

DESCRIPTION

Title of Invention

FLOATING STRUCTURE

Technical Field

[0001]

The present disclosure relates to a floating structure.

Priority is claimed on Japanese Patent Application No. 2020-188463, filed on November 12, 2020, the content of which is incorporated herein by reference.

Background Art

[0002]

PTL 1 discloses a configuration in which a tank of an existing gas transport ship is used for both transporting liquefied petroleum gas (LPG) and transporting liquefied carbon dioxide, and a configuration in which the tank of the existing gas transport ship is used for both transporting liquefied ammonia gas and transporting liquefied carbon dioxide.

Citation List

Patent Literature

[0003]

[PTL 1] Japanese Unexamined Patent Application Publication No. 2004-125039

Summary of Invention

Technical Problem

[0004]

The tank configured as described above includes a safety valve for releasing a pressure inside the tank to an outside of the tank when the pressure inside the tank exceeds a design pressure.

When a flammable liquefied gas such as the liquefied petroleum gas is stored in the tank, the safety valve is connected to a vent riser via a pipe. When the safety valve is opened to discharge gaseous liquefied gas in the tank, the gaseous liquefied gas is not directly discharged to an atmosphere from a discharge port of the safety valve, and is guided to the vent riser from the safety valve through the pipe. The gaseous liquefied gas is discharged to the atmosphere from an outlet of the vent riser disposed at a high place.

[0005]

On the other hand, when the liquefied carbon dioxide is stored inside the tank, the safety valve is opened, and gaseous carbon dioxide in which the liquefied carbon dioxide is vaporized is discharged to the outside of the tank. Since a pressure outside the tank is an atmospheric pressure, a pressure of the carbon dioxide is lowered. Due to the lowered pressure, there is a possibility that the carbon

dioxide may be solidified to generate dry ice. When a pipe to the vent riser is connected to the discharge port of the safety valve, there is a possibility that the pipe may be internally blocked due to the generated dry ice.

[0006]

That is, when the tank in which both the liquefied carbon dioxide and the liquefied gas other than liquefied carbon dioxide can be selected as a storage object, in accordance with the storage object, it is necessary to carry out work for switching a discharge destination by independently installing the safety valve for the liquefied carbon dioxide and the safety valve for the liquefied gas.

However, when the discharge destination of the storage object is incorrect, there is a possibility that a disadvantage such as blockage inside the pipe may arise. Therefore, it is necessary to pay close attention to the discharge destination when the discharge destination of the storage object is switched. Consequently, there is a problem in that a burden on an operator may increase.

[0007]

The present disclosure is made to solve the above-described problems, and an object of the present disclosure is to provide a floating structure which can easily and safely switching a discharge destination of a tank storage object to be discharged from a safety valve.

Solution to Problem

[0008]

According to the present disclosure, in order to solve the above-described problems, there is provided a floating structure including a floating main structure, a tank, a first safety valve, a first pressure introduction line, a second safety valve, a vent riser, a connection pipe, a second pressure introduction line, and a switching valve. The tank is disposed in the floating main structure. The tank can selectively store liquefied carbon dioxide and liquefied gas other than liquefied carbon dioxide. The first safety valve includes a first pilot valve operated when a pressure inside the tank reaches a predetermined set pressure. The first safety valve discharges gas inside the tank to an outside of the tank by operating the first pilot valve. The first pressure introduction line transmits the pressure inside the tank to the first pilot valve. The second safety valve includes a second pilot valve operated when the pressure inside the tank reaches a predetermined set pressure. The second safety valve feeds the gas inside the tank to the outside of the tank by operating the second pilot valve. The vent riser is disposed apart from the second safety valve. The vent riser discharges the gas to the outside. The connection pipe connects the second safety valve and the vent riser. The connection pipe guides the

gas fed from the second safety valve to the vent riser. The second pressure introduction line transmits the pressure inside the tank to the second pilot valve. The switching valve selectively switches a transmission destination of the pressure inside the tank between the first pilot valve and the second pilot valve.

[0009]

According to the present disclosure, there is provided a floating structure including a floating main structure, a tank, a safety valve, a vent riser, and a connection pipe. The tank is disposed in the floating main structure. The tank can selectively store liquefied carbon dioxide and liquefied gas other than liquefied carbon dioxide. The safety valve discharges the gas inside the tank to the outside of the tank when a pressure inside the tank reaches a predetermined set pressure. The vent riser is disposed apart from the safety valve. The vent riser discharges the gas to the outside. The connection pipe connects the safety valve and the vent riser. The connection pipe includes a detachable pipe and a connection pipe main body. The detachable pipe forms a portion of the connection pipe in an extending direction of the connection pipe. The connection pipe main body forms a remaining portion of the connection pipe. The detachable pipe is configured to be detached from the connection pipe main body.

Advantageous Effects of Invention

[0010]

According to the floating structure of the present disclosure, it is possible to easily and safely switch a discharge destination of a tank storage object discharged from the safety valve.

Brief Description of Drawings

[0011]

Fig. 1 is a plan view illustrating a schematic configuration of a ship serving as a floating structure according to an embodiment of the present disclosure.

Fig. 2 is a view illustrating a tank and a safety valve system which are provided in the ship according to the embodiment of the present disclosure, and is a sectional view taken along line II-II in Fig. 1.

Fig. 3 is a sectional view illustrating a schematic configuration of a first safety valve and a second safety valve of a safety valve system according to a first embodiment of the present disclosure.

Fig. 4 is a view illustrating a state where liquefied carbon dioxide is stored in a tank in the safety valve system according to the first embodiment of the present disclosure.

Fig. 5 is a view illustrating a state where liquefied gas is stored in the tank in the safety valve system

according to the first embodiment of the present disclosure.

Fig. 6 is a view illustrating a state where liquefied gas is stored in a tank in a safety valve system according to a modification example of the first embodiment of the present disclosure.

Fig. 7 is a view illustrating a state where liquefied carbon dioxide is stored in the tank in the safety valve system according to the modification example of the first embodiment of the present disclosure.

Fig. 8 is a view illustrating a state where liquefied gas is stored in a tank in a safety valve system according to a second embodiment of the present disclosure.

Fig. 9 is a view illustrating a state where liquefied carbon dioxide is stored in the tank in the safety valve system according to the second embodiment of the present disclosure.

Description of Embodiments

[0012]

<First Embodiment>

Hereinafter, a floating structure according to an embodiment of the present disclosure will be described with reference to Figs. 1 to 9.

(Configuration of Ship)

As illustrated in Fig. 1, in this embodiment, a ship 1A as a floating structure includes at least a hull 2 as a

floating main structure and a tank facility 10.

[0013]

(Configuration of Hull)

The hull 2 has a pair of broadsides 3A and 3B, a ship bottom (not illustrated), and an upper deck 5 which form an outer shell thereof. The broadsides 3A and 3B have a pair of broadside skins each forming right and left broadsides. The ship bottom (not illustrated) has a ship bottom skin connecting the broadsides 3A and 3B. The pair of broadsides 3A and 3B and the ship bottom (not illustrated) cause the outer shell of the hull 2 to have a U-shape in a cross section orthogonal to a bow-stern direction Da. The upper deck 5 described as an example in this embodiment is a whole deck exposed outward. In the hull 2, a superstructure 7 having an accommodation space is formed on the upper deck 5 on a stern 2b side. A position of the superstructure 7 is merely an example, and may be disposed on a bow 2a side of the hull 2, for example.

[0014]

A cargo tank storage compartment (hold) 8 is formed inside the hull 2.

A vent riser 9 (to be described later) is disposed on the upper deck 5 of the hull 2. Disposition of the vent riser 9 is merely an example, and safety valve connection pipes of a plurality of the tanks 11 may be connected to

one vent riser 9.

[0015]

(Configuration of Tank Facility)

A plurality of the tank facilities 10 are disposed inside the cargo tank storage compartment 8 along the bow-stern direction Da. In this embodiment, two tank facilities 10 are disposed at an interval in the bow-stern direction Da.

[0016]

As illustrated in Fig. 2, the tank facility 10 includes at least the tank 11, a loading pipe 13, a unloading pipe 14, and a safety valve system 20A.

In this embodiment, the tank 11 is disposed in the hull 2. For example, the tank 11 has a cylindrical shape extending in a horizontal direction. The tank 11 is not limited to the cylindrical shape, and the tank 11 may have a spherical shape or a square shape.

[0017]

The tank 11 can selectively store liquefied carbon dioxide L1 and liquefied gas L2 other than the liquefied carbon dioxide L1 inside the tank 11. For example, the liquefied gas L2 other than the liquefied carbon dioxide L1 includes liquefied petroleum gas (LPG), liquefied natural gas (LNG), and ammonia. In the following description, the liquefied carbon dioxide L1 and the liquefied gas L2 which

are stored inside the tank 11 may be simply referred to as a stored gas L, except when the liquefied carbon dioxide L1 and the liquefied gas L2 need to be distinguished from each other.

[0018]

The loading pipe 13 loads the stored gas L supplied from an onshore facility into the tank 11. The loading pipe 13 penetrates a top portion of the tank 11 from an outside of the tank 11, and extends to the inside of the tank 11. A tip portion of the loading pipe 13 is open inside the tank 11.

[0019]

The unloading pipe 14 feeds the stored gas L inside the tank 11 to the outside of the ship. The unloading pipe 14 penetrates the top portion of the tank 11 from the outside of the tank 11, and extends to the inside of the tank 11. A pump (not illustrated) is provided in a tip portion of the unloading pipe 14. The pump suctions the stored gas L inside the tank 11. The unloading pipe 14 feeds the stored gas L suctioned by the pump to the outside of the tank 11 (outside of the ship).

[0020]

(Configuration of Safety Valve System)

The safety valve system 20A mainly includes a first safety valve 21, a second safety valve 31, a connection pipe

45, a vent riser 9, a first pressure introduction line 41, a second pressure introduction line 42, and a switching valve 43.

[0021]

The first safety valve 21 is disposed in the top portion of the tank 11. The first safety valve 21 is configured to function when the liquefied carbon dioxide L1 is stored inside the tank 11. The first safety valve 21 releases a pressure inside the tank 11 when a gas phase (gaseous) pressure inside the tank 11 reaches a predetermined set pressure. As illustrated in Fig. 3, the first safety valve 21 is a so-called pilot type, and includes a main valve 22 and a first pilot valve 23.

[0022]

The main valve 22 is disposed inside a main valve valve casing 24. An inflow port 24a and a discharge port 24b are formed in the main valve valve casing 24. The inflow port 24a communicates with the inside of the tank 11. The discharge port 24b is open toward the outside of the tank 11. That is, the discharge port 24b is open to an atmosphere. The main valve 22 is configured to be connectable to and detachable from the inflow port 24a. When the main valve 22 closes the inflow port 24a, the first safety valve 21 is brought into a blocked state. The pressure inside the tank 11 acts on the main valve 22 from the inflow port 24a side.

The main valve valve casing 24 includes a back pressure chamber 24d on a side opposite to the inflow port 24a side with respect to the main valve 22.

[0023]

The first pilot valve 23 applies a pilot pressure for biasing the main valve 22 in a closing direction. The first pilot valve 23 includes a tubular cylinder 25, a valve body 26, and a biasing member 27.

The valve body 26 is disposed to be capable of reciprocating inside the cylinder 25. The biasing member 27 is disposed on one side in a direction in which the biasing member 27 reciprocates with respect to the valve body 26. The biasing member 27 biases the valve body 26 to the other side inside the cylinder 25. A pressure introduction chamber 25s is formed on the other side (side opposite to the biasing member 27) with respect to the valve body 26 inside the cylinder 25. The pressure inside the tank 11 is transmitted to the pressure introduction chamber 25s through a first pressure introduction line 41 (to be described later). In other words, the pressure introduction chamber 25s can communicate with the inside of the tank 11 via the first pressure introduction line 41, and is configured so that the inside of the pressure introduction chamber 25s and a gas phase inside the tank 11 have the same pressure when communicating with the inside of the tank 11.

The pressure introduction chamber 25s and the back pressure chamber 24d of the main valve valve casing 24 are connected to communicate with each other via a communication line 28.

[0024]

The valve body 26 of the first pilot valve 23 configured in this way is normally biased to the pressure introduction chamber 25s side by the biasing member 27. When the pressure inside the tank 11 increases, the pressure inside the pressure introduction chamber 25s also increases in response thereto. When the pressure inside the pressure introduction chamber 25s exceeds a biasing force of the biasing member 27, the valve body 26 moves inside the cylinder 25 against the biasing force of the biasing member 27. When the pressure inside the pressure introduction chamber 25s reaches a predetermined set pressure, for example, the inside of the pressure introduction chamber 25s is released to the atmosphere, and the pressure inside the pressure introduction chamber 25s decreases. The pressure decrease inside the pressure introduction chamber 25s is transmitted to the back pressure chamber 24d through the communication line 28. In this manner, a pressure difference is generated between the inflow port 24a side and the back pressure chamber 24d side while the main valve 22 is interposed therebetween, and the main valve 22 moves in a direction apart from the inflow port 24a. In this

manner, the first safety valve 21 is brought into an opened state, and the inflow port 24a and the discharge port 24b communicate with each other. In this case, vaporized gas (gas) of the liquefied carbon dioxide L1 inside the tank 11 is discharged from the discharge port 24b.

[0025]

The second safety valve 31 is disposed in the top portion of the tank 11. The second safety valve 31 is configured to function when the liquefied gas L2 is stored inside the tank 11. The second safety valve 31 releases the pressure inside the tank 11 when the pressure in a gas phase inside the tank 11 reaches a predetermined set pressure. The second safety valve 31 includes a main valve 32 having the same structure as the first safety valve 21, and a second pilot valve 33.

[0026]

The main valve 32 is disposed inside the main valve valve casing 34. An inflow port 34a and a discharge port 34b are formed in the main valve valve casing 34. The inflow port 34a communicates with the inside of the tank 11. As illustrated in Fig. 2, a connection pipe 45 (to be described later) is connected to the discharge port 34b. The main valve 32 is configured to be connectable to and detachable from the inflow port 34a. When the main valve 32 closes the inflow port 34a, the second safety valve 31

is brought into a blocked state. The pressure inside the tank 11 acts on the main valve 32 from the inflow port 34a side. The main valve valve casing 34 includes a back pressure chamber 34d on a side opposite to the inflow port 34a side with respect to the main valve 32.

[0027]

The second pilot valve 33 applies a pilot pressure for biasing the main valve 32 in a closing direction. The second pilot valve 33 has the same configuration as the first pilot valve 23, and includes a tubular cylinder 35, a valve body 36, and a biasing member 37.

The valve body 36 is disposed to be capable of reciprocating inside the cylinder 35. The biasing member 37 is disposed on one side in a direction in which the biasing member 37 reciprocates with respect to the valve body 36. The biasing member 37 biases the valve body 36 to the other side inside the cylinder 35. A pressure introduction chamber 35s is formed on the other side (side opposite to the biasing member 37) with respect to the valve body 36 inside the cylinder 35. The pressure inside the tank 11 is transmitted to the pressure introduction chamber 35s through a second pressure introduction line 42 (to be described later). In other words, the pressure introduction chamber 35s can communicate with the inside of the tank 11 via the second pressure introduction line 42, and is

configured so that the inside of the pressure introduction chamber 35s and a gas phase inside the tank 11 have the same pressure when communicating with the inside of the tank 11. The pressure introduction chamber 35s and the back pressure chamber 34d are connected to communicate with each other via a communication line 38.

[0028]

As in the valve body 26 of the first pilot valve 23, the valve body 36 of the second pilot valve 33 is normally biased to the pressure introduction chamber 35s side by the biasing member 37. When the pressure inside the tank 11 increases, the pressure inside the pressure introduction chamber 35s also increases in response thereto. When the pressure inside the pressure introduction chamber 35s exceeds the biasing force of the biasing member 37, the valve body 36 moves inside the cylinder 35 against the biasing force of the biasing member 37. When the pressure inside the pressure introduction chamber 35s reaches a predetermined set pressure, for example, the inside of the pressure introduction chamber 35s is released to the atmosphere, and the pressure inside the pressure introduction chamber 35s decreases. The pressure decrease inside the pressure introduction chamber 35s is transmitted to the back pressure chamber 34d through the communication line 38. In this manner, a pressure difference is generated

between the inflow port 34a side and the back pressure chamber 34d side while the main valve 32 is interposed therebetween, and the main valve 32 moves in a direction apart from the inflow port 34a. In this manner, the second safety valve 31 is brought into an opened state, and the inflow port 34a and the discharge port 34b communicate with each other. In this case, vaporized gas (gas) of the liquefied gas L2 inside the tank 11 is fed to the connection pipe 45 from the discharge port 34b.

[0029]

As illustrated in Fig. 2, the vent riser 9 is connected to the second safety valve 31. More specifically, the vent riser 9 is connected to the second safety valve 31 via the connection pipe 45. The vent riser 9 is disposed apart from the second safety valve 31, and discharges the vaporized gas of the liquefied gas L2 fed from the second safety valve 31 to the outside (in other words, the atmosphere). The connection pipe 45 connects the second safety valve 31 and the vent riser 9, and guides the gas fed from the discharge port 34b of the second safety valve 31 to the vent riser 9.

[0030]

The first pressure introduction line 41 is a pipe for transmitting the pressure inside the tank 11 to the first pilot valve 23. The second pressure introduction line 42 is a pipe for transmitting the pressure inside the tank 11

to the second pilot valve 33. The first pressure introduction line 41 and the second pressure introduction line 42 are connected to the tank 11 via the switching valve 43. The switching valve 43 in this embodiment is connected to the tank 11 via a pressure supply pipe 44. The switching valve 43 is a so-called three-way valve, and can communicate with the pressure supply pipe 44 by selecting one of the first pressure introduction line 41 and the second pressure introduction line 42. The switching valve 43 causes the gas phase inside the tank 11 to communicate with the first pressure introduction line 41 or the second pressure introduction line 42 through the pressure supply pipe 44. In this way, the switching valve 43 can selectively switch a transmission destination of the pressure inside the tank 11 between the first pilot valve 23 and the second pilot valve 33.

[0031]

As illustrated in Fig. 4, when the liquefied carbon dioxide L1 is stored inside the tank 11, the switching valve 43 causes the first pressure introduction line 41 on the first safety valve 21 side and the gas phase inside the tank 11 to communicate with each other. On the other hand, as illustrated in Fig. 5, when the liquefied gas L2 is stored inside the tank 11, the switching valve 43 causes the second pressure introduction line 42 on the second safety valve 31

side and the gas phase inside the tank 11 to communicate with each other. A switching operation of the switching valve 43 may be manually performed by an operator, or may be automatically performed.

[0032]

The switching valve 43 includes a detection unit 43s that detects a transmission destination of the pressure inside the tank 11. The detection unit 43s has a limit switch that detects a switching state of a switching switch of the switching valve 43. An information output unit 43m that outputs information indicating the transmission destination of the pressure detected by the detection unit 43s to the outside is connected to the switching valve 43. For example, the information indicating the transmission destination of the pressure detected by the detection unit 43s indicates whether the transmission destination of the pressure is the first safety valve 21 side or the second safety valve 31 side. For example, the information output unit 43m can output the information indicating the transmission destination of the pressure by lighting a lamp indicating the transmission destination of the pressure or displaying character information indicating the transmission destination of the pressure.

[0033]

(Operational Effect)

In the ship 1A of the above-described embodiment, when the liquefied carbon dioxide L1 is stored in the tank 11, the first safety valve 21 is caused to function. The first safety valve 21 functions by transmitting the pressure inside the tank 11 to the first pilot valve 23 through the first pressure introduction line 41. When the pressure in the gas phase inside the tank 11 reaches a predetermined set pressure, the first pilot valve 23 is operated. When the first pilot valve 23 is operated, the gas inside the tank 11 (gas of the liquefied carbon dioxide L1) is discharged to the outside of the tank 11 by the first safety valve 21.

[0034]

On the other hand, when the liquefied gas L2 other than the liquefied carbon dioxide L1 is stored in the tank 11, the second safety valve 31 is caused to function. The second safety valve 31 functions by transmitting the pressure inside the tank 11 to the second pilot valve 33 through the second pressure introduction line 42. When the pressure in the gas phase inside the tank 11 reaches a predetermined set pressure, the second pilot valve 33 is operated. When the second pilot valve 33 is operated, the second safety valve 31 feeds the gas inside the tank 11 (vaporized gas of the liquefied gas L2) to the outside of the tank 11. The gas fed from the tank 11 is fed to the

vent riser 9 through the connection pipe 45. Thereafter, the gas guided to the vent riser 9 is discharged to the outside from the vent riser 9.

[0035]

In this way, the vaporized gas of the liquefied gas L2 is discharged from the vent riser 9 disposed apart from the second safety valve 31. In contrast, the vaporized gas of the liquefied carbon dioxide L1 is directly discharged from the first safety valve 21. Unlike the second safety valve 31, the first safety valve 21 is not connected to the connection pipe 45 and the vent riser 9. Therefore, even in a case where the dry ice is generated when the liquefied carbon dioxide L1 discharges the vaporized gas in the first safety valve 21, it is possible to prevent the connection pipe 45 from being blocked due to the generated dry ice.

[0036]

Furthermore, the switching valve 43 can selectively switch the transmission destination of the pressure inside the tank 11 between the first pilot valve 23 and the second pilot valve 33. That is, the switching valve 43 may be switched as follows. When the liquefied carbon dioxide L1 is stored in the tank 11, the pressure inside the tank 11 is transmitted to the first safety valve 21, and when the liquefied gas L2 is stored, the pressure inside the tank 11 is transmitted to the second safety valve 31. In this

manner, a proper safety valve (first safety valve 21 or second safety valve 31) can be selected to function in accordance with a storage object to be stored in the tank 11. Therefore, the discharge destination of the storage object in the tank 11 can be easily and safely switched.

[0037]

In addition, in the ship 1A of the above-described embodiment, the information indicating the transmission destination of the pressure inside the tank 11 in the switching valve 43 which is detected by the detection unit 43s is output to the outside by the information output unit 43m. Therefore, an operator can easily recognize the transmission destination of the pressure inside the tank 11 in the switching valve 43, based on the information output from the information output unit 43m. That is, when a type of the storage object stored inside the tank 11 and the safety valve functioning by transmitting the pressure inside the tank 11 are different, the operator can easily recognize and deal with the difference.

[0038]

(Modification Example of First Embodiment)

In the above-described embodiment, configurations may be provided as follows.

As illustrated in Figs. 6 and 7, the connection pipe 45 includes a detachable pipe 49 forming a portion of the

connection pipe 45 and a connection pipe main body 48 forming a remaining portion of the connection pipe 45 excluding the detachable pipe 49. The detachable pipe 49 forms the portion of the connection pipe 45 in an extending direction of the connection pipe 45. The detachable pipe 49 is configured to be detached from the connection pipe main body 48. The detachable pipe 49 in this modification example is disposed on a side close to the second safety valve 31 in the connection pipe 45. More specifically, the detachable pipe 49 is attached so that the connection pipe main body 48 serving as the remaining portion of the connection pipe 45 and the second safety valve 31 can communicate with each other, and is flange-connected to the connection pipe main body 48, for example. According to this configuration, as illustrated in Fig. 6, the detachable pipe 49 is normally mounted as a portion of the connection pipe 45. In this manner, as in the above-described embodiment, when the second safety valve 31 is caused to function in a case where the liquefied gas L2 is stored inside the tank 11, the vaporized gas of the liquefied gas L2 is guided from the second safety valve 31 to the vent riser 9, and is discharged to the outside through the connection pipe 45.

[0039]

In this configuration, for example, in a state where

the liquefied carbon dioxide L1 is stored inside the tank 11, when the first safety valve 21 does not normally function for some reason, as illustrated in Fig. 7, the detachable pipe 49 is detached from the connection pipe 45. In this manner, the discharge port 34b of the second safety valve 31 is opened to the atmosphere, and the gas discharged from the discharge port 34b is brought into a state where the gas can be immediately discharged to the atmosphere. In the switching valve 43, even in a state where the liquefied carbon dioxide L1 is stored inside the tank 11, the transmission destination of the pressure inside the tank 11 is set to the second pressure introduction line 42 on the second safety valve 31 side. In this manner, when the second safety valve 31 functions, the pressure inside the tank 11 increases, and exceeds a predetermined set pressure, the vaporized gas of the liquefied carbon dioxide L1 inside the tank 11 can be discharged to the outside (atmosphere) via the second safety valve 31.

[0040]

In this case, the detachable pipe 49 is in a detached state in preparation for a case where the dry ice is generated by the gas of the carbon dioxide discharged from the second safety valve 31. Therefore, the discharge port 34b of the second safety valve 31 is brought into a state close to a case where the discharge port 34b is directly

opened to the atmosphere. In this manner, even when the dry ice is generated by the gas of the carbon dioxide discharged from the discharge port 34b during an operation of the second safety valve 31, it is possible to prevent the connection pipe 45 from being blocked due to the generated dry ice.

[0041]

In the above-described modification example, the detachable pipe 49 is disposed on the side close to the second safety valve 31 in the connection pipe 45. However, the present disclosure is not limited thereto. The detachable pipe 49 may be disposed at any position in the connection pipe 45.

[0042]

<Second Embodiment>

Next, a second embodiment of the floating structure according to the present invention will be described. The second embodiment described below is different from the first embodiment in only a configuration of a safety valve system. Therefore, description will be made by assigning the same reference numerals to elements which are the same as those of the first embodiment, and repeated description will be omitted.

As illustrated in Fig. 8, in the second embodiment, a ship 1B as a floating structure includes at least a safety

valve system 20B in the tank facility 10.

[0043]

In the second embodiment, the tank 11 can selectively store the liquefied carbon dioxide L1 and the liquefied gas L2 other than the liquefied carbon dioxide L1 inside the tank 11. For example, the liquefied gas L2 other than the liquefied carbon dioxide L1 includes liquefied petroleum gas (LPG), liquefied natural gas (LNG), and ammonia.

[0044]

The loading pipe 13 loads the stored gas L supplied from an onshore facility into the tank 11. The loading pipe 13 penetrates a top portion of the tank 11 from an outside of the tank 11, and extends to the inside of the tank 11. A tip portion of the loading pipe 13 is open inside the tank 11.

[0045]

The unloading pipe 14 feeds the stored gas L inside the tank 11 to the outside of the ship. The unloading pipe 14 penetrates the top portion of the tank 11 from the outside of the tank 11, and extends to the inside of the tank 11. A pump (not illustrated) is provided in a tip portion of the unloading pipe 14. The pump suctions the stored gas L inside the tank 11. The unloading pipe 14 feeds the stored gas L suctioned by the pump to the outside of the tank 11 (outside of the ship).

[0046]

(Configuration of Safety Valve System)

The safety valve system 20B mainly includes a safety valve 51, a connection pipe 55, and the vent riser 9.

[0047]

The safety valve 51 is disposed in the top portion of the tank 11. The safety valve 51 releases the pressure inside the tank 11 when the pressure of the stored gas L inside the tank 11 reaches a predetermined set pressure. The safety valve 51 may be of a pilot type as in the first embodiment.

[0048]

The vent riser 9 is disposed apart from the safety valve 51. The vent riser 9 discharges the vaporized gas of the liquefied gas L2 fed from the safety valve 51 to the outside. The vent riser 9 is connected to the safety valve 51 via the connection pipe 55.

[0049]

The connection pipe 55 connects the safety valve 51 and the vent riser 9. The connection pipe 55 is connected to a discharge port 54b of the safety valve 51. The connection pipe 55 partially includes a detachable pipe 59 which is detachable. As in the detachable pipe 49 of the first embodiment, the detachable pipe 59 is flange-connected to a connection pipe main body 58 which is a remaining

portion of the connection pipe 55. In addition, the detachable pipe 59 of the second embodiment is disposed between the connection pipe main body 58 and the safety valve 51 on a side close to the safety valve 51 in the connection pipe 55. The detachable pipe 59 may be disposed at any position in the connection pipe 55 without being limited to the side close to the safety valve 51.

[0050]

In this safety valve system 20B, when the liquefied gas L2 is stored inside the tank 11, the detachable pipe 59 is connected as a portion of the connection pipe 55. When the safety valve 51 is operated to discharge the vaporized gas of the liquefied gas L2 inside the tank 11 to the outside, the vaporized gas of the liquefied gas L2 is guided from the safety valve 51 to the vent riser 9, and is discharged to the outside through the connection pipe 55.

[0051]

On the other hand, as illustrated in Fig. 9, when the liquefied carbon dioxide L1 is stored inside the tank 11, the detachable pipe 59 is detached from the connection pipe 55. In this case, the connection pipe 55 is disposed between the safety valve 51 and the connection pipe main body 58. Therefore, in a state where the detachable pipe 59 is detached, the discharge port 54b of the safety valve 51 is brought into a state close to a case where the discharge

port 54b is directly opened to the atmosphere.

[0052]

Therefore, even when the pressure inside the tank 11 increases, exceeds a predetermined set pressure, the safety valve 51 is operated, the vaporized gas of the liquefied carbon dioxide L1 inside the tank 11 is discharged from the discharge port 54b due to the gas of the carbon dioxide, and the dry ice is generated, it is possible to prevent the connection pipe 55 from being blocked due to the generated dry ice.

[0053]

(Operational Effect)

According to the ship 1B of the second embodiment described above, when the liquefied carbon dioxide L1 is stored in the tank 11, the detachable pipe 59 which is a portion of the connection pipe 55 is detached. In this manner, the discharge port 54b of the safety valve 51 can be opened to the atmosphere at a position close to the discharge port 54b of the safety valve 51. Accordingly, even when the dry ice is generated by the gas of the carbon dioxide discharged from the discharge port 54b during the operation of the safety valve 51, it is possible to prevent the connection pipe 55 from being blocked due to the generated dry ice. In addition, when the liquefied gas L2 is stored in the tank 11, the vaporized gas of the liquefied

gas L2 fed from the safety valve 51 during the operation of the safety valve 51 can be guided to the vent riser 9 and discharged to the outside through the connection pipe 55.

In this way, while the safety valve 51 is used for both the liquefied carbon dioxide L1 and the liquefied gas L2, the detachable pipe 59 is simply attached and detached in accordance with a type of the storage object to be stored in the tank 11. In this manner, a discharge form from the safety valve 51 can be properly selected. The operator can easily recognize that the detachable pipe 59 is in a detached state. Therefore, the discharge destination of the storage object in the tank 11 to be discharged from the safety valve 51 can be easily and safely switched. In addition, since the safety valve 51 can be used for both the liquefied carbon dioxide L1 and the liquefied gas L2, costs for the facility can be reduced.

[0054]

(Other Embodiments)

Hitherto, the embodiments of the present disclosure have been described in detail with reference to the drawings. However, specific configurations are not limited to the above-described embodiments, and design changes within the scope not departing from the concept of the present disclosure are also included.

For example, in the above-described embodiment, the

first safety valve 21, the second safety valve 31, and the safety valve 51 are provided one by one. However, the present disclosure is not limited thereto. A plurality of the first safety valves 21, the second safety valves 31, and the safety valves 51 may be respectively provided. When the plurality of first safety valves 21, second safety valves 31, and safety valves 51 are provided, the set pressures of the first safety valve 21, the second safety valve 31, and the safety valve 51 may be differently changed in a stepwise manner.

[0055]

In the above-described embodiment, a configuration including two tanks 11 has been adopted. However, the present disclosure is not limited thereto. The configuration may include one, three, or more tanks 11.

In addition, in the above-described embodiment, the ships 1A and 1B have been described as examples of the floating structure. However, the present disclosure is not limited thereto. The floating structure may be an offshore floating structure facility which does not include a propulsion mechanism.

[0056]

<Appendix>

The floating structures 1A and 1B described in the respective embodiments can be understood as follows, for

example.

[0057]

(1) According to a first aspect, there are provided the floating structures 1A and 1B including the floating main structure 2, the tank 11 disposed in the floating main structure 2 to selectively store the liquefied carbon dioxide L1 and the liquefied gas L2 other than the liquefied carbon dioxide L1, the first safety valve 21 having the first pilot valve 23 operated when the pressure inside the tank 11 reaches a predetermined set pressure and discharging the gas inside the tank 11 to the outside of the tank 11 by operating the first pilot valve 23, the first pressure introduction line 41 transmitting the pressure inside the tank 11 to the first pilot valve 23, the second safety valve 31 having the second pilot valve 33 operated when the pressure inside the tank 11 reaches a predetermined set pressure and feeding the gas inside the tank 11 to the outside of the tank 11 by operating the second pilot valve 33, the vent riser 9 disposed apart from the second safety valve 31 and discharging the gas to the outside, the connection pipe 45 connecting the second safety valve 31 and the vent riser 9 to guide the gas fed from the second safety valve 31 to the vent riser 9, the second pressure introduction line 42 transmitting the pressure inside the tank 11 to the second pilot valve 33, and the switching

valve 43 selectively switching the transmission destination of the pressure inside the tank 11 between the first pilot valve 23 and the second pilot valve 33.

Examples of the floating structures 1A and 1B include the ship and an offshore floating structure facility. Examples of the floating main structure 2 include the hull and the floating main structure 2 of the offshore floating structure facility.

Examples of the liquefied gas L2 include liquefied petroleum gas, liquefied natural gas, and ammonia.

[0058]

The floating structures 1A and 1B cause the first safety valve 21 to function when the liquefied carbon dioxide L1 is stored in the tank 11. The first safety valve 21 functions by transmitting the pressure inside the tank 11 to the first pilot valve 23 through the first pressure introduction line 41. When the pressure inside the tank 11 reaches the set pressure, the first pilot valve 23 is operated. When the first pilot valve 23 is operated, the gas inside the tank 11 (vaporized gas of the liquefied carbon dioxide L1) can be discharged to the outside of the tank 11 by the first safety valve 21.

When the liquefied gas L2 other than the liquefied carbon dioxide L1 is stored in the tank 11, the second safety valve 31 is caused to function. The second safety

valve 31 functions by transmitting the pressure inside the tank 11 to the second pilot valve 33 through the second pressure introduction line 42. When the pressure inside the tank 11 reaches the set pressure, the second pilot valve 33 is operated. When the second pilot valve 33 is operated, the second safety valve 31 feeds the gas inside the tank 11 (vaporized gas of the liquefied gas L2) to the outside of the tank 11. The gas fed from the second safety valve 31 is fed to the vent riser 9 through the connection pipe 45. The gas is discharged to the outside from the vent riser 9. In this way, the vaporized gas of the liquefied gas L2 is discharged from the vent riser 9 disposed apart from the second safety valve 31. In contrast, the vaporized gas of the liquefied carbon dioxide L1 is directly discharged from the first safety valve 21. Therefore, even when the dry ice is generated when the carbon dioxide gas is discharged by the first safety valve 21, it is possible to prevent the connection pipe 45 from being blocked due to the generated dry ice.

The switching valve 43 selectively switches the transmission destination of the pressure inside the tank 11 between the first pilot valve 23 and the second pilot valve 33. That is, the switching valve 43 may be switched as follows. When the liquefied carbon dioxide L1 is stored in the tank 11, the pressure inside the tank 11 is transmitted

to the first safety valve 21, and when the liquefied gas L2 is stored, the pressure inside the tank 11 is transmitted to the second safety valve 31. In this manner, the proper safety valves 21 and 31 can function depending on a storage object to be stored in the tank 11. Therefore, the discharge destination of the storage object in the tank 11 which is discharged from the safety valves 21 and 31 can be easily and safely switched.

[0059]

(2) According to a second aspect of the floating structures 1A and 1B, the floating structures 1A and 1B of (1) further includes the detection unit 43s detecting the transmission destination of the pressure inside the tank 11 in the switching valve 43, and the information output unit 43m outputting the information indicating the transmission destination detected by the detection unit 43s to the outside.

[0060]

In this manner, the information indicating the transmission destination of the pressure inside the tank 11 in the switching valve 43 which is detected by the detection unit 43s is output to the outside by the information output unit 43m. Therefore, an operator can easily recognize the transmission destination of the pressure inside the tank 11 in the switching valve 43, based on the information output

from the information output unit 43m.

[0061]

(3) According to a third aspect of the floating structures 1A and 1B, in the floating structures 1A and 1B of (1) or (2), the connection pipe 45 includes the detachable pipe 49 forming a portion of the connection pipe 45 in an extending direction of the connection pipe 45, and the connection pipe main body 48 forming a remaining portion of the connection pipe 45. The detachable pipe 49 is configured to be detached from the connection pipe main body 48.

[0062]

In this manner, since the detachable pipe 49 serving as a portion of the connection pipe 45 connected to the second safety valve 31 is detached, the gas discharged from the discharge port 34b of the second safety valve 31 is immediately discharged to the atmosphere. Therefore, when the first safety valve 21 is not normally operated in a state where the liquefied carbon dioxide L1 is stored in the tank 11, the connection pipe 45 is detached. In this manner, even when the dry ice is generated by the gas of carbon dioxide discharged from the discharge port 34b during the operation of the second safety valve 31, it is possible to prevent the connection pipe 45 from being blocked due to the generated dry ice.

[0063]

(4) According to a fourth aspect, there are provided the floating structures 1A and 1B including the floating main structure 2, the tank 11 disposed in the floating main structure 2 to selectively store the liquefied carbon dioxide L1 and the liquefied gas L2 other than the liquefied carbon dioxide L1, the safety valve 51 feeding the pressure inside the tank 11 to the outside of the tank 11 when the pressure inside the tank 11 reaches a predetermined set pressure, the vent riser 9 disposed apart from the safety valve 51 and discharging the gas to the outside, and the connection pipe 55 connecting the safety valve 51 and the vent riser 9 to guide the gas fed from the safety valve 51 to the vent riser 9. The connection pipe 55 includes the detachable pipe 59 forming a portion of the connection pipe 55 in an extending direction of the connection pipe 55, and the connection pipe main body 58 forming a remaining portion of the connection pipe 55. The detachable pipe 59 is configured to be detached from the connection pipe main body 58.

[0064]

In this manner, when the liquefied carbon dioxide L1 is stored in the tank 11, since a portion of the connection pipe 55 is detached, the gas discharged from the discharge port 54b of the safety valve 51 can be immediately

discharged to the atmosphere. Accordingly, even when the dry ice is generated by the gas of the carbon dioxide discharged from the discharge port 54b during the operation of the safety valve 51, it is possible to prevent the connection pipe 55 from being blocked due to the generated dry ice.

In addition, when the liquefied gas L2 is stored in the tank 11, the vaporized gas of the liquefied gas L2 fed from the safety valve 51 during the operation of the safety valve 51 is discharged to the outside from the vent riser 9 through the connection pipe 55. In this way, while the safety valve 51 is used for both the liquefied carbon dioxide L1 and the liquefied gas L2, the discharge form from the safety valve 51 can be properly selected in accordance with a type of the storage object to be stored in the tank 11. The operator can easily recognize that the detachable pipe 59 is in a detached state. Therefore, the discharge destination of the storage object in the tank 11 to be discharged from the safety valve 51 can be easily and safely switched. In addition, since the safety valve 51 can be used for both the liquefied carbon dioxide L1 and the liquefied gas L2, costs for the facility can be reduced.

Industrial Applicability

[0065]

According to the floating structure of the present

disclosure, it is possible to easily and safely switch a discharge destination of a tank storage object discharged from the safety valve.

Reference Signs List

[0066]

1A, 1B: Ship (floating structure)

2: Hull (floating main structure)

2a: Bow

2b: Stern

3A, 3B: Broadside

5: Upper deck

7: Superstructure

8: Cargo tank storage compartment

9: Vent riser

10: Tank facility

11: Tank

13: Loading pipe

14: Unloading pipe

20A, 20B: Safety valve system

21: First safety valve

22: Main valve

23: First pilot valve

24: Main valve valve casing

24a: Inflow port

24b: Discharge port

24d: Back pressure chamber

25: Cylinder

25s: Pressure introduction chamber

26: Valve body

27: Biasing member

28: Communication line

31: Second safety valve

32: Main valve

33: Second pilot valve

34: Main valve valve casing

34a: Inflow port

34b: Discharge port

34d: Back pressure chamber

35: Cylinder

35s: Pressure introduction chamber

36: Valve body

37: Biasing member

38: Communication line

41: First pressure introduction line

42: Second pressure introduction line

43: Switching valve

43m: Information output unit

43s: Detection unit

44: Pressure supply pipe

45: Connection pipe

48: Connection pipe main body
49: Detachable pipe
51: Safety valve
53: Pilot valve
54b: Discharge port
55: Connection pipe
58: Connection pipe main body
59: Detachable pipe
L: Stored gas
L1: Liquefied carbon dioxide
L2: Liquefied gas

Claims

[Claim 1]

A floating structure comprising:

a floating main structure;

a tank disposed in the floating main structure to selectively store liquefied carbon dioxide and liquefied gas other than liquefied carbon dioxide;

a first safety valve including a first pilot valve operated when a pressure inside the tank reaches a predetermined set pressure and discharging gas inside the tank to an outside of the tank by operating the first pilot valve;

a first pressure introduction line transmitting the pressure inside the tank to the first pilot valve;

a second safety valve including a second pilot valve operated when the pressure inside the tank reaches a predetermined set pressure and feeding the gas inside the tank to the outside of the tank by operating the second pilot valve;

a vent riser disposed apart from the second safety valve and discharging the gas to the outside;

a connection pipe connecting the second safety valve and the vent riser to guide the gas fed from the second safety valve to the vent riser;

a second pressure introduction line transmitting the pressure inside the tank to the second pilot valve; and

a switching valve selectively switching a transmission destination of the pressure inside the tank between the first pilot valve and the second pilot valve.

[Claim 2]

The floating structure according to Claim 1, further comprising:

a detection unit detecting the transmission destination of the pressure inside the tank in the switching valve; and

an information output unit outputting information indicating the transmission destination detected by the detection unit to the outside.

[Claim 3]

The floating structure according to Claim 1 or 2,

wherein the connection pipe includes

a detachable pipe forming a portion of the connection pipe in an extending direction of the connection pipe, and

a connection pipe main body forming a remaining portion of the connection pipe, and

the detachable pipe is configured to be detached from

the connection pipe main body.

[Claim 4]

A floating structure comprising:

a floating main structure;

a tank disposed in the floating main structure to selectively store liquefied carbon dioxide and liquefied gas other than liquefied carbon dioxide;

a safety valve feeding gas inside the tank to an outside of the tank when a pressure inside the tank reaches a predetermined set pressure;

a vent riser disposed apart from the safety valve and discharging the gas to the outside; and

a connection pipe connecting the safety valve and the vent riser to guide the gas fed from the safety valve to the vent riser,

wherein the connection pipe includes

a detachable pipe forming a portion of the connection pipe in an extending direction of the connection pipe, and

a connection pipe main body forming a remaining portion of the connection pipe, and

the detachable pipe is configured to be detached from the connection pipe main body.