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Tarossi

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[54] **CENTRALIZED CARGO HANDLING SYSTEM FOR CRYOGENIC VESSELS**

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[21] Appl. No.: **424,053**

Related U.S. Application Data

[63] Continuation of Ser. No. 323,406, Jan. 15, 1973, which is a continuation of Ser. No. 118,445, Feb. 24, 1970, abandoned.

[52] **U.S. Cl.** ..... **114/74 A**

[51] **Int. Cl.** **B63b 25/08**

[58] **Field of Search** ..... 114/74 R, 74 A, 72, 73; 62/50, 52, 53

[56] **References Cited**

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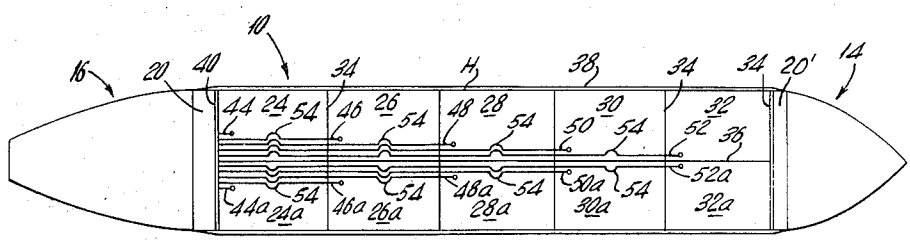
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[57] **ABSTRACT**

An externally insulated tanker vessel intended especially for the transport of liquid cargoes at temperatures differing from ambient temperature, including a cargo handling system which utilizes a centralized pumping station located aft of the cargo carrying midbody of the vessel and a piping system within the tanks. Towards this end, all of the electrical and mechanical devices, such as the pumps, valves, and safety interlocks, necessary for the safe loading and discharge of the liquefied cargo are centralized at the pumping station. An inert atmosphere is maintained throughout the pump room although provision is made for aeration to facilitate inspection, maintenance and repair. The piping system is mounted such that movement relative to the hull is permitted to reduce any thermally induced stresses.

9 Claims, 4 Drawing Figures



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SHEET 1 OF 3

FIG. 1.

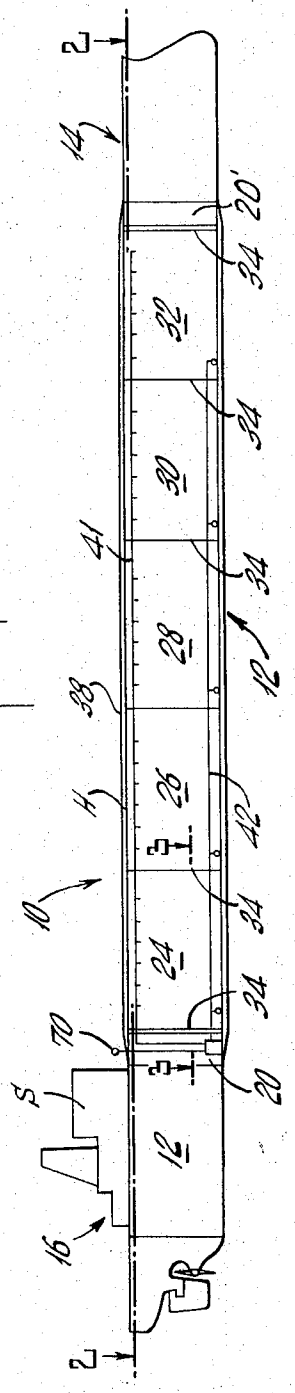
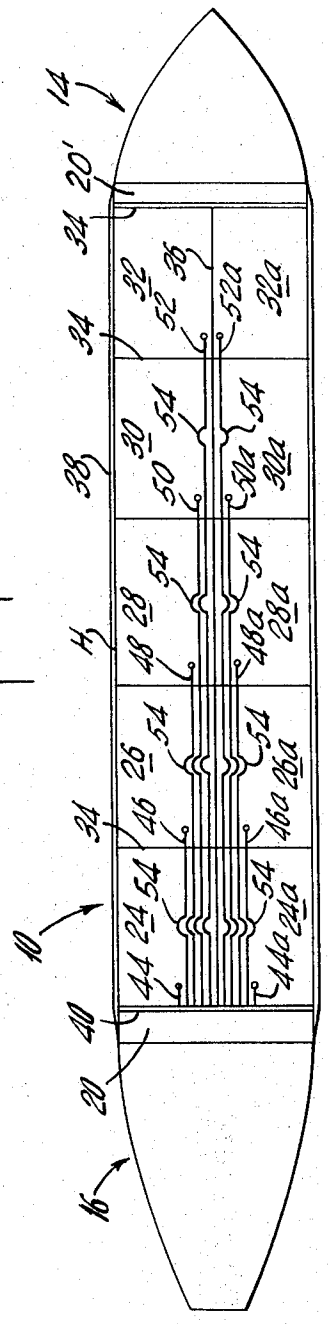


FIG. 2.



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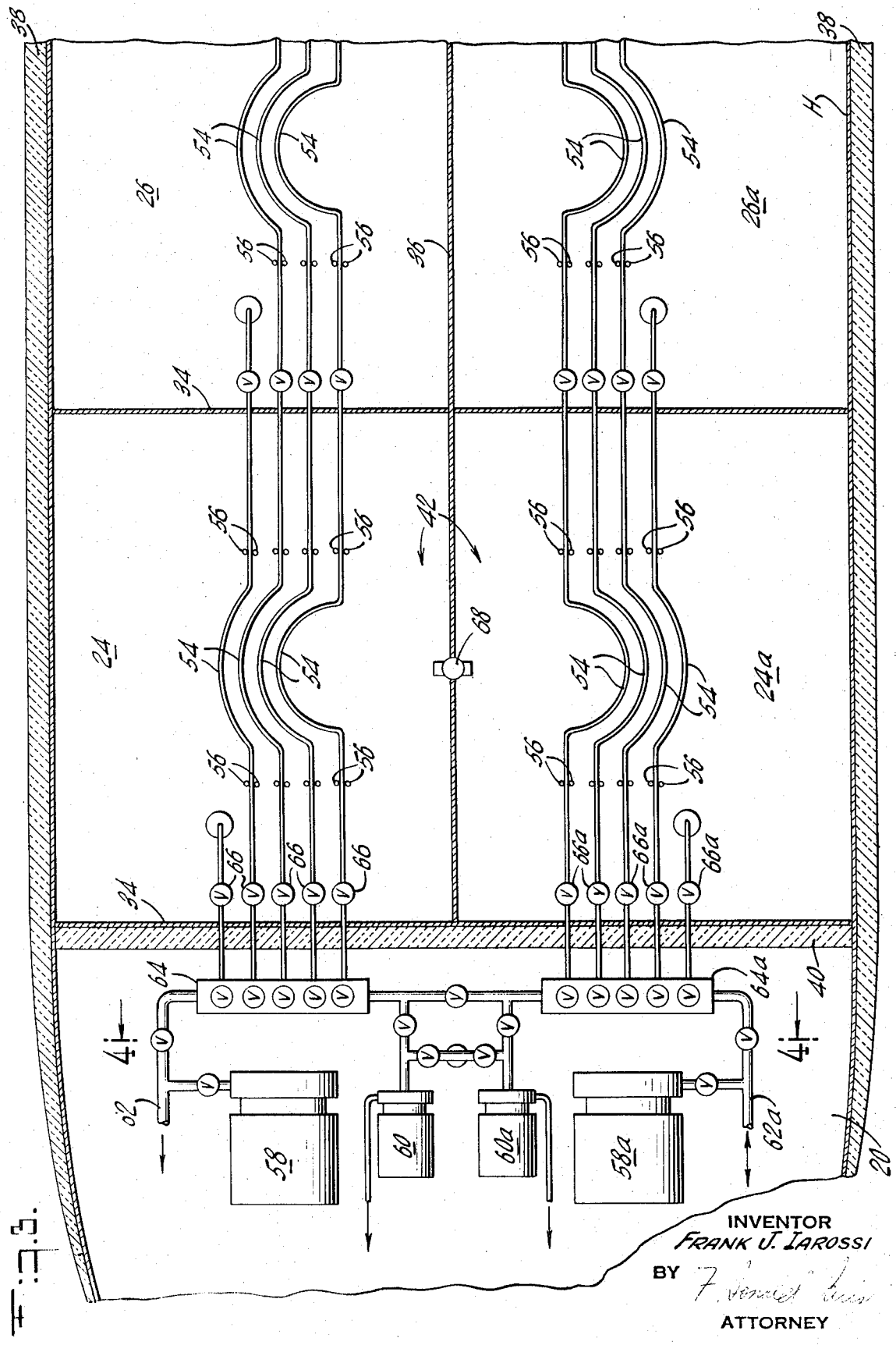
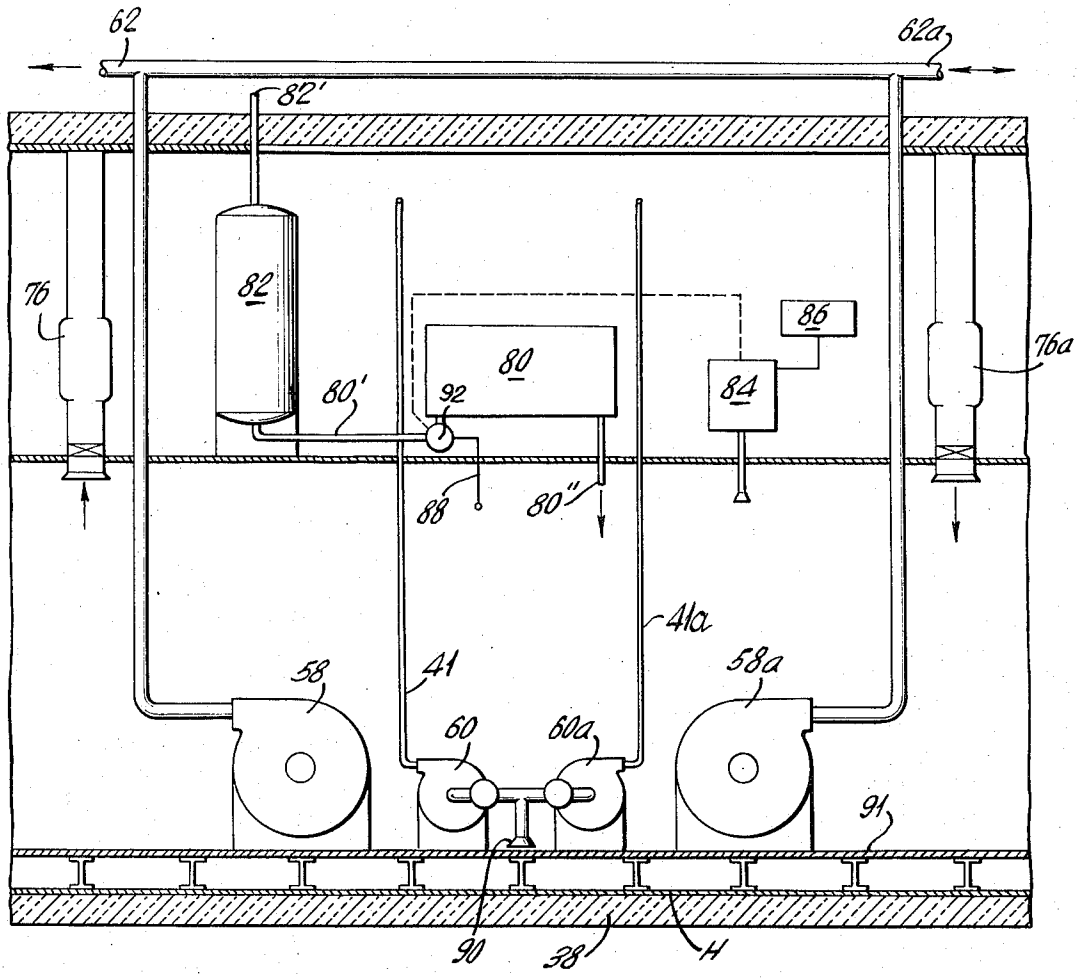


FIG. 3

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Fig. 4.



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CENTRALIZED CARGO HANDLING SYSTEM FOR CRYOGENIC VESSELS

This is a continuation of application Ser. No. 323,406 filed Jan. 15, 1973, which was a continuation of Ser. No. 118,445, filed Feb. 24, 1970, now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to liquid carrying tankers and more particularly, to an externally insulated LNG tanker, wherein the tanker may comprise a single shell internally stiffened both longitudinally and transversely and cargo sections subdivided into tank spaces by longitudinal and transverse bulkheads with the tanker shell forming the outer tank boundary.

It is well known that the waterborne transportation of liquefied natural gas at or near atmospheric pressure has required radical departures from conventional tanker design. Since at cryogenic temperature the steels normally employed in ship construction become so brittle that they no longer provide structural integrity, the major design effort has been directed toward the development of satisfactory tank systems to contain the cryogenic cargo apart from the ship's structure.

To cope with the problem of low temperature embrittlement of mild steel, a variety of designs have been provided for independent or self-supporting and integrated or membrane tanks. However, these prior art solutions have proven to be relatively unsatisfactory in that not only do they provide an LNG ship which is significantly more expensive than a conventional tanker of similar capacity, but the ship is dependent upon the integrity of a multitude of barrier and warning systems for structural security, and in the case of membrane tanks, there is raised the question of long term durability.

The novel construction and arrangement of the present invention for a centralized cargo handling system is employed in conjunction with the utilization of low temperature nickel alloy steel or a like material for the hull structure throughout the cargo section or midbody of the vessel. Since at cryogenic temperatures nickel steel possesses mechanical properties far superior to those of ordinary structural steel, many of the problems which have greatly complicated previous LNG ships are bypassed. A 9 percent nickel steel hull would be resistant to a brittle fracture at temperatures as low as −320°F. and would itself provide a suitable container for the liquefied natural gas cargo. This removes the necessity for independent tanks or membrane liners, access spaces, cofferdams and secondary barriers. One such typical vessel construction employing an externally insulated nickel steel hull is disclosed in the U.S. Gorman Pat. No. 3,283,734, assigned to the assignee of the present invention. The foregoing Gorman patent does not disclose the means for accomplishing the handling of the liquefied cargo.

Heretofore substantially all LNG ships built or those which are presently under construction have utilized independent cargo pumps submerged in each tank. Such arrangements significantly increase the complexity of and associated cost of any cargo handling system. Furthermore, maintenance and repairs can be accomplished only after warm-up, inerting and aeration of the cargo tanks.

The present invention contemplates utilizing a centralized cargo handling system which employs a centralized pumping station and piping system within the tanks. Preferably, the centralized pumping station is located aft of the cargo carrying midbody of the vessel while all of the electrical and mechanical devices such as the pumps, valves, safety interlocks, etc., necessary for the safe loading and discharge of the liquefied cargo are centralized at the pumping station. The inert atmosphere required is maintained throughout the pump room while provision is made for aeration to facilitate inspection, maintenance and repair.

Typical of the advantages obtained by employing a centralized cargo handling system are reduced capital investments since a centralized system permits the use of a common cargo piping system of special materials but of substantially conventional design. In other words, the piping is entirely within the tanks and in a common inerted pump room in lieu of the independent pumps and deck piping normally utilized by the prior art. Also, increased vessel safety is obtained by the elimination of the cargo pumps within the tank thereby removing a possible source of ignition and the elimination of most of the cargo piping on deck, which reduces the likelihood of fire, structural failure or personal injury that can result from cargo leakage. A further advantage obtained is increased reliability since with the elimination of the cargo pumps within the tanks this reduces the difficulty and frequency of pump maintenance and associated delays. By employing a centralized cargo handling system according to the present invention the conventional systems which can be eliminated comprise the nitrogen inerting of access and interbarriers spaces; gas analysis of the access interbarrier spaces; temperature sensing of the access and interbarrier spaces; drainage of the access and interbarrier spaces; separate discharge pumps for each tank; and a significant portion of the on deck cargo piping as mentioned heretofore. By eliminating the installation of motor-driven submerged pumps within each of the tanks and the corresponding potential source of ignition, warm-up and cool down operations then may be carried out without an intermediate inert gas purging operation which is now required.

It is clearly apparent from the foregoing that the present invention has numerous significant advantages over the prior art cargo handling arrangements presently in use for liquefied cargoes at temperatures higher or lower than ambient temperature. The novel arrangement and construction of the presently proposed cargo handling system provides greater cargo capacity for given ship dimensions than presently known technology, in addition to providing a vessel having the advantages disclosed above.

Accordingly, it is an object of the present invention to provide a vessel designed to carry liquids at other than ambient temperature with a novel and improved cargo handling system.

Another object of the present invention is to provide an externally insulated tanker with a novel centralized cargo handling system for the handling of liquid cargoes.

Still yet a further object of the present invention is to provide a liquid cyrogenic cargo carrying vessel with a system for handling the liquefied cargo, such as LNG, through a centralized pumping station and piping system within the tank.

Having in mind the above and other objects that will be evident from an understanding of this disclosure, the present invention comprises the combinations and ar-

rangements as illustrated in the presently preferred embodiment of the invention, which is hereinafter set forth in such detail as to enable those skilled in the art readily to understand the function, operation, construction and advantages of it when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic elevational view of an externally insulated tanker incorporating the present invention;

FIG. 2 is a schematic plan view taken substantially along the line 2—2 of FIG. 1;

FIG. 3 is an enlarged cross-sectional view taken substantially on the line 3—3 of FIG. 1 illustrating the centralized pumping station and piping arrangement within the aftermost tank;

FIG. 4 is an enlarged cross-sectional view taken substantially on the line 4—4 of FIG. 3 illustrating in elevation the pumping station and showing in particular the features for maintaining an inert atmosphere and for periodic aeration.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Having reference to the drawings, the present invention is illustrated in FIG. 1 as embodied in an externally insulated tanker having a nickel steel plate hull at its midbody, reference being made to the U.S. Gorman Patent No. 3,283,734 for a more complete and detailed explanation thereof.

The tanker generally includes a hull H, an engine room or power plant **12**, and a superstructure S, all arranged as shown. The forward hull portion or bow **14** and the after hull portion or stern **16** are fabricated conventionally from mild steel plate and mild steel strengthening members. The forward and after hull portions **14** and **16** each typically may include ballast tanks (not shown).

In accordance with the teachings of the previous invention as disclosed in the Gorman patent, the cargo carrying midbody of the vessel is fabricated from a metal plate possessing physical and mechanical properties compatible with the particular cargo to be carried. One such typical material may comprise a nickel steel containing substantially 9 percent nickel as disclosed in the aforesaid Gorman patent. The cargo hold or midbody of the vessel may be subdivided into a plurality of individual cargo holds **24, 24***a*; **26, 26***a*; **28, 28***a*; **30, 30***a*; and **32, 32***a* by means of transverse bulkheads **34** and a longitudinal bulkhead **36** extending vertically between the deck and vessel bottom, and is completely enveloped or clad externally with a suitable thermal insulation material **38.** It should be noted that although the ship's midbody structure has been disclosed as comprising a material such as 9 percent nickel steel for cryogenic products, such as methane and the like, in the case of other low temperature products such as LPG, usual tank quality steel would be sufficient while ordinary quality steel would suffice for high temperature products.

The present invention discloses an arrangement for handling of the liquefied natural gas cargo by means of a centralized cargo handling system. As illustrated in FIGS. 1 and 2, there is provided a cofferdam which comprises a pump room **20** between the aftmost cargo tank **24, 24**a and the engine room **12.** This pump room or pumping station is maintained at ambient temperature, but with a nitrogen atmosphere as will be described hereinafter in greater detail, and is insulated from the cargo carrying hold by means of internal insulation **40** a cofferdam **20'** is also provided at the forward end of the vessel. For a more complete description of the specific construction and arrangement of the insulation in the area between the cargo hold and the conventional vessel structure, both at the stern and the bow, reference should be made to copending U.S. Patent application Ser. No. 32,691, now U.S. Pat. No. 3,671,315 assigned to the assignee of the present invention. Extending from the pump room beneath the deck of the vessel are a plurality of cool down and recirculating pipes generally designated **41.** Along the keel of the ship extending from the pump room toward the bow is the main cargo piping, which includes the tank fill and discharge pipes, generally designated **42.** FIG. 2 shows in detail the arrangement of the pipes comprising the cool down and recirculating piping **41** and as illustrated, comprises pipes **44, 44***a*; **46, 46***a*; **48, 48***a*; **50, 50***a*; and **52, 52***a*. As illustrated, a single pair of cool down and recirculating pipes, for example **44** and **44***a*, extend to and terminate at a corresponding cargo hold. Expansion loops **54,** which may be optional, are provided along with the length of the pipes to allow for contraction of the pipes on cooling. Also pipe support means **56** are provided to allow for longitudinal movement of each of the pipes.

The pump room **20** contains two main cargo pumps **58** and **58***a*, each of which are connected through suitable conventional piping and valve arrangements generally designated **64** and **64***a* to their corresponding tank fill and discharge pipes. See FIG. 3. Each of the fill and discharge pipes **42** is provided with conventional emergency cutoff valves **66** and **66***a* to isolate the pump room from the cargo tanks for maintenance and in the case of an emergency which may require shutting off flow in one or more of the pipes. Within each portion of the longitudinal bulkhead **36** which extends between adjacent transverse bulkheads **34,** there is provided an emergency crossover valve **68** which can be utilized in conventional fashion to transfer cargo transversely from one tank to another in the event of a malfunction in the cargo system to the first tank. Also provided in the pump room are a pair of recirculating pumps **60** and **60***a* connected by a suitable piping arrangement through the valve arrangements **64, 64***a* to the cargo discharge pipes **42** and to the cool down and recirculating pipes **41** and **41***a*. These pumps function to cool the cargo tank section from ambient to cryogenic temperature and to prevent the buildup of undesirable temperature differentials during the return voyage by taking suction from the nearly empty cargo tanks and recirculating back to the tanks in the form of spray cooling. Cargo fill and discharge lines **62** and **68***a* are provided for transferring cargo to or from shore facilities. As schematically illustrated in FIG. **1,** there is provided a loading manifold **70** for bringing the cargo onboard through lines **62, 62***a*, and distributing it throughout the cargo holds.

FIG. 4 shows aerating means **76** and **76***a*, one of which functions as an air inlet and the other as an exhaust. Thus, while an inert atmosphere is maintained throughout the pump room as will be explained in greater detail hereafter, the aerating means provide the desired atmosphere for aeration of the pump room to

facilitate inspection, maintenance and repair of the equipment. An inert atmosphere is obtained by means of a nitrogen evaporator and heater **80.** A tank **82** stores liquid nitrogen received through an inlet pipe **82'** and feeds the liquid nitrogen into the evaporator and heater **80.** A gas analyzer **84** connected to the nitrogen inlet line **80'** through valve **92** functions to control the amount of liquid nitrogen passed to the evaporator and thence to the pump room. Operatively connected therewith is an alarm **86** which sounds if methane vapors are present in the pump room. The inert atmosphere is maintained by exhausting warm inert gas into the pump room through the outlet line **80''** and thus, maintains the desired inert atmosphere. A pressure sensor **88** of conventional construction is connected to the nitrogen evaporator and heater **80** to provide an indication as to when the pressure is above a predetermined level. A drainage pipe **90** is connected with the recirculation pumps **60, 60***a* for removal of liquid cargo leakage from the drip pan **91.**

It will be appreciated from the foregoing description that a novel and improved cargo handling system for a tanker as disclosed herein enjoys significant advantages over conventional systems as discussed in the introductory portion of this application.

It should be understood that the specific construction and arrangement herein illustrated and described is intended to be representative of a preferred embodiment only and that certain changes may be made therein without departing from the clear teachings of the present disclosure. Accordingly, reference should be made to the following appended claims in determining the full scope of the invention.

Having thus set forth the nature of the invention, what is claimed herein is:

1. A tanker for the transportation of liquid cargo at atmospheric pressure and cryogenic temperatures comprising, in combination:

a. a deck;

b. a hull having forward, after and intermediate cargo-carrying portions, said cargo-carrying portion having a transverse bulkhead located at each end thereof and being constructed and arranged into a plurality of cargo-carrying holds between said ends;

c. cofferdam means located aft of said cargo-carrying portion to provide a pump room for housing electrical and mechanical equipment necessary for the loading and discharge of the liquid cargo,

aa. said pump room including manifold means for loading and discharging said liquid cargo and pump means operably associated therewith;

d. a first piping system including a first plurality of separate and independent main cargo pipes extending longitudinally along the bottom of said hull within said cargo-carrying portion, each one of said separate and independent pipes being connected at one end to said pump means and terminating in a different corresponding one of said cargo-carrying holds, whereby said liquid cargo can be selectively distributed throughout the tanker; and

e. a second piping system including a second plurality of separate and independent cooldown and recirculation pipes extending longitudinally at the top of said hull adjacent and below said deck, each one of said separate and independent cooldown and recirculation pipes being connected at one end to said pump means and selected ones of said pipes operably extending to and terminating at different corresponding ones of said cargo-carrying holds.

2. A tanker according to claim **1** wherein means are provided within said pump room for maintaining an inert atmosphere therein.

3. A tanker according to claim **2** wherein there is provided within said pump room means for aerating said room to facilitate inspection, maintenance and repair of the equipment housed therein.

4. A tanker according to claim **1** wherein said first and second piping systems include valves for selectively shutting off the flow of liquid through said pipes.

5. A tanker according to claim **1** wherein said pipes terminating in said cargo-carrying holds forward of the cargo-carrying hold directly adjacent said pump room are provided with expansion loops to allow for contraction of said pipes upon cooling thereof.

6. A tanker according to claim **1** wherein said pump room includes a storage tank for storing liquid nitrogen, a combined nitrogen evaporator and heater adapted for an inert atmosphere within said pump room, means including a valve and a gas analyzing control device connecting said storage tank and said nitrogen evaporator and heater for feeding liquid nitrogen into the latter, and pressure sensing means operative in response to the pressure maintained in said pump room for closing said valve to terminate the supply of liquid nitrogen to said evaporator and heater.

7. A tanker according to claim **6** wherein gas analyzer means is provided within said pump room and means operably connecting said gas analyzer means to said valve for sampling the atmosphere maintained within said pump room and providing an alarm in the event of cargo leakage.

8. A tanker according to claim **1** wherein said pump means comprises first and second main cargo pumps and first and second recirculating pumps, safety interlocking means interconnecting said pumps in operable relationship with said first and second piping systems.

9. A tanker for the transportation of liquid cargo at atmospheric pressure and cryogenic temperatures comprising in combination:

a. a deck;

b. a hull having forward, after and intermediate cargo-carrying portions, said cargo-carrying portion having a transverse bulkhead located at each end thereof and being constructed and arranged into a plurality of cargo-carrying holds between said ends;

c. cofferdam means located aft of said cargo-carrying portion to provide a pump room for housing electrical and mechanical equipment necessary for the loading and discharge of the liquid cargo,

aa. said pump room including manifold means for loading and discharging said liquid cargo, first and second main cargo pumps and first and second recirculating pumps, means operably interconnecting said first and second cargo and recirculating pumps with first and second piping systems respectively, said pump room further including means for maintaining an inert atmosphere therein comprising nitrogen evaporator and heater means and a storage tank for supplying liquid nitrogen to said evaporator and heater means and analyzer means for controlling the amount of liquid nitrogen passed to said

evaporator and heater means, and means for aerating said pump room to facilitate inspection, maintenance and repair of equipment located therein, pressure sensing means operative in response to the pressure of said pump room for terminating the supply of liquid nitrogen into the pump room;

d. said first piping system including a first plurality of separate and independent main cargo-carrying pipes extending longitudinally along the bottom of said hull within said cargo-carrying portion, each one of said separate and independent pipes being operably connected at one end with said main cargo pumps and terminating at the opposite end in different ones of said cargo-carrying holds, whereby said liquid cargo is selectively distributed throughout the tanker; and

e. said second piping system including a second plurality of separate and independent cooldown and recirculation pipes extending longitudinally at the top of said hull adjacent and below said deck, each one of said separate and independent cooldown and recirculation pipes being operably connected at one end to said recirculation pumps and the opposite end of said pipes operably extending to and terminating in different ones of said cargo-carrying holds.

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