COLD-BOX APPARATUS AND COLD-BOX SYSTEM

Technical field of the present invention

The present invention relates to cold boxes for liquid natural gas (LNG) tanks aboard a ship.

Background of the present invention

A cold-box is operationally associated with or connected to a liquid natural gas (LNG) tank for gas handling. Aboard ship, requirements regarding the containment, monitoring and control of LNG are heavily regulated and cannot be neglected or waived.

There is no law or regulation requiring LNG tanks aboard ship. What is required however is a control system for the LNG tank if such a tank is aboard the ship. Therefore, it is usual to have a control system coacting with an LNG tank, and in that regard, to have two separate LNG tanks each with its own control system. This provides the necessary redundancy and back-up systems required by shipping regulations for such LNG tank(s).

However, failure or malfunction of the control system will adversely impact operation of the related bulk gas tank and perhaps operation of the ship as well.

Disclosure of the present invention: object, solution, advantages

Starting from the disadvantages and shortcomings as described above and taking the prior art as discussed into account, an object of the present invention is to improve the operation of a bulk gas tank.

This object is accomplished by an apparatus comprising the features of claim 1 as well as by a system comprising the features of claim 12. Advantageous embodiments and expedient improvements of the present invention are disclosed in the respective dependent claims.

According to the present invention, there is therefore provided a cold-box apparatus having a plurality of cold boxes or cold-box compartments for use with a bulk gas tank. Said cold boxes or cold-box compartments, for example made of stainless steel, are operationally associated with a bulk gas tank, in particular containing a gas comprising liquid natural gas (LNG).

In particular, said plurality of cold-box compartments may comprise a pair of cold-box compartments.

Independently thereof or in combination therewith, a first one of the plurality of cold-box compartments may be mounted above a second one of said plurality of cold-box compartments.

Alternatively thereto, a first one and a second one of said plurality of cold-box compartments may be mounted side-by-side.

According to an advantageous embodiment of the present invention
- a first one of the plurality of cold-box compartments may be mounted to a first side of the bulk gas tank, and
- a second one of the plurality of cold-box compartments may be mounted to a second side of the bulk gas tank;

in particular, the second side of the bulk gas tank may be opposite to the first side of the bulk gas tank.

The cold-box compartments may be arranged adjacent to the bulk gas tank.

In order to provide structure and strength to the bulk gas tank, at least one reinforcement ring may circumscribe an exterior surface of the bulk gas tank.

In order to enable loading and unloading of the tank and of the cold-box compartments to a desired location aboard ship or ashore, at least one lifting lug may be provided at an exterior of the bulk gas tank. The lifting lug(s) may be mounted or affixed to a top or upper region of the bulk gas tank.

For example in order to provide access to an interior of each of said cold-box compartments, each one of the cold-box compartments may expediently be provided with at least one entrance hatch.

According to an advantageous embodiment of the present invention, each of the cold-box compartments may be insulated, for example at all sides.

At least one lashing lug may be provided for lashing or securing the bulk gas tank to a ship deck or trailer for transportation. In most instances, however, the lug(s) may be removed, for example by cutting, after the bulk gas tank has been securely mounted to a deck of a ship.

According to a favoured embodiment of the present invention, at least one pipe may be provided for each one of the plurality of cold-box compartments, the at least one pipe connecting a corresponding one of the cold-box compartments with the bulk gas tank.

Each cold-box compartment may comprise its own ventilation, and/or its own gas and fire detection equipment.

In an expedient embodiment of the present invention, a single cold-box may be used, wherein a port side (PS) compartment of the cold-box may include one set of power supply for the bulk gas tank, while the starboard side (SB) compartment of the cold-box may include a similar set of power supply

equipment for the bulk gas tank.

The lower and upper cold-box compartments may be connected for ventilation, and/or gas and fire detection equipment. In addition, the upper cold-box compartment may include equipment for a bunker (fueling) operation.

It is also possible to have the upper cold-box as an isolated compartment separate and discreet from the remainder of the cold-box.

According to the present invention, there is also provided a cold-box system which includes a bulk gas tank, and a plurality of cold-box compartments operationally associated with the bulk gas tank, in particular mounted to the bulk gas tank.

In one preferred embodiment of the present invention, the cold-box compartments may be spaced apart from the tank, for example aboard a waterborne platform.

The gas in the bulk gas tank may be liquefied natural gas (LNG) but the present embodiments may be configured for use with any type of gas or gas system, bulk or otherwise.

The apparatus, the system and/or the tank may be disposed ashore or aboard a waterborne or an ocean going platform, such as for example an LNG ship.

The apparatus according to the present invention as well as the system according to the present invention provide for power management, in particular for redundancy regarding power aboard ship for the bulk gas tank.

Brief description of the drawings

For a more complete understanding of the present inventive embodiment disclosures and as already discussed above, there are several options to embody as well as to improve the teaching of the present invention in an advantageous manner. To this aim, the present invention is described in more detail below; in particular, reference may be made to the claims dependent on claim 1 as well as dependent on claim 12; further improvements, features and advantages of the present invention are explained below in more detail with reference to a preferred embodiment by way of non-limiting example and to the accompanying drawings taken at least partly in connection with the following description of the embodiments, of which:

FIG. 1 shows an embodiment of a cold-box apparatus according to the present invention for use with an LNG tank aboard ships;

FIG. 2A to FIG. 2E show different views of the embodiment of FIG. 1;

FIG. 3 shows another embodiment of the cold-box apparatus according to the present invention; and

FIG. 4 shows still another embodiment of the cold-box apparatus according to the present invention.

In the appended drawing figures, like equipment is labelled with the same reference numerals throughout the description of FIG. 1 to FIG. 4.

Detailed description of the drawings; best way of embodying the present invention

Before describing the present inventive embodiments in detail, it is to be understood that the inventive embodiments are not limited in their application to the details of construction and arrangement of parts illustrated in the accompanying drawing figure, since the present invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

The present invention will be described with reference to the drawing figures.

The present embodiments provide redundancy regarding power aboard ship, particularly aboard LNG ocean going vessels or other bulk gas product carriers. That is, the present embodiments eliminate the need for two separate LNG tanks aboard ship as is normally required for system redundancy purposes.

Instead, the present embodiments call for using a plurality of cold-boxes, for example two cold-boxes (or control systems), for each LNG tank; and each cold-box has the necessary equipment for power supply. Such embodiments provide the necessary and regulatory redundancy (back-up) of the power systems required for each LNG tank aboard ship. In certain applications and under shipping classification rules, a cold-box is referred to as a "tank connection space".

The present embodiments eliminate the need for two separate LNG tanks aboard a ship, as the requirement for redundancy of control systems is achieved with one LNG tank having two cold-boxes, each one of the cold-boxes having the necessary equipment to supply power to the tank.

All dimensions and weights referred to in Fig. 1 to FIG. 4 are by way of example only.

Referring to FIG. 1 and to FIG. 2A to Fig. 2E, a bulk gas tank, such as for example an LNG tank 10 for shipboard use has two cold-box compartments, or cold-boxes 12, 14 operationally associated therewith. As shown in said Figures, cold box 12 is the starboard (SB) side cold box operationally associated with the tank 10, and cold-box 14 is the port side (PS) cold box also operationally

associated with the tank and mounted next to the cold box 12.

The cold boxes 12, 14 may be arranged adjacent to the tank 10. At least one or alternatively a plurality of reinforcement rings 16 are shown in FIG. 1 and in FIG. 2A to FIG. 2D circumscribing an exterior surface of the tank 10. The rings 16 provide structure and strength to the tank 10.

Lifting lugs 18 are provided at an exterior of the tank 10 for loading and unloading the tank and the cold boxes 12, 14 to a desired location aboard ship or ashore. The lifting lugs 18 may be mounted or affixed to a top or upper region of the tank 10 as shown for example in FIG. 2A.

Each of the cold boxes 12, 14 is provided with a corresponding entrance hatch 20, 22, respectively, to permit entry into the respective one of the cold-boxes 12, 14. The cold box 12 is provided, by way of example only, with a plurality of the hatches 20, as shown in FIG. 2A.

Each of the cold boxes 12, 14 can be insulated at all sides with, for example, A60 insulation. The construction of the cold-boxes can be with stainless steel.

Lashing lugs 24 are provided for lashing or securing the tank 10 to ship decks or trailers for transportation. In most instances, however, the lugs 24 will be removed (by cutting for example) after the tank 10 is securely mounted to a deck 26 of a ship.

Another exemplary embodiment of the cold-box apparatus of the present invention is shown in FIG. 3.

Elements illustrated in FIG. 3 which correspond to the elements described above with respect to FIG. 1 and to FIG. 2A to FIG. 2E are designated by corresponding reference numerals increased by 100. Each of the cold-boxes 112, 114 for the tank 110 has its own internal compartment in which is provided ventilation, and gas and fire detection equipment.

The embodiment of FIG. 3 is designed for use in the same manner as the embodiments of FIG. 1 and of FIG. 2A to FIG. 2E unless otherwise stated. Referring to FIG. 3, the cold boxes are shown being arranged differently.

Still another exemplary embodiment of the cold-box apparatus of the present invention is shown in FIG. 4.

Elements illustrated in FIG. 4 which correspond to the elements described above with respect to FIG. 1 and to FIG. 2A to FIG. 2E are designated by corresponding numerals increased by 200. As shown in FIG. 4, each one of the cold-boxes 212, 214 is connected to the tank 210 with "naked" piping or piping in a trunk (i.e. double piping).

This embodiment provides for the cold-boxes 212, 214 to be disposed at a location remote from the tank 210. Additionally, the cold-boxes 212, 214 could be arranged as a free standing unit, i.e. such as for example a free standing integral unit, located in a separate space or compartment aboard the ship, but spaced apart from the tank 210. Such a space or compartment would have a wall or bulkhead separating the cold-boxes 212, 214 from the tank 210 for added safety and security.

The cold-box 212 could be provided with piping 30 interconnecting that cold-box 212 with the tank 210, while the cold-box 214 could be provided with piping 32 interconnecting that cold-box 214 with the tank. As shown in FIG. 4, the piping 30, 32 is elevated off the deck 226 of the ship and is constructed of a material that is corrosive resistant to the effects of salt and brackish water found in marine and inter-coastal environments, and the gaseous cargo of the tank 210.

Similar to the embodiments discussed above, the cold-boxes 212, 214 provide control and power requirements for the tank 210. LNG or natural gas (NG) pass through the pipes 30, 32 to respective ones of the cold-boxes 212, 214. Other gases can be stored in the tank 210 (and the tanks 10, 110) for which the cold-boxes 212, 214 are used.

For the regulatory redundancy criteria necessary with respect to the LNG tanks 10, 110, 210 it is essential to have a pair of cold-boxes for each LNG tank, or alternatively a single cold-box with two separate compartments therein, each of the compartments providing the necessary redundancy with respect to the LNG tank.

Each cold-box or compartment as the case may be has its own ventilation, and gas and fire detection equipment.

In the embodiment shown in FIG. 2B, a single cold-box may be used, wherein a port side (PS) compartment of the cold-box includes one set of power supply for the LNG tank 10, while the starboard side (SB) compartment of the cold-box includes a similar set of power supply equipment for the tank.

The SB lower and upper compartments (formerly represented as 12) are connected for ventilation, and gas and fire detection equipment. In addition, the SB upper compartment includes equipment for bunker (fueling) operations.

Regulations do not require that bunker equipment need to be redundant. It is also possible to have the upper cold-box as an isolated compartment separate and discreet from the remainder of the cold-box. However, it is not necessary to do so because such an arrangement would require additional ventilation, gas detection, etc.

Although the cold-boxes of the present embodiments have been described with respect to LNG, the

present embodiments can be configured for use with any type of gas or gas system, bulk or otherwise.

It will be understood that the embodiments described herein are merely exemplary, and that one skilled in the art may make variations and modifications without departing from the spirit and scope of the invention. All such variations and modifications are intended to be included within the scope of the invention as described and claimed herein. Further, all embodiments disclosed are not necessarily in the alternative, as various embodiments of the invention may be combined to provide the desired result.

List of reference numerals

10, 110, 210	bulk gas tank, in particular liquid natural gas (LNG) tank
12, 112, 212	first cold-box compartment or first cold-box, in particular on the starboard (SB) side
14, 114, 214	second cold-box compartment or second cold-box, in particular on the port side (PS)
16, 216	ring, in particular reinforcement ring
18	lifting lug
20	hatch, in particular entrance hatch, of first cold-box compartment or first cold-box 12
22, 222	hatch, in particular entrance hatch, of second cold-box compartment or second cold-box 14
24, 224	lashing lugs
26, 226	deck
30	pipe of first cold-box compartment or first cold-box 212
32	pipe of second cold-box compartment or second cold-box 214

Claims

1. A cold-box apparatus for use with a bulk gas tank onboard a ship, comprising a plurality of cold-box compartments operationally associated with the bulk gas tank,
wherein at least two of the cold-box compartments are each configured for separate power supply to the bulk gas tank to provide redundancy of power equipment for the bulk gas tank.

2. The apparatus according to claim 1, wherein the plurality of cold-box compartments comprises a pair of cold-box compartments.

3. The apparatus according to claim 1 or 2, wherein a first one of the plurality of cold-box compartments is mounted above a second one of said plurality of cold-box compartments.

4. The apparatus according to at least one of claims 1 or 2, wherein a first one and a second one of said plurality of cold-box compartments are mounted side-by-side.

5. The apparatus according to at least one of claims 1 or 2, wherein
- a first one of the plurality of cold-box compartments is mounted to a first side of the bulk gas tank, and
- a second one of the plurality of cold-box compartments is mounted to a second side of the bulk gas tank.

6. The apparatus according to claim 5, wherein the second side of the bulk gas tank is opposite to the first side of the bulk gas tank.

7. The apparatus according to at least one of claims 1 to 6, wherein each one of the plurality of cold- box compartments comprises at least one hatch.

8. The apparatus according to claim 7, wherein the hatch is provided for access to an interior of each of said cold-box compartments.

9. The apparatus according to at least one of claims 1 to 8, wherein the bulk gas tank contains a gas comprising liquid natural gas (LNG).

10. The apparatus according to at least one of claims 1 to 9, further comprising at least one pipe for each one of the plurality of cold-box compartments, the at least one pipe connecting a corresponding one of the cold-box compartments with the bulk gas tank.

11. The apparatus according to at least one of claims 1 to 10, wherein the plurality of cold-box compartments are disposed aboard a waterborne platform.

12. The apparatus according to at least one of claims 1 to 11 wherein each cold-box compartment comprise ventilation capability, a gas and fire detection equipment, or both.

13. A cold-box system for use with a bulk gas tank onboard a ship, comprising:
- a cold-box apparatus according to at least one of claims 1 to 12, said cold-box apparatus in particular comprising a plurality of cold-box compartments operationally associated with the bulk gas tank, and
- the bulk gas tank.

14. The system according to claim 13, wherein the plurality of cold-box compartments are mounted to the bulk gas tank.

15. The system according to claim 13 or 14, wherein the bulk gas tank is spaced apart from the plurality of cold-box compartments.

16. The system according to at least one of claims 13 to 15, wherein the bulk gas tank is disposed aboard a waterborne platform.

17. The system according to at least one of claims 13 to 16, wherein the bulk gas tank comprises a reinforcement ring circumscribed on an exterior surface of the bulk gas tank.

18. The system according to at least one of claims 13 to 17, wherein the bulk gas tank comprises a mountable lifting lug.

19. The system according to claim 18, wherein the lifting lug is mounted to an upper region of the bulk gas tank.

20. The system according to at least one of claims 13 to 19 wherein the apparatus comprises a lashing lug.