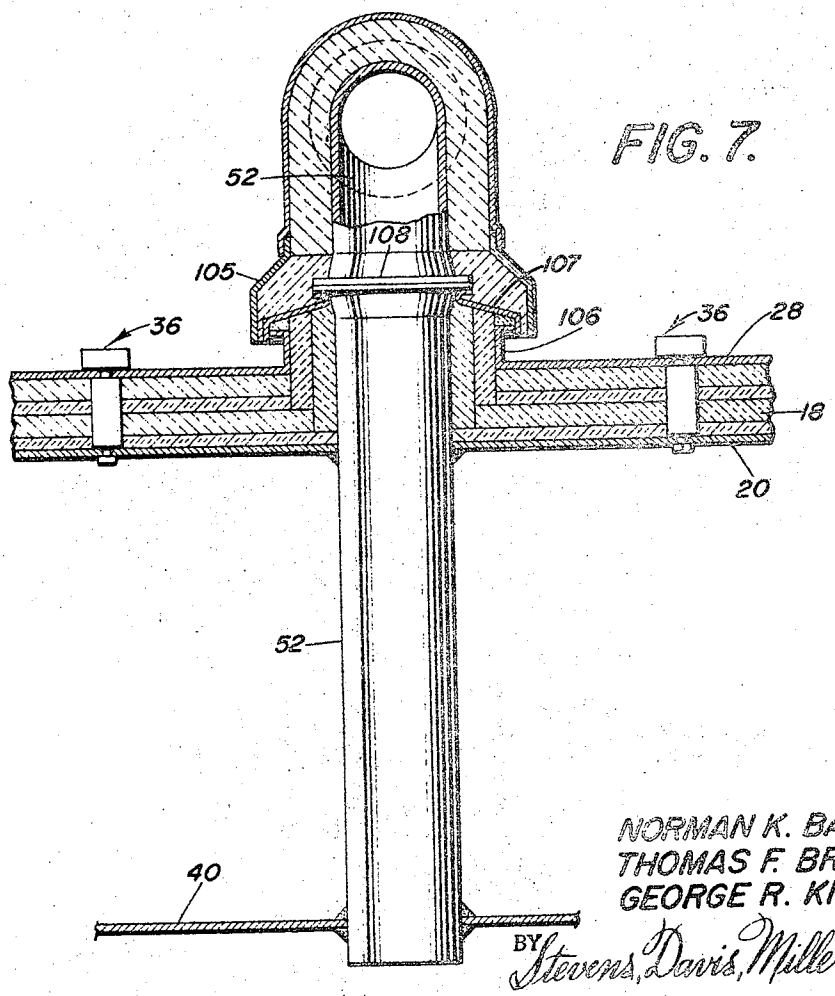

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FIG. 5.

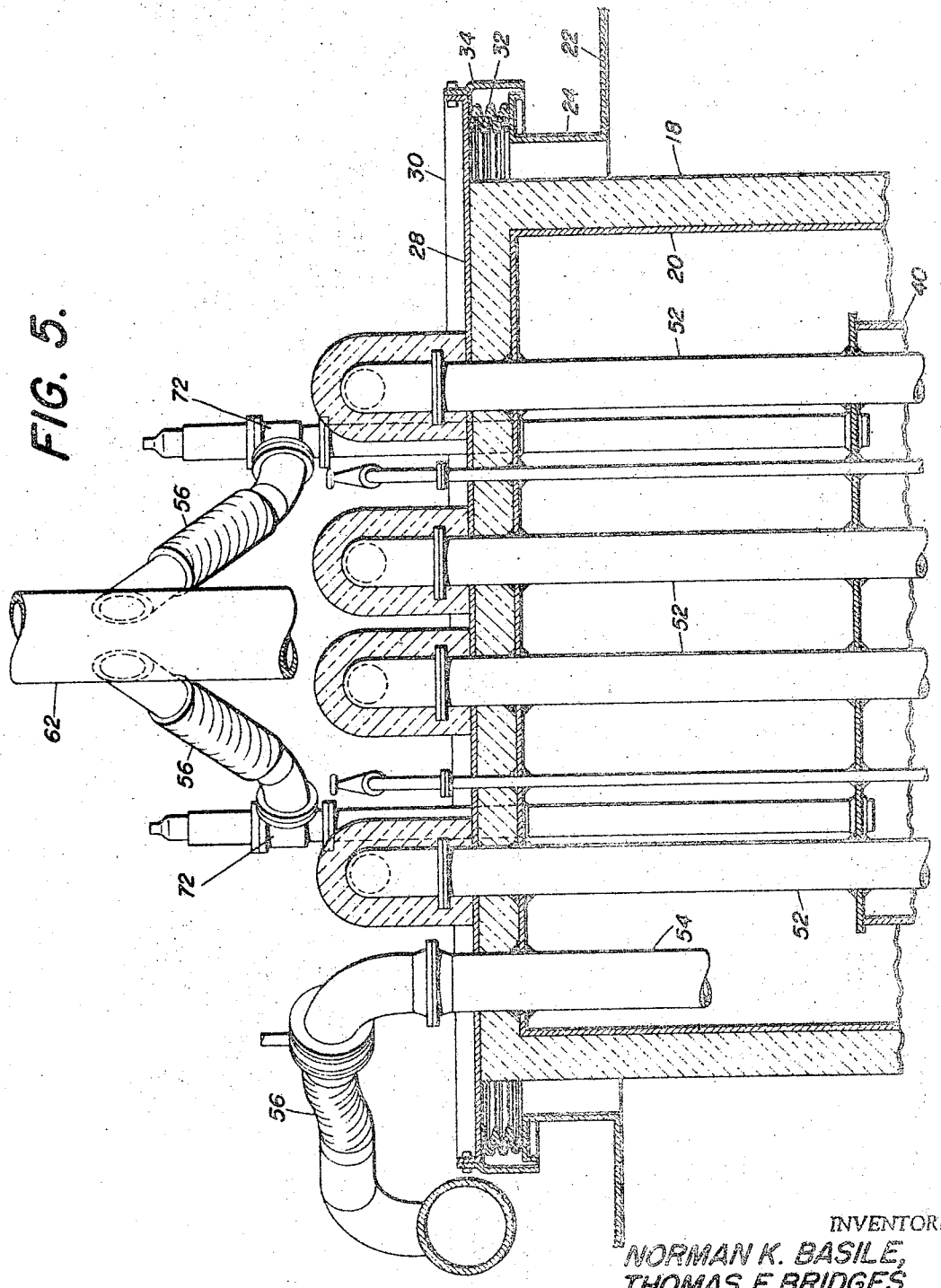

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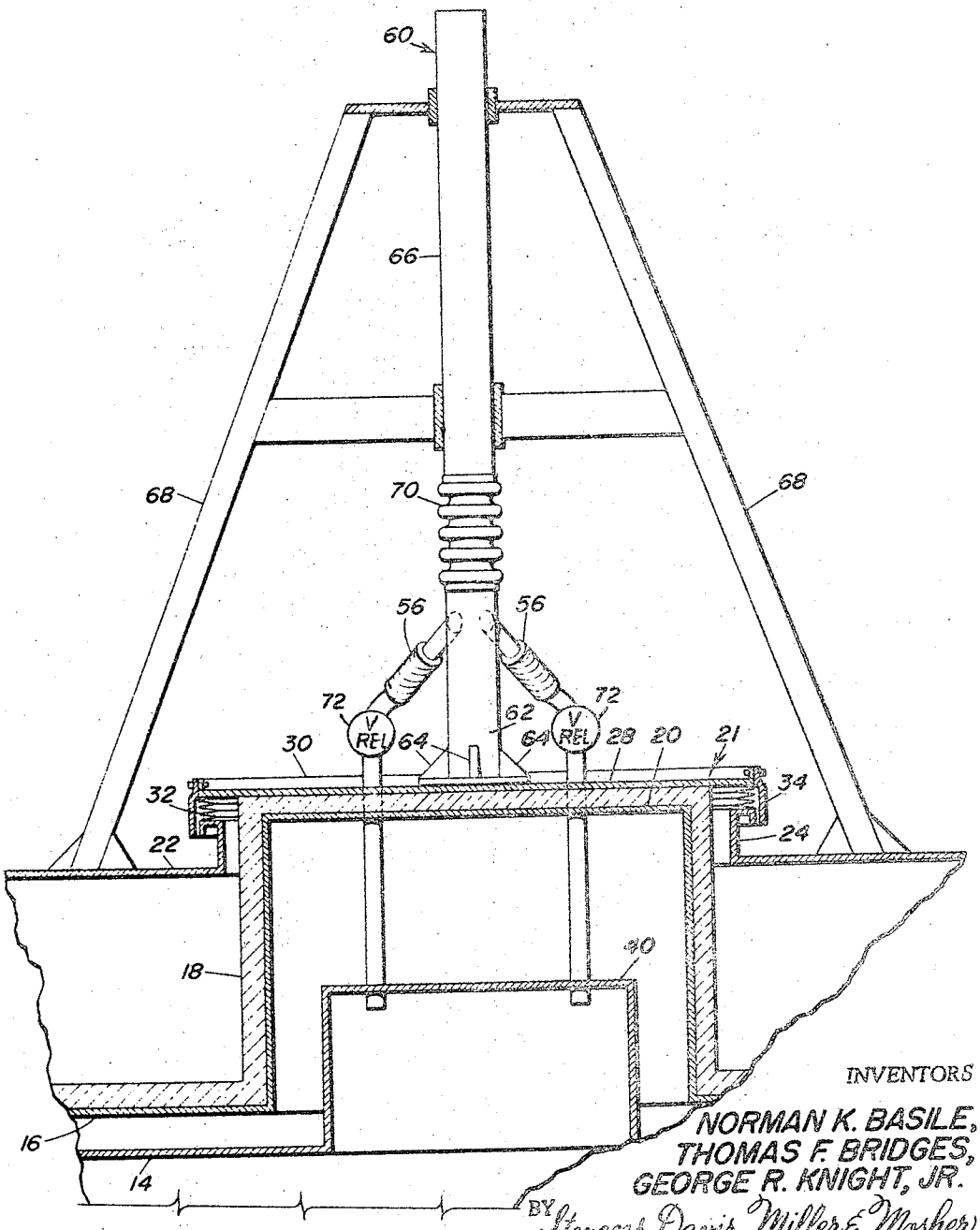
FIG. 6.



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3,397,662

HATCH ARRANGEMENT FOR LIQUEFIED GAS STORAGE TANKS

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Filed June 28, 1966, Ser. No. 564,487
15 Claims. (Cl. 114—74)

ABSTRACT OF THE DISCLOSURE

A hatch arrangement for a liquefied gas storage tank wherein the tank is provided with a trunk at its center top with the bottom of the trunk located below the upper deck. Insulation covers the top and sides of the trunk, and a hatch cover supported by insulation encloses an opening in the upper deck and is attached to the top of the trunk and the upper deck by means of a flexible sealing coupling to permit thermal growth of the tank independent of the ship's structure.

The present invention relates to hatch arrangements for liquefied gas storage tanks and, more particularly, to hatch arrangements for tanks aboard liquefied gas transport vessels.

It is known that tanks of the type described experience thermal expansion and contraction when loaded and unloaded with liquefied gases at about ambient pressure. Not only does the tank move in all lateral directions, but it expands and contracts vertically as well, which, if such growth is restrained, results in dangerous stress levels within the tank.

The hatch arrangement according to the present invention affords substantial vertical freedom for hatch movement relative to the deck, as well as for all structure and fittings carried by the hatch.

It is one object of the present invention to provide a hatch arrangement which includes a hatch cover rigidly connected to, and which moves vertically with, the trunk top of the tank. A flexible expansion joint seals the hatch cover with the main deck and affords vertical movement without creating deck stresses.

Another object of the present invention is to provide a tank with a top spaced below the upper deck, but which includes a central trunk to accommodate piping, said trunk extending upward through the upper deck. Insulation blankets the trunk walls and top, and a hatch cover rigid with the trunk top sandwiches the uppermost insulation.

In tanks having a double barrier, members extending through the trunk top and inner barrier top fix the spaced relationship therebetween to help distribute stress concentrations and reduce the stress level in other parts of the tank.

It is a further object of the present invention to provide an individual blow-off mast for each tank and vertically arranged on the hatch cover thereof. The upper section of the mast is supported by a plurality of posts in fixed relation with the upper deck. The lower section is fixed relative to the vertically movable trunk, and an expansion coupling connects the upper and lower sections. In addition, pressure relief valves are provided on the hatch cover with expansion couplings coupling them to the mast lower section to enable lateral expansion without stress. The blow-off mast is connected to the hatch in an arrangement which directs any leakage onto the hatch cover surface for evaporation.

Another object of the present invention is to provide a hatch arrangement with a cover material which withstands cryogenic liquids so that any such leakage thereon harmlessly evaporates without contacting the ship's carbon steel structure.

Still another object of the present invention is to provide a trunk top of the type described cooperating with the hatch cover wherein a sealed, removable insulated plug is provided in a manhole formed in the trunk and hatch tops, said plug being arranged in a cavity below the hatch cover and above the trunk top.

Other and further objects of the present invention will become apparent with the following detailed description when taken in view of the appended drawings in which:

FIG. 1 is a diagrammatic side elevation of a vessel having tanks according to the present invention;

FIG. 2 is a transverse vertical section taken along line 2—2 of FIG. 1 illustrating parts of the inner and outer tank and the hatch cover therefor;

FIG. 3 is a vertical section taken along line 3—3 of FIG. 2;

FIG. 4 is a vertical section illustrating part of the insulated plug and manhole location in the trunk top;

FIG. 5 is a transverse vertical section illustrating the piping and parts of the blow-off mast;

FIG. 6 is a vertical transverse section taken along line 6—6 of FIG. 1 and diagrammatically illustrating the blow-off mast arrangement; and

FIG. 7 is an enlarged vertical section showing details of a pipe penetrating the trunk.

Referring to the drawings in detail, a vessel **10** is provided with a plurality of (in this case four) cargo tanks **12** for storing liquefied gas cargo at about ambient pressure. The cargo can be methane, ethylene, propane or any other desired type. Each tank **12** can be a double barrier, self-supporting structure having an inner tank **14**, a spaced outer tank **16**, with the ship's inner hull and deck preferably spaced therefrom. Insulation **18** is hung in layers on the outer tank wall and may be secured in a manner more fully disclosed in the copending patent application entitled "Novel Insulated Tank Configuration," by Thomas F. Bridges, George R. Knight, Jr., and Norman W. Penney, Ser. No. 539,489, filed Apr. 1, 1966.

Each tank **12** has a central hatch arrangement **21** which accommodates gas and liquid piping used for feeding and returning various fluids to the compartments of each tank **12**. Hatch arrangement **21** comprises an upstanding, box-like trunk **20**, the walls of which extend from the top of tank **16** up through the upper deck **22** of the ship. The walls and top of the trunk **20** are blanketed with layers of insulation which can be secured as disclosed in the aforementioned patent application.

Continuously spaced around the top of trunk **20** is an upstanding plating **24** supported on deck **22** which has an outward facing horizontal lip **26** and a downward flange at its outer edge. A weather hatch cover **28** made of nickel-steel or an aluminum alloy rests on the insulation covering the top of trunk **20** and has an outer edge terminating in an upstanding flange **30**. Flange **30** is located over lip **26** and prevents spillage from reaching deck **22**. Cover **28** is held fast to the trunk so that the combination moves as a unit.

To isolate trunk **20** from the atmosphere but enable vertical movement relative to deck **22**, a folded or corrugated flexible expansion joint **32** runs continuously around trunk **20** with its upper edge fastened to cover **28** and its lower edge fastened to lip **26**. Joint **32** may be any suitable synthetic reinforced rubber or similar flexible impervious material. A continuous guard **34** is secured to flange **30** and protects joint **32** from weather and impact damage.

The primary tank **14** also includes an uninsulated trunk **40** smaller than, and spaced inward from, trunk **20**. The tops of trunks **20** and **40** move together in a manner described below.

Referring to FIG. 3, attachment 36 includes an elongated phenolic block 42 having a length preferably equal to the insulation thickness at the trunk top. Each end of block 42 is axially tapped with the tapped openings aligned with the opening drilled in cover 28 and the trunk top. Bolts 44 and 46 are received by block 42 generally as shown to secure the combination. A coaming ring 48 welded to cover 28 about the head of bolt 44 acts to hold a mastic material 50 for sealing and insulation purposes.

Any suitable number of attachments 36 are provided at several spaced locations on the hatch arrangement. Prior to assembly, the tank top and cover 28 are clamped together in the proper relative positions; openings are then drilled, and in this way these openings which receive bolts 44 and 46 must be aligned. In assembly, bolts 46 are positioned and welded to the trunk top. Next, blocks 42 are threaded on bolts 46, and the insulation is laid in place. After positioning cover 28, bolts 44 are threaded in, after which coaming 48 is welded, and the mastic poured.

Referring now to FIGS. 1 and 5–7, a plurality of pipes 52 extends vertically through the top of trunks 20 and 40 and serves to deliver and return various fluids to the inner tank. Additional pipes 54 communicate with the outer tank space. Pipes 52 are welded to the tops of trunks 20 and 40 and, as such, provide a rigid connection and fix the distance therebetween. In this way, the trunk tops move together relative to deck 22 in response to changing thermal conditions.

In order to prevent stresses, each pipe 52 and 54 is coupled to a supply or return line stationary with deck 22 through a hydraulically formed bellows-type stainless steel expansion joint 56.

In FIG. 7, if leaks develop in the section of pipe 52 above flange 108, leakage runs down shield 107 out onto cover 28, where it harmlessly evaporates. Coaming 106 and collar 105 retain insulation blocks about the pipe, and it is preferred that the insulation within collar 105 be of moisture impermeable polyurethane.

Each tank 12 is provided with an individual blow-off mast 60, which includes a lower section 62 attached to the cover 28, preferably at the vertical center axis of the tank. Section 62 is welded to the hatch cover 28 for rigidity, and angle braces 64 are attached to the hatch cover 28 and section 62 to distribute lateral forces.

Mast 60 has an upper section 66 held above and generally in axial alignment with the lower section by horizontal supports clamped thereto, said supports being attached to upstanding posts 68 mounted on deck 22.

A flexible intermediate section 70 couples section 62 with section 66 and may be of the aforementioned bellows-type expansion joint. With this arrangement, section 62 moves with trunks 20 and 40, while section 66 remains stationary with deck 22.

Since some degree of lateral expansion and contraction occurs outward from the vertical tank axis, pressure relief valves 72 are also coupled to section 62 through flexible joints 56.

The hatch arrangement also includes a manhole 73 and insulated plug 74 therefor. The insulation around the manhole is shaped with an inward and downward sloping edge 76 terminating at an inner shelf 78. The exposed surfaces of the edge and shelf are coated with a phenolic material, such as micarta. Coaming 80, having a horizontal upper end 81, is welded around the opening of cover 28, and the manhole cover 82 is secured thereon upon a rubber or asbestos gasket 84 by bolts 86. Thus, cover 82 is releasably secured to cover 28. The opening in trunk 20 is closed by a diaphragm 100 bolted to a continuous 9% nickel-steel or aluminum alloy rim 102 provided with a gasket therebetween.

Plug 74 is made of layers of insulation also coated over with a phenolic material. Teflon gaskets 88 and 90 run along lip 92 and the bottom of plug 74 to double seal the manhole when in place. To secure plug 74 in place, at least two (only one is shown) rotatable hand-worked levers 96, cooperating with cams 98 mounted on coaming 80, force plug downward, thereby pressure sealing the opening.

What is claimed is:

1. A liquefied gas storage tank arranged on a ship, said tank comprising a trunk at the center top thereof, the bottom of said trunk being disposed below the upper deck of the ship, insulation covering the top and sides of said trunk, a hatch cover supported by said insulation being above the upper deck and rigidly attached to the top of said trunk, the upper deck defining an opening continuously spaced from the sides of said trunk, flexible sealing means coupling the periphery of said hatch cover to the upper deck to isolate said tank from the ambient and to permit the tank to thermally grow independent of the ship's structure, said sealing means comprising a flexible expansion joint having one edge connected to the hatch cover adjacent its periphery and its other edge coupled to the upper deck, and a metal guard connected rigid with said hatch cover at its periphery and extending downward to surround and enclose said flexible expansion joint to protect same from weather and impact damage.

2. A liquefied gas storage tank arranged on a ship, said tank comprising a trunk at the center top thereof, the bottom of said trunk being disposed below the upper deck of the ship, insulation covering the top and sides of said trunk, a hatch cover composed of a material which resists cryogenic temperatures supported by said insulation being above the upper deck and rigidly attached to the top of said trunk, an upstanding peripheral flange mounted on the top of said hatch cover to prevent spillage of cryogenic fluids from running onto the ship's structure, the upper deck defining an opening continuously spaced from the sides of said trunk, and flexible sealing means coupling the periphery of said hatch cover to the upper deck to isolate said tank from the ambient and to permit the tank to thermally grow independent of the ship's structure, said sealing means comprising a flexible expansion joint having one edge connected to the hatch cover adjacent its periphery and its other edge coupled to the upper deck.

3. A liquefied gas storage tank arranged on a ship, said tank comprising a trunk at the center top thereof, the bottom of said trunk being disposed below the upper deck of the ship, insulation covering the top and sides of said trunk, a hatch cover supported by said insulation being above the upper deck and rigidly attached to the top of said trunk, the upper deck defining an opening continuously spaced from the sides of said trunk, flexible sealing means coupling the periphery of said hatch cover to the upper deck to isolate said tank from the ambient and to permit the tank to thermally grow independent of the ship's structure, said sealing means comprising a flexible expansion joint having one edge connected to the hatch cover adjacent its periphery and its other edge coupled to the upper deck, an inner barrier within the tank having a second upstanding trunk spaced everywhere from said first-mentioned trunk, and a plurality of elongated members connected rigidly with the tops of said first-mentioned and second trunks.

4. A liquefied gas storage tank arranged on a ship, said tank comprising a trunk at the center top thereof, the bottom of said trunk being disposed below the upper deck of the ship, insulation covering the top and sides of said trunk, a hatch cover supported by said insulation being above the upper deck and rigidly attached to the top of said trunk, the upper deck defining an opening continuously spaced from the sides of said trunk, flexible sealing means coupling the periphery of said hatch cover to the upper deck to isolate said tank from the ambient and to permit the tank to thermally grow independent of the ship's structure, said sealing means comprising a flexible expansion joint having one edge connected to the hatch cover adjacent its periphery and its other edge coupled to the upper deck, a blow-off mast having a lower section

rigidly connected to said hatch cover, an upper section, means for supporting said upper section above said lower section and generally coaxial therewith and for supporting said upper section rigidly relative to said upper deck, and a flexible expansion joint coupled from said lower section to said upper section to permit the lower section to move with the hatch arrangement.

5. A liquefied gas storage tank arranged on a ship, said tank comprising a trunk at the center top thereof, the bottom of said trunk being disposed below the upper deck of the ship, insulation covering the top and sides of said trunk, a hatch cover supported by said insulation being above the upper deck and rigidly attached to the top of said trunk, the upper deck defining an opening continuously spaced from the sides of said trunk, flexible sealing means coupling the periphery of said hatch cover to the upper deck to isolate said tank from the ambient and to permit the tank to thermally grow independent of the ship's structure, said sealing means comprising a flexible expansion joint having one edge connected to the hatch cover adjacent its periphery and its other edge coupled to the upper deck, pipes penetrating the top of said trunk and said hatch cover, each pipe comprising at least one enlargement positioned above the hatch cover, a coaming member provided on said hatch cover spaced from said pipes and running continuously therearound, the spaces between said coaming and said pipes being insulated, and a metal shield extending from beneath said enlargement downward and outward over the top of said coaming to deliver leakage of cryogenic fluids from above said enlargement onto the top of said hatch cover.

6. A liquefied gas storage tank arranged on a ship, said tank comprising a trunk at the center top thereof, the bottom of said trunk being disposed below the upper deck of the ship, insulation covering the top and sides of said trunk, a hatch cover supported by said insulation being above the upper deck and rigidly attached to the top of said trunk, the upper deck defining an opening continuously spaced from the sides of said trunk, flexible sealing means coupling the periphery of said hatch cover to the upper deck to isolate said tank from the ambient and to permit the tank to thermally grow independent of the ship's structure, said sealing means comprising a flexible expansion joint having one edge connected to the hatch cover adjacent its periphery and its other edge coupled to the upper deck, said insulation defining an opening, and said hatch cover defining an opening larger than said insulation opening, an insulated plug adapted to seat in said insulation opening, a metal coaming mounted on said hatch cover running continuously about the opening therein, and a manhole cover releasably secured on the top of said coaming and being spaced above the top of said plug when the latter is in place.

7. A liquefied gas storage tank arranged on a ship, said tank comprising a trunk at the center top thereof, the bottom of said trunk being disposed below the upper deck of the ship, insulation covering the top and sides of said trunk, a hatch cover supported by said insulation being above the upper deck and rigidly attached to the top of said trunk, the upper deck defining an opening continuously spaced from the sides of said trunk, flexible sealing means coupling the periphery of said hatch cover to the upper deck to isolate said tank from the ambient and to permit the tank to thermally grow independent of the ship's structure, said sealing means comprising a flexible expansion joint having one edge connected to the hatch cover adjacent its periphery and its other edge coupled to the upper deck, and a plurality of attachments connecting the cover to the tank top, each attachment comprising a block contacting the cover and top, a first bolt extending through the cover and threaded in said block, a second bolt extending through the top and threaded in said block, and mastic-like material covering the head of said first bolt to seal the same with the cover.

8. A tank as set forth in claim 3 wherein said members are pipes which extend through said insulation and hatch cover, each pipe having a flexible expansion joint coupled to a pipe section which is stationary relative to the upper deck so that the pipe extending through said hatch cover moves freely therewith.

9. A tank as set forth in claim 4 wherein said lower section is positioned at about the vertical center axis of the tank, at least one pipe spaced from said lower section and extending through said hatch cover, said one pipe being fitted with a pressure relief valve, and expansion joint means connected from said relief valve to the lower section of said blow-off mast.

10. A tank as set forth in claim 5 comprising collar means spaced from and surrounding each said pipe and shield, and insulation filling the space between said collar means and said lower section.

11. A tank as set forth in claim 6 wherein said plug comprises sealing means which engage the surface of said insulation, and locking means mounted on the top of said plug and the inside of said coaming for releasably pressuring said sealing means into intimate engagement with said insulation.

12. A tank as set forth in claim 11 wherein the top of said tank defines an opening smaller than the opening of said insulation, and a diaphragm made of cryogenic temperature-resistant material releasably mounted to the tank top to close the opening therein, said diaphragm being spaced below the bottom of said plug when the latter is in place.

13. A tank as set forth in claim 12 wherein said insulation has upper and lower horizontal surfaces, and wherein the adjacent surfaces of said plug are congruous to said surfaces of said insulation, and wherein said sealing means comprises a pair of gaskets mounted to form a seal for each of said horizontal insulation surfaces, said gaskets being mounted on one of said insulation and adjacent plug surfaces.

14. A tank as set forth in claim 13 wherein said locking means comprises a hand-worked lever rotatably mounted on the top of said plug, and a cooperating cam mounted on the inside of said coaming.

15. A tank as set forth in claim 14 wherein said plug comprises at least two layers of insulation, and the exposed layers of said insulation and said plug being coated with a phenolic material.

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