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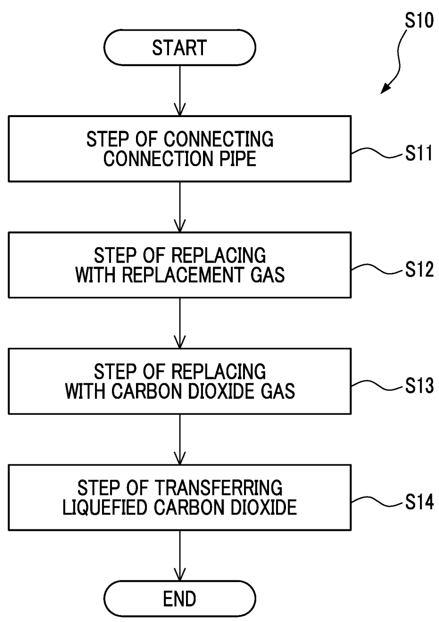
(54) METHOD FOR TRANSFERRING LIQUEFIED CARBON DIOXIDE, AND FLOATING BODY

(57) A method for transferring liquefied carbon dioxide according to the present invention includes the steps of: connecting a connection pipe for connection to an external facility arranged in the outside of a floating structure to piping that communicates with the inside of a tank provided to the floating structure; replacing the insides of the connection pipe and the piping with a replacement gas by feeding the replacement gas having the moisture content adjusted to smaller than or equal to a predetermined upper limit value into the insides of the connection pipe and the piping; replacing the insides of the connection pipe and the piping with a carbon dioxide gas from the replacement gas; and transferring the liquefied carbon dioxide between the external facility and the tank through the connection pipe and the piping.

FIG. 5



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Description

Technical Field

[0001] The present disclosure relates to a method for transferring liquefied carbon dioxide, and a floating structure.

[0002] Priority is claimed on Japanese Patent Application No. 2020-180560, filed October 28, 2020, the content of which is incorporated herein by reference.

Background Art

[0003] For example, in PTL 1, a configuration including a transfer device (natural gas transfer device) for transferring liquefied gas from a ship (import ship) provided with a tank for storing a liquefied gas (liquefied natural gas (LNG)) to a facility (import terminal) on land is disclosed. In such a configuration, the ship moored at the facility on land communicates fluidly with the facility and transfers the liquefied gas in the tank to the storage tank on land.

Citation List

Patent Literature

[0004] [PTL 1] PCT Japanese Translation Patent Publication No. 2010-503132

Summary of Invention

Technical Problem

[0005] Incidentally, when the liquefied gas is loaded into the tank from an external facility such as a facility on land or when the liquefied gas in the tank is unloaded to the external facility, the pipes such as the loading pipe or the unloading pipe provided in the tank are connected to the external facility via a connection pipe. However, when connecting the connection pipe to the pipe, there is a possibility that air (atmosphere) intrudes the inside of the pipe. Then, in a case where the liquefied carbon dioxide is accommodated in the tank, when air intrusion into the pipe occurs, the moisture contained in the air reacts with the carbon dioxide, and carbonic acid or hydrate is formed. When carbonic acid or hydrate is formed in this manner, there is a possibility that corrosion occurs inside the pipe or the tank.

[0006] Therefore, after the connection pipe is connected to the pipe of the tank, the connection pipe is filled with carbon dioxide gas. As a result, direct contact of the moisture contained in the air with the liquefied carbon dioxide is suppressed. However, also in this case, when the carbon dioxide gas is filled, there is a possibility that the moisture contained in the air in the connection pipe reacts with the carbon dioxide, resulting in corrosion inside the tank or the pipe.

[0007] The present disclosure has been made to solve the above problems, and an object thereof is to provide a method for transferring liquefied carbon dioxide and a floating structure that can suppress the reaction between carbon dioxide and moisture when the liquefied carbon dioxide is transferred, and suppress occurrence of corrosion of the inside of the tank or the pipe.

Solution to Problem

[0008] In order to solve the above problems, a method for transferring liquefied carbon dioxide according to the present disclosure includes a step of connecting a connection pipe, a step of replacing with a replacement gas, a step of replacing with a carbon dioxide gas, and a step of transferring liquefied carbon dioxide. In the step of connecting the connection pipe, the connection pipe is connected to a pipe communicating with an inside of a tank provided in a floating structure. The connection pipe is for connection to an external facility disposed outside the floating structure, to the pipe. In the step of replacing with the replacement gas, the replacement gas is fed into the connection pipe and the pipe, and the gas inside the connection pipe and the pipe is replaced with the replacement gas. The moisture content of the replacement gas is adjusted to be equal to or less than a predetermined upper limit value. In the step of replacing with the carbon dioxide gas, the replacement gas is replaced with the carbon dioxide gas on the inside of the connection pipe and the pipe. In the step of transferring the liquefied carbon dioxide, the liquefied carbon dioxide is transferred between the external facility and the tank through the connection pipe and the pipe.

[0009] The floating structure according to the present disclosure includes a floating main structure, a tank, a pipe, a replacement gas supply unit, and a carbon dioxide supply unit. The tank is disposed in the floating main structure. The tank is capable of storing liquefied carbon dioxide. The pipe communicates with an inside of the tank. The pipe is connectable to a connection pipe for supplying liquefied carbon dioxide between an external facility and the tank. The replacement gas supply unit feeds a replacement gas into the pipe and the connection pipe in a case where the connection pipe is connected to the pipe. A moisture content of the replacement gas is adjusted to be equal to or less than a predetermined upper limit value. The carbon dioxide supply unit feeds a carbon dioxide gas into the pipe and the connection pipe.

Advantageous Effects of Invention

[0010] According to the method for transferring liquefied carbon dioxide and the floating structure according to the present disclosure, it is possible to suppress the reaction between the carbon dioxide and the moisture when the liquefied carbon dioxide is transferred, and to suppress the occurrence of corrosion inside the tank or the pipe.

Brief Description of Drawings

[0011]

Fig. 1 is a plan view showing a schematic configuration of a ship as a floating structure according to an embodiment of the present disclosure.
Fig. 2 is a view showing a tank and a pipe provided in the ship according to the embodiment of the present disclosure, and is a sectional view taken along line I-I of Fig. 1.
Fig. 3 is a view showing the tank and the pipe provided in the ship according to the embodiment of the present disclosure, and is a sectional view taken along line II-II of Fig. 1.
Fig. 4 is a diagram showing an external facility connected to the ship according to the embodiment of the present disclosure by a connection pipe.
Fig. 5 is a flowchart showing a procedure of a method for transferring liquefied carbon dioxide according to the embodiment of the present disclosure.
Fig. 6 is a view showing a step of connecting the connection pipe in the method for transferring liquefied carbon dioxide according to the embodiment of the present disclosure.
Fig. 7 is a view showing a step of replacing with a replacement gas in the method for transferring liquefied carbon dioxide according to the embodiment of the present disclosure.
Fig. 8 is a view showing a step of replacing with a carbon dioxide gas in the method for transferring liquefied carbon dioxide according to the embodiment of the present disclosure.
Fig. 9 is a view showing a step of transferring liquefied carbon dioxide in the method for transferring liquefied carbon dioxide according to the embodiment of the present disclosure.

Description of Embodiments

[0012] Hereinafter, a floating structure and a method for transferring liquefied carbon dioxide according to embodiments of the present disclosure will be described with reference to Figs. 1 to 9.

(Configuration of Ship)

[0013] As shown in Figs. 1 and 2, in the embodiment of the present disclosure, a ship 1 which is a floating structure carries liquefied carbon dioxide. The ship 1 includes at least a hull 2 as a floating main structure, a tank facility 10, a replacement gas supply unit 20 (refer to Fig. 2), and a carbon dioxide supply unit 30 (refer to Fig. 2).

(Configuration of Hull)

[0014] The hull 2 has a pair of sides 3A and 3B, a bottom 4 (refer to Fig. 2), and an upper deck 5, which form an outer shell thereof. The sides 3A and 3B each have a pair of side shell platings which form the left and right sides on both sides in a ship width direction Dw. The bottom 4 is disposed below in a vertical direction Dv and has a bottom shell plating connecting these sides 3A and 3B to each other. As shown in Fig. 2, due to the pair of sides 3A and 3B and the bottom 4, the outer shell of the hull 2 has a U-shape in a cross section orthogonal to a stem-stern direction Da. The upper deck 5 shown in this embodiment is a continuous deck exposed to the outside. In the hull 2, a superstructure 7 having an accommodation space is formed on the upper deck 5 on a stern 2b side.

[0015] Inside the hull 2, a cargo tank storage compartment (hold) 8 is formed on a stem 2a side of the superstructure 7. The cargo tank storage compartment 8 is recessed toward the bottom below the upper deck 5, and is open upward.

(Configuration of Tank Facility)

[0016] A plurality of tank facilities 10 are disposed in the cargo tank storage compartment 8 along the stem-stern direction Da. In the embodiment of the present disclosure, two tank facilities 10 are disposed at intervals in the stem-stern direction Da.

[0017] As shown in Figs. 2 and 3, the tank facility 10 includes at least a tank 11 and a pipe 12.

[0018] In this embodiment, the tank 11 is disposed on the hull 2. The tank 11 has, for example, a cylindrical shape extending in the horizontal direction. In this embodiment, the tank 11 is disposed in the long axis direction along the stem-stern direction Da. The tank 11 accommodates a liquefied carbon dioxide L inside thereof. The tank 11 is not limited to a cylindrical shape, and the tank 11 may have a spherical shape, a square shape, or the like.

[0019] The pipe 12 includes a loading pipe 13 and an unloading pipe 14. That is, as the pipe 12 of the tank facility 10, there are two types of pipes, the loading pipe 13 and the unloading pipe 14.

[0020] As shown in Fig. 3, the loading pipe 13 forms a pipe line for loading the liquefied carbon dioxide L supplied from an external facility 100 (refer to Fig. 4) on the outside of the ship, such as an on-land liquefied carbon dioxide supply facility, into the tank 11. A part of the loading pipe 13 on a side close to one end 13a thereof penetrates the top of the tank 11 and extends from the outside to the inside of the tank 11. A part of the loading pipe 13 on a side close to the one end 13a extends in the vertical direction Dv inside the tank 11. The one end 13a of the loading pipe 13 opens in the tank 11 at the lower portion of the tank 11.

[0021] The rest of the loading pipe 13, that is, a part on a side close to the other end 13b is disposed outside the tank 11. As shown in Fig. 2, the other end 13b of the loading pipe 13 is provided with a connection portion 13j connected to the outside of the ship. The connection portion 13j has, for example, a flange or the like. The connection portion 13j is disposed toward one (for example, the side 3A) of the sides 3A and 3B. The opening of a connection portion 14j is normally blocked by a lid (not shown). By removing the lid (not shown) of the connection portion 13j, it is possible to connect the end portion of the connection pipe 50 for connection to a facility side tank 101 of the external facility 100 in place of the lid (not shown).

[0022] The unloading pipe 14 delivers the liquefied carbon dioxide L in the tank 11 to the external facility 100 on the outside of the ship. A part of the unloading pipe 14 on a side close to one end 14a penetrates the top of the tank 11 from the outside of the tank 11 and extends to the inside of the tank 11. The one end 14a of the unloading pipe 14 is disposed in the lower portion inside the tank 11. A pump (not shown) is provided at the one end 14a of the unloading pipe 14. The pump (not shown) sucks the liquefied carbon dioxide L in the tank 11 and delivers the liquefied carbon dioxide L to the unloading pipe 14. The unloading pipe 14 guides the liquefied carbon dioxide L delivered from the pump to the outside of the tank 11 (the outside of the ship).

[0023] A part of the unloading pipe 14 on a side close to the other end 14b, which is the rest of the unloading pipe 14, is disposed outside the tank 11. As shown in Fig. 2, the other end 14b of the unloading pipe 14 is provided with the connection portion 14j to the outside of the ship. The connection portion 14j has, for example, a flange or the like, and is disposed toward one (for example, the side 3A) of the sides 3A and 3B. The opening of a connection portion 14j is normally blocked by a lid (not shown). By removing the lid (not shown) of the connection portion 14j, it is possible to connect the end portion of the connection pipe 50 for connection to a facility side tank 101 of the external facility 100 in place of the lid (not shown).

[0024] As shown in Fig. 4, in a case where the liquefied carbon dioxide L is loaded into the tank 11 from the external facility 100, the connection pipe 50 connects and allows a facility side pipe 102 provided in the facility side tank 101 of the external facility 100 and the connection portion 13j of the loading pipe 13 to communicate with each other. In addition, in a case where the liquefied carbon dioxide L is unloaded from the tank 11 to the external facility 100, the connection pipe 50 connects and allows the facility side pipe 102 provided in the facility side tank 101 of the external facility 100 and the connection portion 14j of the unloading pipe 14 to communicate with each other. In the following description, except for the case where the loading pipe 13 and the unloading pipe 14 are distinguished, the loading pipe 13 and the unloading pipe 14 are simply referred to as pipes 12, and the connection portions 13j and 14j are simply referred to as connection portions 12j.

[0025] Opening-closing valves 15 and 105 are provided on the pipe 12 and the facility side pipe 102 on the external facility 100 side, respectively. The opening-closing valve 15 opens and closes a flow channel in the pipe 12. The opening-closing valve 105 opens and closes a flow channel in the facility side pipe 102. In addition, an opening valve 106 is provided in the facility side pipe 102. When the opening valve 106 is opened, the flow channel inside the facility side pipe 102 and the outside communicate with each other. When the opening-closing valves 15 and 105 are closed in a state where the facility side pipe 102 and the pipe 12 are connected to each other by the connection pipe 50, the inside of the pipe 12, the connection pipe 50, and the facility side pipe 102 positioned between the opening-closing valve 15 and the opening-closing valve 105 is not communicated with the facility side tank 101 or the tank 11. Here, the outside to which the flow channel in the facility side pipe 102 is communicated is not limited to the atmosphere. For example, a container such as a tank capable of storing the gas discharged through the opening valve 106 may be adopted.

[0026] As shown in Fig. 2, the replacement gas supply unit 20 feeds a replacement gas Ga into the pipe 12 and the connection pipe 50 in a state where the connection pipe 50 for connection to the external facility 100 is connected to the pipe 12. As the replacement gas Ga, a gas that does not cause a chemical reaction with carbon dioxide is used. The moisture content of the replacement gas Ga is adjusted to be equal to or less than a predetermined upper limit value. As the replacement gas Ga, air having the moisture content adjusted to be equal to or less than a predetermined upper limit value (so-called dry air) or an inert gas such as nitrogen or argon can be used. In this embodiment, dry air is used as the replacement gas Ga. The replacement gas supply unit 20 includes an air dryer 21. The air dryer 21 removes moisture from the atmosphere taken in from the outside to form dry air having the moisture content adjusted to be equal to or less than a predetermined upper limit value, for example, a dew point temperature of -40°C. The air dryer 21 is connected to the pipe 12 via a replacement gas supply pipe 22. An opening-closing valve 23 is provided in the replacement gas supply pipe 22. The dry air formed by the air dryer 21 is fed to the inside of the pipe 12, the connection pipe 50, and the facility side pipe 102 through the replacement gas supply pipe 22 by opening the opening-closing valve 23. The upper limit value of the moisture content in the dry air may be any value as long as the moisture in the pipe can be efficiently removed, and can be obtained in advance by an experiment or the like.

[0027] As shown in Figs. 2 and 4, the carbon dioxide supply unit 30 feeds a carbon dioxide gas Gc into the pipe 12, the connection pipe 50, and the facility side pipe 102 in a state where the connection pipe 50 for connection to the external facility 100 is connected to the pipe 12. In this embodiment, the carbon dioxide supply unit

30 uses the boil-off gas formed by the vaporization of the liquefied carbon dioxide L in the tank 11 as the carbon dioxide gas Gc. The carbon dioxide supply unit 30 includes a boil-off gas supply pipe 31 (refer to Figs. 2 and 3). The boil-off gas supply pipe 31 allows the gas phase in the upper portion in the tank 11 and the pipe 12 to communicate with each other. The carbon dioxide supply unit 30 feeds the boil-off gas from the tank 11 to the inside of the connection pipe 50 and the facility side pipe 102 through the pipe 12.

(Procedure of Method for Transferring Liquefied Carbon Dioxide)

[0028] As shown in Fig. 5, a method S10 for transferring the liquefied carbon dioxide L according to this embodiment includes a step S11 of connecting the connection pipe 50, a step S12 of replacing with the replacement gas Ga, a step S13 of replacing with the carbon dioxide gas Gc, and a step S14 of transferring the liquefied carbon dioxide L.

[0029] In the step S11 of connecting the connection pipe 50, as shown in Fig. 6, one end of the connection pipe 50 for connection to the external facility 100 is connected to the pipe 12. Further, the other end of the connection pipe 50 is connected to the facility side pipe 102 of the external facility 100. At this time, the opening-closing valves 15, 23, and 105, and the opening valve 106 are kept in the closed state. In this state, air is contained in the pipe 12, the connection pipe 50, and the facility side pipe 102 positioned between the opening-closing valve 15 and the opening-closing valve 105.

[0030] In the step S12 of replacing with the replacement gas Ga, as shown in Fig. 7, the replacement gas Ga is fed into the inside of the connection pipe 50 by the replacement gas supply unit 20. To this end, the air dryer 21 is operated, and the opening-closing valves 15 and 105 are closed, and the opening-closing valves 23 and the opening valves 106 are opened. By removing the moisture in the air (atmosphere) taken in from the outside by the air dryer 21, dry air having the moisture content adjusted to be equal to or less than a predetermined upper limit value is formed, and the dry air becomes the replacement gas Ga. The replacement gas Ga is supplied to the connection portion 12j of the pipe 12 through the replacement gas supply pipe 22. The supplied replacement gas Ga flows from the pipe 12 to the connection pipe 50 and the facility side pipe 102, and sequentially pushes the air inside the pipe 12, the connection pipe 50, and the facility side pipe 102 to the outside from the opening valve 106. The dew point of the air discharged from the opening valve 106 is measured, and the replacement gas Ga is continuously fed until the dew point falls within the preset allowable value range. When the measured dew point falls within the allowable value range, the feeding of the replacement gas Ga by the replacement gas supply unit 20 is stopped, and the opening valve 106 and the opening-closing valve 23 are closed. As a result, the inside of the pipe 12, the connection pipe 50, and the facility side pipe 102 between the opening-closing valves 15 and 105 is replaced with the replacement gas Ga.

[0031] In the step S13 of replacing with the carbon dioxide gas Gc, the inside of the connection pipe 50 is replaced with the carbon dioxide gas Gc from the replacement gas Ga. To this end, as shown in Fig. 8, the opening-closing valves 15 and 105 are opened, and the opening valve 106 and the opening-closing valve 23 are closed. In this state, the boil-off gas of the tank 11 is fed as the carbon dioxide gas Gc to the inside of the connection pipe 50 and the facility side pipe 102 through the carbon dioxide supply unit 30 and the pipe 12. As a result, the replacement gas Ga (dry air) inside the pipe 12, the connection pipe 50, and the facility side pipe 102 is sequentially pushed out to the external facility 100 side. On the external facility 100 side, the carbon dioxide concentration of the air-fuel mixture of the replacement gas Ga and the carbon dioxide gas Gc extruded from the connection pipe 50 side is measured. When the measured carbon dioxide concentration falls within the preset concentration range, the carbon dioxide supply unit 30 stops the supply of the carbon dioxide gas Gc.

[0032] In the step S14 of transferring the liquefied carbon dioxide L, as shown in Fig. 9, the liquefied carbon dioxide L is transferred between the external facility 100 and the tank 11 through the connection pipe 50 and the pipe 12. For example, in a case where the liquefied carbon dioxide L is loaded into the tank 11 from the external facility 100, the liquefied carbon dioxide L is fed into the tank 11 from the facility side tank 101 of the external facility 100 through the facility side pipe 102, the connection pipe 50, and the pipe 12 (loading pipe 13).

[0033] Further, in a case where the liquefied carbon dioxide L is unloaded from the inside of the tank 11 to the external facility 100, the liquefied carbon dioxide L is fed into the facility side tank 101 of the external facility 100 from the pipe 12 (unloading pipe 14) through the connection pipe 50 and the facility side pipe 102.

(Effects)

[0034] According to the method S10 for transferring liquefied carbon dioxide of the above-described embodiment, gas on the inside of the connection pipe 50 and the pipe 12 is replaced with the replacement gas Ga and then further replaced with the carbon dioxide gas Gc. The moisture content of the replacement gas Ga is adjusted to be equal to or less than a predetermined upper limit value. Accordingly, when the replacement gas Ga is replaced with the carbon dioxide gas Gc, the reaction between the carbon dioxide gas Gc and the moisture is suppressed. After replacing the inside of the connection pipe 50 and the pipe 12 with the carbon dioxide gas Gc, the liquefied carbon dioxide L transferred between the external facility 100 and the tank 11 flows to the inside of the connection pipe 50 and the pipe 12, and thus, even at this time, the occurrence of the reaction between the carbon dioxide gas Gc and the moisture is suppressed. Therefore, it is possible to suppress the reaction between the carbon dioxide and the moisture when the liquefied carbon dioxide L is transferred, and to suppress the occurrence of corrosion inside the tank 11 or the pipe 12.

[0035] Further, the replacement gas Ga is dry air having the moisture content adjusted to be equal to or less than a predetermined upper limit value. The dry air used as the replacement gas Ga can be formed by drying the air (atmosphere) with the air dryer 21. Therefore, it is possible to easily prepare the dry air on the ship 1.

[0036] Further, the carbon dioxide gas Gc is a boil-off gas formed by vaporization of the liquefied carbon dioxide L stored in the tank 11. Accordingly, the carbon dioxide gas Gc can be easily obtained on the ship 1.

[0037] In the ship 1 of the above-described embodiment, in a case where the connection pipe 50 for connection to the external facility 100 is connected to the pipe 12, the replacement gas supply unit 20 feeds the replacement gas Ga having the moisture content adjusted to be equal to or less than a predetermined upper limit value into the connection pipe 50 and the pipe 12. Accordingly, the inside of the connection pipe 50 and the pipe 12 can be replaced with the replacement gas Ga. Further, the carbon dioxide supply unit 30 feeds the carbon dioxide gas Gc to the inside of the connection pipe 50 and the pipe 12, and thus the replacement gas Ga can be replaced with the carbon dioxide gas Gc on the inside of the connection pipe 50 and the pipe 12. After that, the liquefied carbon dioxide L is transferred between the external facility 100 and the tank 11 through the connection pipe 50 and the pipe 12, and accordingly, it is possible to suppress the reaction between the carbon dioxide and the moisture when the liquefied carbon dioxide L is transferred, and to suppress the occurrence of corrosion inside the tank 11 or the pipe 12.

[0038] In addition, the ship 1 includes the air dryer 21. Accordingly, by drying the atmosphere (air) taken in from the outside by the air dryer 21, it is possible to provide the dry air having the moisture content adjusted to be equal to or less than a predetermined upper limit value as the replacement gas Ga. Accordingly, on the ship 1, it becomes possible to easily obtain the replacement gas Ga having the moisture content adjusted to be equal to or less than a predetermined upper limit value.

[0039] In addition, the ship 1 feeds the boil-off gas formed by the vaporization of the liquefied carbon dioxide L stored in the tank 11 into the pipe 12 and the connection pipe 50 as the carbon dioxide gas Gc. Accordingly, the carbon dioxide gas Gc can be easily obtained on the ship 1.

(Other Embodiments)

[0040] Above, the embodiments of the present disclosure have been described in detail with reference to the drawings, but the specific configuration is not limited to the embodiments, and includes design changes and the like within a scope not departing from the gist of the present disclosure.

[0041] In the above embodiment, as the connection portion 12j of the pipe 12, the connection portion 13j of the loading pipe 13 and the connection portion 14j of the unloading pipe 14 are individually provided, but the present disclosure is not limited thereto. For example, the loading pipe 13 and the unloading pipe 14 may be connected to one pipe 12 on the other end 13b and 14b sides, and the connection portion 12j may be shared by the loading pipe 13 and the unloading pipe 14.

[0042] Further, in the above-described embodiment, the liquefied carbon dioxide L is transferred between the ship 1 and the external facility 100 installed on land, but the present disclosure is not limited thereto. The liquefied carbon dioxide L may be transferred between the ship 1 and an offshore floating structure facility that is disposed offshore and does not include a propulsion mechanism. In this case, the offshore floating structure facility corresponds to the external facility 100 as viewed from the ship 1.

[0043] In the above embodiment, as the carbon dioxide gas Gc, a boil-off gas formed by vaporization of the liquefied carbon dioxide L in the tank 11 is used. However, other than the boil-off gas, the carbon dioxide gas Gc may be, for example, a carbon dioxide gas accommodated in another container on the same ship or on the outside of the ship.

[0044] Further, in the ship 1 of the above embodiment, the configuration is provided with two tanks 11, but the number and arrangement of the tanks 11 are not limited thereto. Three or more tanks 11 may be provided. Further, in the above embodiment, a case where the plurality of tanks 11 are disposed side by side in the stem-stern direction Da has been shown. However, the tanks 11 may be disposed side by side in the ship width direction (in other words, the left-right side direction). In addition, in the above embodiment, the ship 1 is exemplified as the floating structure, but the present disclosure is not limited thereto. The floating structure may be an offshore floating structure facility that does not include a propulsion mechanism. In a case where the floating structure is an offshore floating structure facility, the external facility 100 viewed from the offshore floating structure facility may be a ship.

<Additional Note>

[0045] The method S10 for transferring the liquefied carbon dioxide L and the floating structure 1 described in each of the embodiments are ascertained as follows, for example.

(1) According to a first aspect, there is provided a method S10 for transferring the liquefied carbon dioxide L including: the step S11 of connecting the connection pipe 50 for connection to the external fa-

cility 100 disposed outside the floating structure 1 to the pipe 12 communicating with the inside of the tank 11 provided in the floating structure 1; the step S12 of feeding the replacement gas Ga having the moisture content adjusted to be equal to or less than a predetermined upper limit value into the connection pipe 50 and the pipe 12, and replacing the inside of the connection pipe 50 and the pipe 12 with the replacement gas Ga; the step S13 of replacing the replacement gas Ga inside the connection pipe 50 and the pipe 12 with the carbon dioxide gas Gc; and the step S14 of transferring the liquefied carbon dioxide L between the external facility 100 and the tank 11 through the connection pipe 50 and the pipe 12.

[0046] Examples of the floating structure 1 include a ship and an offshore floating structure facility. Examples of the floating main structure 2 include the floating main structure 2 of a hull or an offshore floating structure facility.

[0047] Examples of the replacement gas Ga include dry air and an inert gas.

[0048] According to this method S10 for transferring liquefied carbon dioxide L, gas on the inside of the connection pipe 50 and the pipe 12 is replaced with the replacement gas Ga and then further replaced with the carbon dioxide gas Gc. Since the moisture content of the replacement gas Ga is adjusted to be equal to or less than a predetermined upper limit value, the reaction between the carbon dioxide and the moisture is suppressed when the replacement gas Ga is replaced with the carbon dioxide gas Gc. After replacing the inside of the connection pipe 50 and the pipe 12 with the carbon dioxide gas Gc, the liquefied carbon dioxide L transferred between the external facility 100 and the tank 11 flows into the connection pipe 50 and the pipe 12, and thus, even at this time, the occurrence of the reaction between the carbon dioxide and the moisture is suppressed. Therefore, it is possible to suppress the reaction between the carbon dioxide and the moisture when the liquefied carbon dioxide L is transferred, and to suppress the occurrence of corrosion inside the tank 11 or the pipe 12.

[0049] (2) In the method S10 for transferring the liquefied carbon dioxide L according to a second aspect, which is the method S10 for transferring the liquefied carbon dioxide L of (1), the replacement gas Ga is dry air having a moisture content adjusted to be equal to or less than a predetermined upper limit value.

[0050] Accordingly, the dry air used as the replacement gas Ga can be formed by drying the air (atmosphere) with the air dryer. Therefore, it is possible to easily prepare the dry air on the floating structure 1.

[0051] (3) In the method S10 for transferring the liquefied carbon dioxide L according to a third aspect, which is the method S10 for transferring the liquefied carbon dioxide L of (1) or (2), the carbon dioxide gas Gc is a boil-off gas formed by vaporization of the liquefied carbon dioxide L stored in the tank 11.

[0052] Accordingly, the carbon dioxide gas Gc can be easily obtained on the floating structure 1.

[0053] (4) According to a fourth aspect, there is provided the floating structure 1 including: the floating main structure 2; the tank 11 disposed in the floating main structure 2 and capable of storing the liquefied carbon dioxide L; the pipe 12 which communicates with the inside of the tank 11 and to which the connection pipe 50 for supplying the liquefied carbon dioxide L between the external facility 100 and the tank 11 is connectable; the replacement gas supply unit 20 that feeds the replacement gas Ga having a moisture content adjusted to be equal to or less than a predetermined upper limit value into the pipe 12 and the connection pipe 50 in a case where the connection pipe 50 is connected to the pipe 12; and the carbon dioxide supply unit 30 that feeds the carbon dioxide gas Gc into the pipe 12 and the connection pipe 50.

[0054] In the floating structure 1, the replacement gas supply unit 20 feeds the replacement gas Ga having the moisture content adjusted to be equal to or less than a predetermined upper limit value into the connection pipe 50 and the pipe 12, and accordingly, the gas on the inside of the connection pipe 50 and the pipe 12 can be replaced with the replacement gas Ga. Further, the carbon dioxide supply unit 30 feeds the carbon dioxide gas Gc to the inside of the connection pipe 50 and the pipe 12, and thus the replacement gas Ga can be replaced with the carbon dioxide gas Gc on the inside of the connection pipe 50 and the pipe 12. After that, the liquefied carbon dioxide L is transferred between the external facility 100 and the tank 11 through the connection pipe 50 and the pipe 12, and accordingly, it is possible to suppress the reaction between the carbon dioxide and the moisture when the liquefied carbon dioxide L is transferred, and to suppress the occurrence of corrosion inside the tank 11 or the pipe 12.

[0055] (5) In the floating structure 1 according to a fifth aspect, which is the floating structure 1 of (4), the replacement gas supply unit 20 includes the air dryer 21 that reduces an amount of moisture contained in the atmosphere taken in from the outside.

[0056] Accordingly, the air dryer 21 reduces the moisture content in the atmosphere taken in from the outside, and accordingly, the dry air can be provided as the replacement gas Ga having the moisture content adjusted to be equal to or less than a predetermined upper limit value.

[0057] (6) In the floating structure 1 according to a sixth aspect, which is the floating structure 1 of (4) or (5), the carbon dioxide supply unit 30 feeds the boil-off gas formed by vaporization of the liquefied carbon dioxide L stored in the tank 11 into the pipe 12 and the connection pipe 50 as the carbon dioxide gas Gc.

[0058] Accordingly, by using the boil-off gas as the carbon dioxide gas Gc, the carbon dioxide gas Gc can be easily obtained on the floating structure 1.

Industrial Applicability

[0059] According to the method for transferring liquefied carbon dioxide and the floating structure according to the present disclosure, it is possible to suppress the reaction between the carbon dioxide and the moisture when the liquefied carbon dioxide is transferred, and to suppress the occurrence of corrosion inside the tank or the pipe.

Reference Signs List

[0060]

1: Ship (floating structure)
2: Hull (floating main structure)
2a: Stem
2b: Stern
3A, 3B: Side
4: Bottom
5: Upper deck
7: Superstructure
8: Cargo tank storage compartment
10: Tank facility
11: Tank
12: Pipe
12j: Connection portion
13: Loading pipe
13a: One end
13b: Other end
13j: Connection portion
14: Unloading pipe
14a: One end
14b: Other end
14j: Connection portion
15: Opening-closing valve
20: Replacement gas supply unit
21: Air dryer
22: Replacement gas supply pipe
23: Opening-closing valve
30: Carbon dioxide supply unit
50: Connection pipe
100: External facility
101: Facility side tank
102: Facility side pipe
105: Opening-closing valve
106: Opening valve
Ga: Replacement gas
Gc: Carbon dioxide gas
L: Liquefied carbon dioxide

Claims

1. A method for transferring liquefied carbon dioxide comprising:

   a step of connecting a connection pipe for connection to an external facility disposed outside a floating structure, to a pipe communicating with an inside of a tank provided in the floating structure;
   a step of feeding a replacement gas having a moisture content adjusted to be equal to or less than a predetermined upper limit value into the connection pipe and the pipe, and replacing an inside of the connection pipe and the pipe with the replacement gas;
   a step of replacing the replacement gas inside the connection pipe and the pipe with a carbon dioxide gas; and
   a step of transferring liquefied carbon dioxide between the external facility and the tank through the connection pipe and the pipe.

2. The method for transferring liquefied carbon dioxide according to Claim 1, wherein
   the replacement gas is dry air having a moisture content adjusted to be equal to or less than a predetermined upper limit value.

3. The method for transferring liquefied carbon dioxide according to Claim 1 or 2, wherein
   the carbon dioxide gas is a boil-off gas formed by vaporization of liquefied carbon dioxide stored in the tank.

4. A floating structure comprising:

   a floating main structure;
   a tank disposed in the floating main structure and capable of storing liquefied carbon dioxide;
   a pipe which communicates with an inside of the tank and to which a connection pipe for supplying liquefied carbon dioxide between an external facility and the tank is connectable;
   a replacement gas supply unit that feeds a replacement gas having a moisture content adjusted to be equal to or less than a predetermined upper limit value into the pipe and the connection pipe in a case where the connection pipe is connected to the pipe; and
   a carbon dioxide supply unit that feeds a carbon dioxide gas into the pipe and the connection pipe.

5. The floating structure according to Claim 4, wherein the replacement gas supply unit includes an air dryer that reduces an amount of moisture contained in an atmosphere taken in from an outside.

6. The floating structure according to Claim 4 or 5, wherein
   the carbon dioxide supply unit feeds a boil-off gas formed by vaporization of liquefied carbon dioxide stored in the tank into the pipe and the connection

pipe as the carbon dioxide gas.

FIG. 1

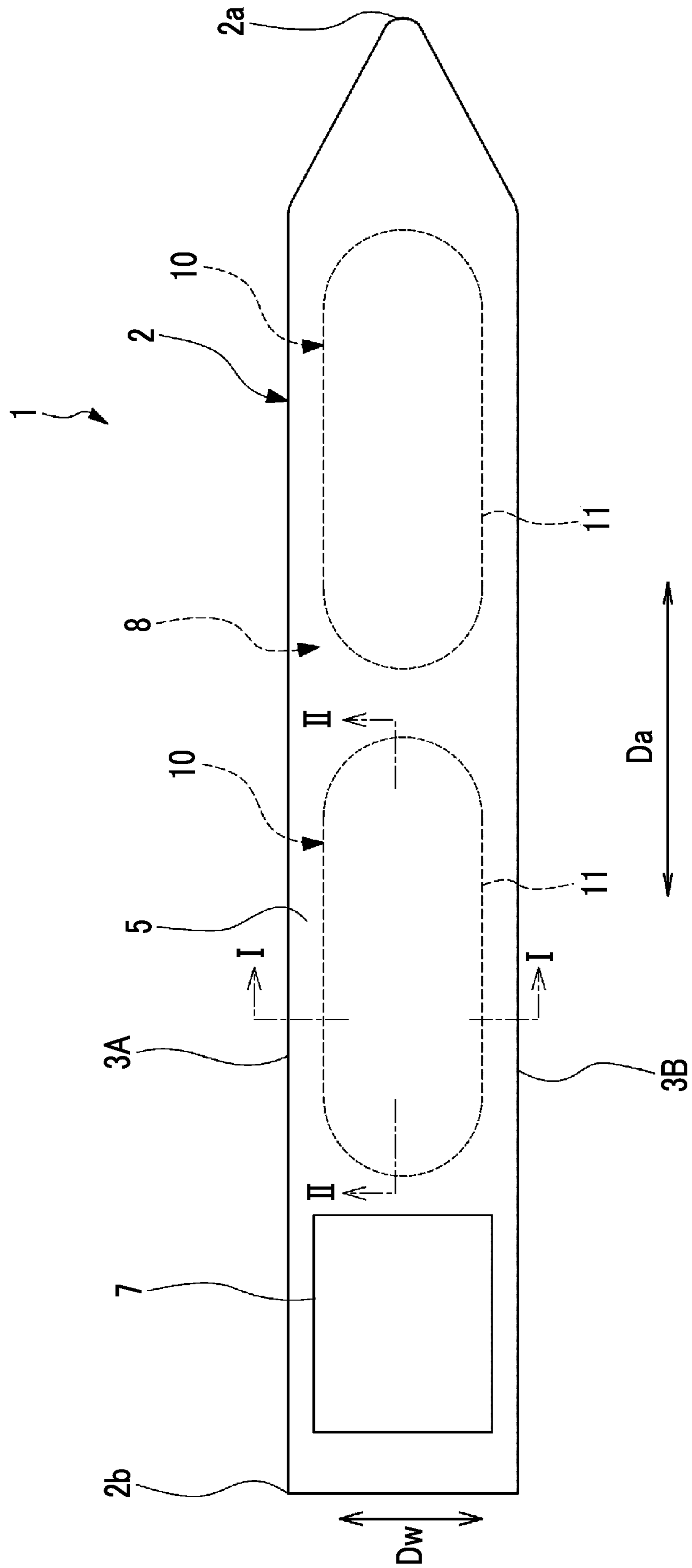


FIG. 2

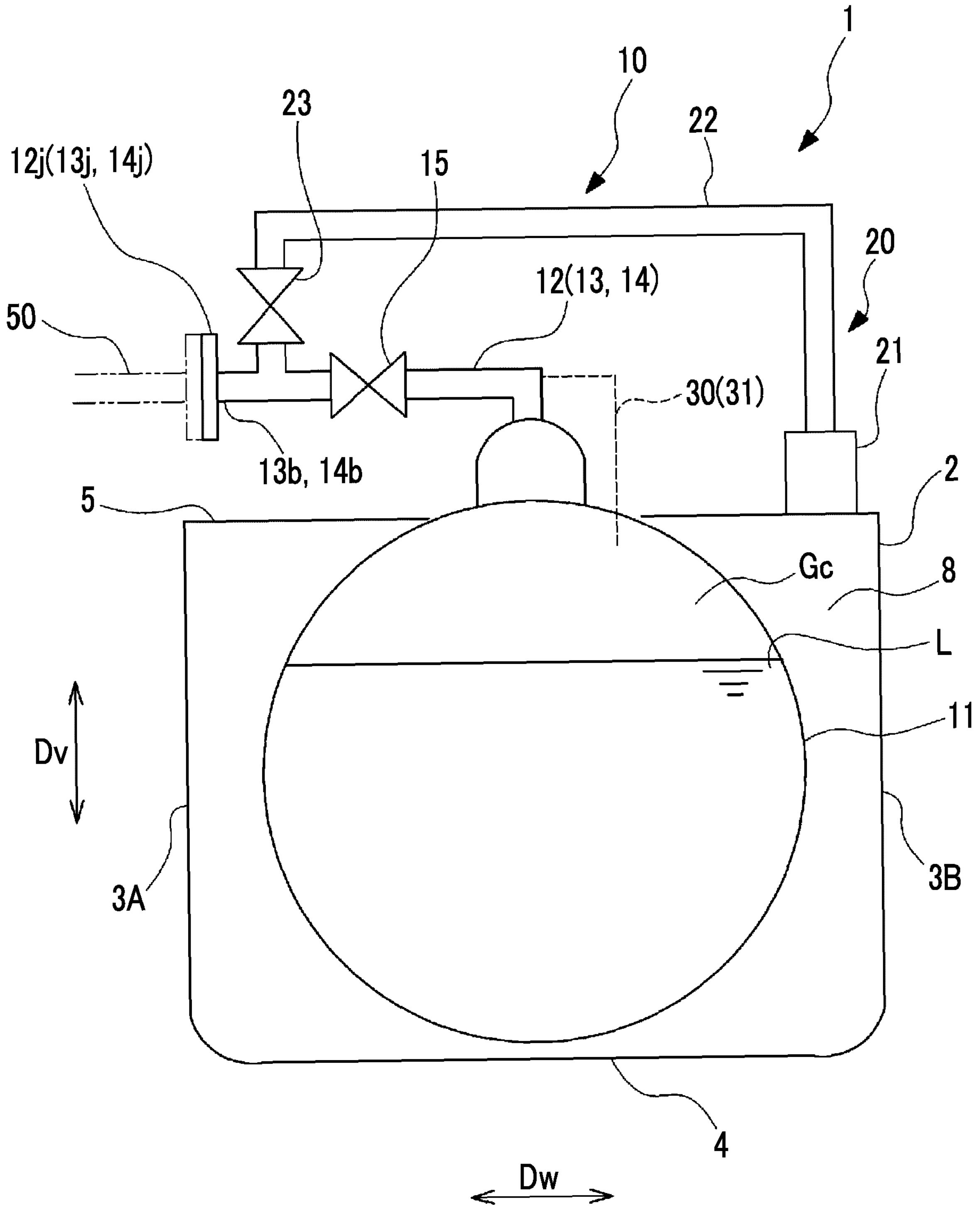

1
10
22
23
15
12j(13j, 14j)
20
12(13, 14)
50
21
30(31)
13b, 14b
2
5
Gc
8
L
11
Dv
3A
3B
4
Dw

FIG. 3

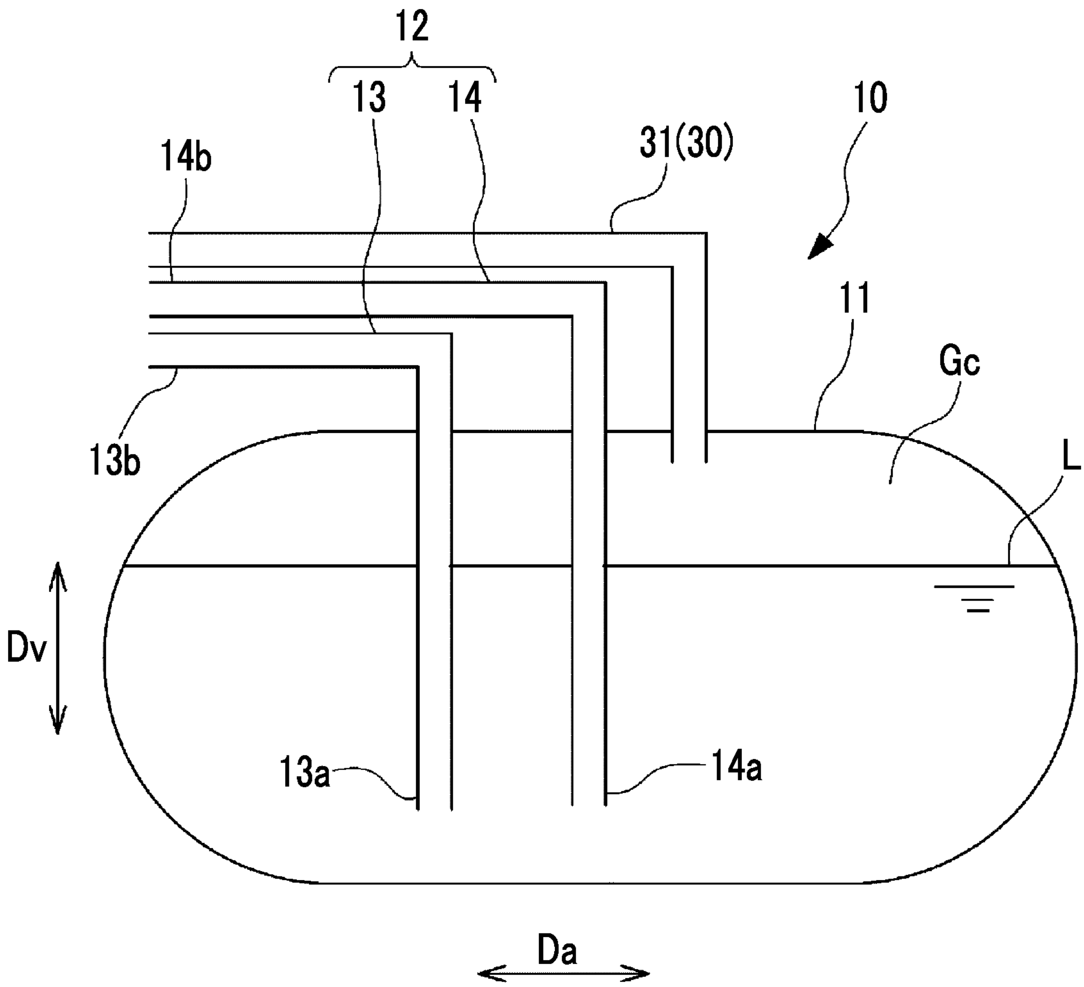


FIG. 4

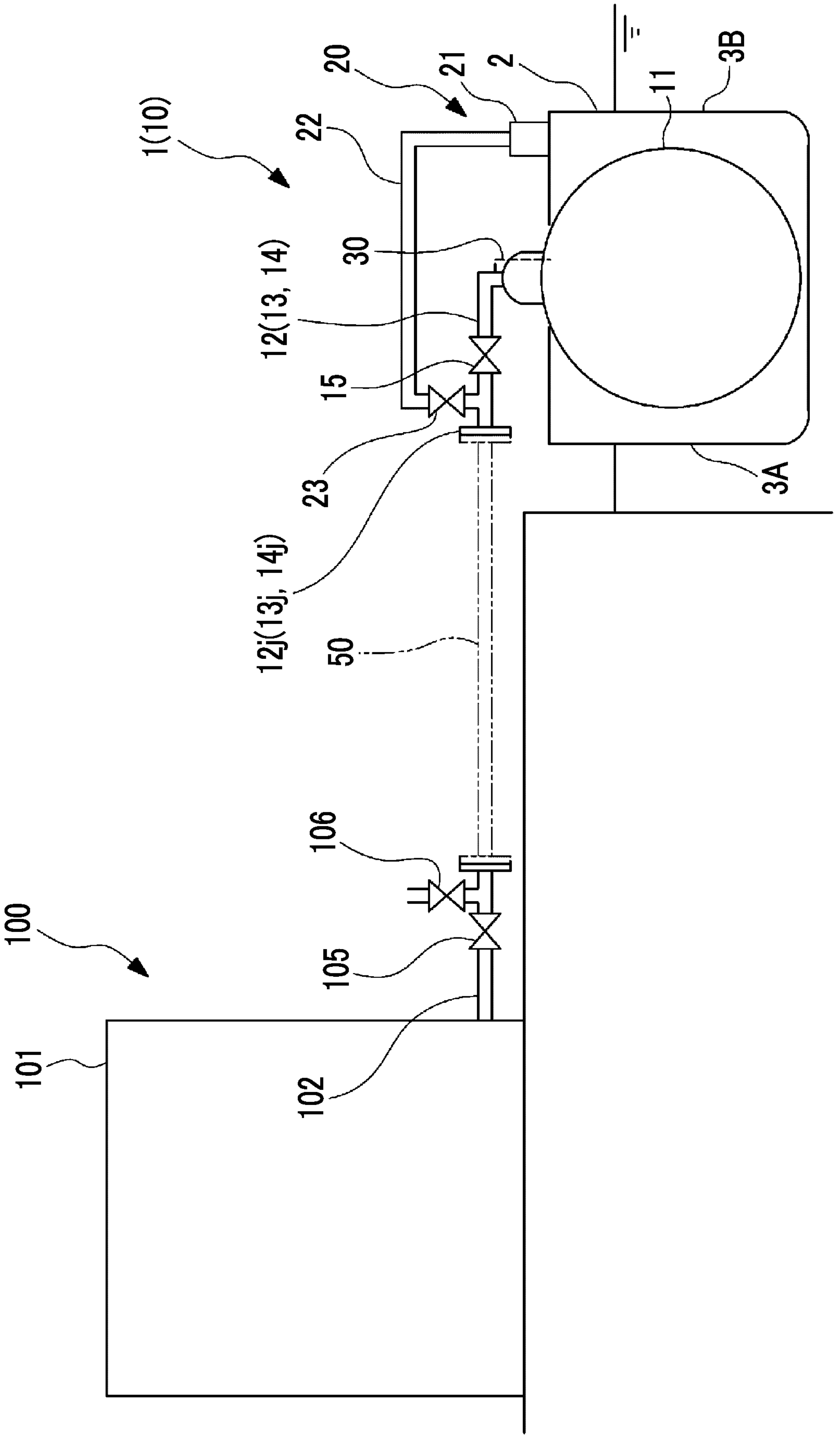

1(10)
20
21
2
3B
11
22
30
12(13, 14)
15
23
3A
12j(13j, 14j)
50
106
100
105
101
102

FIG. 5

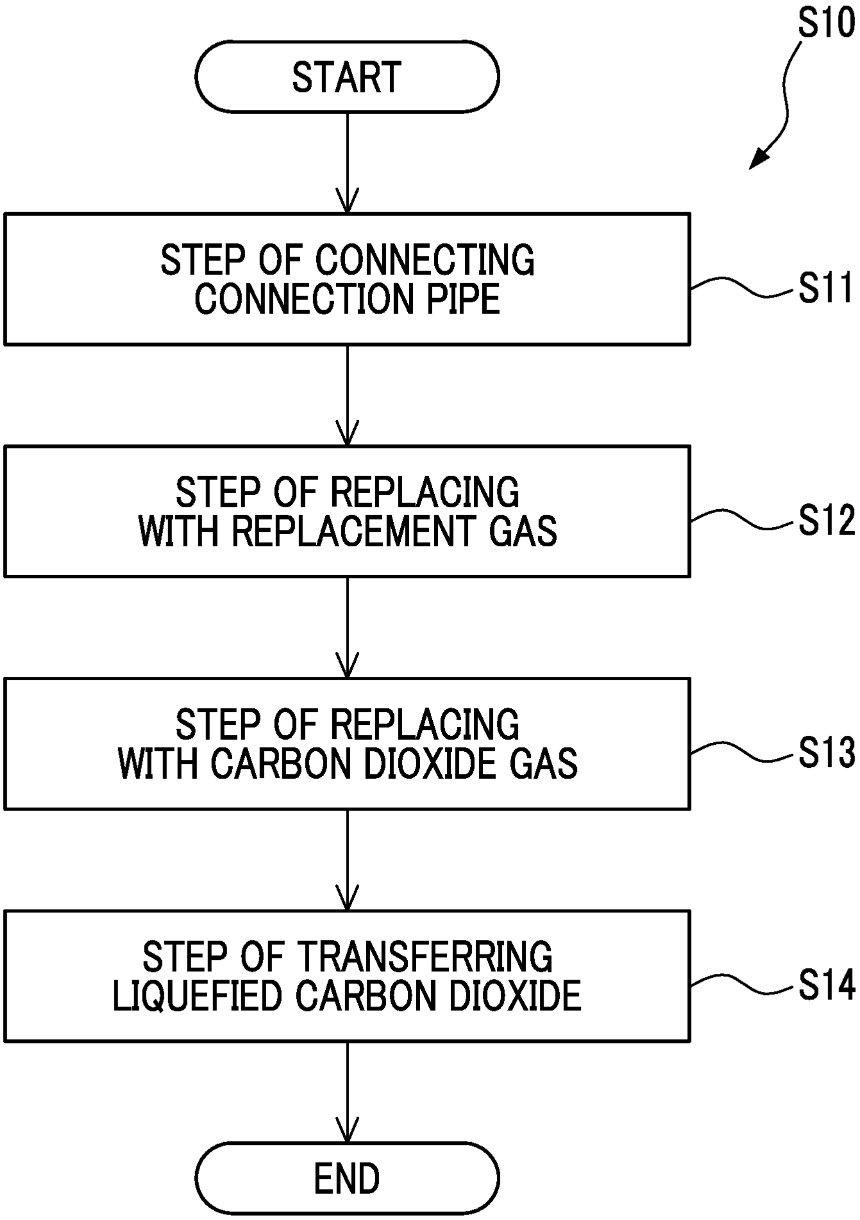
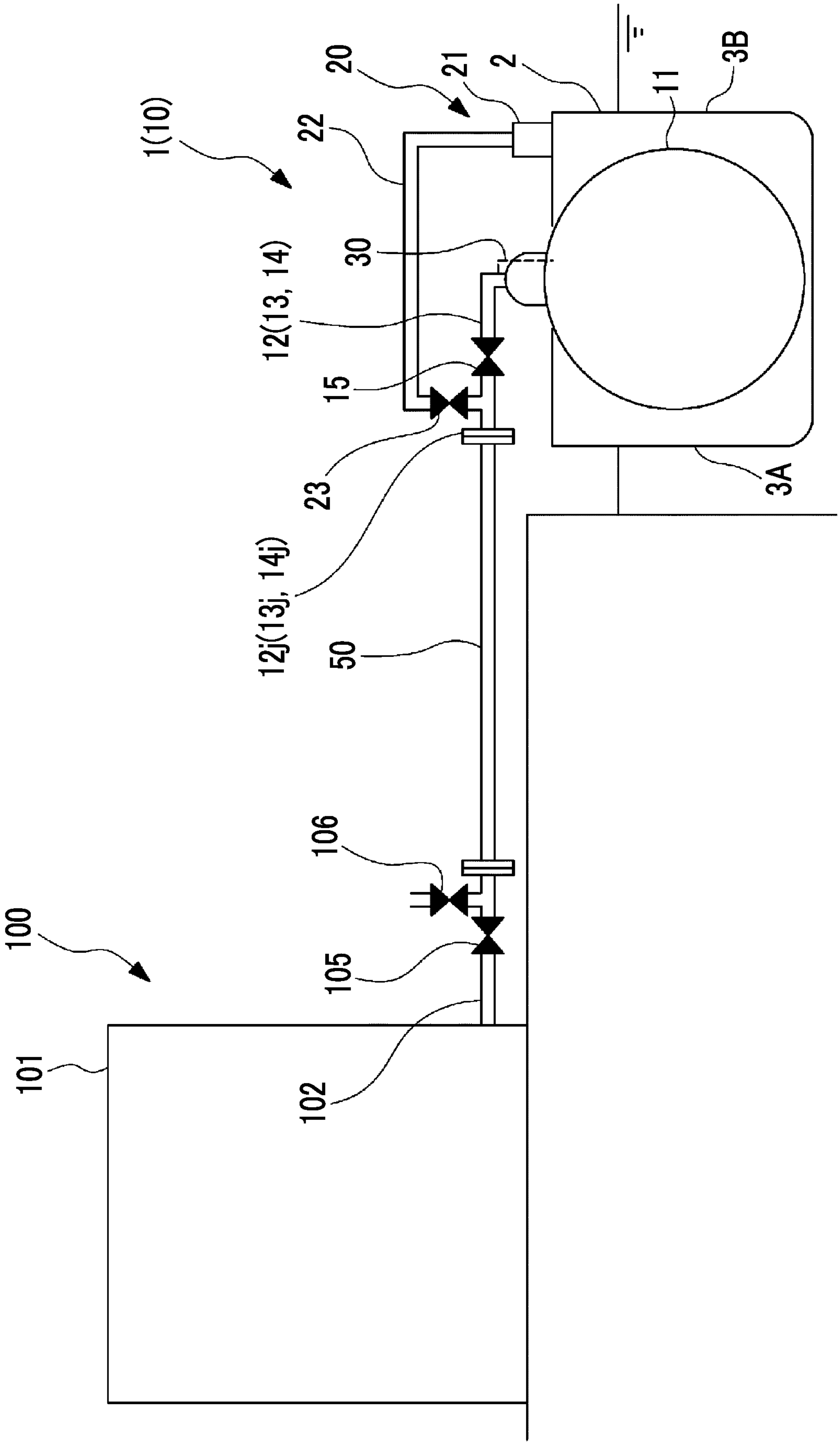

S10
START
STEP OF CONNECTING CONNECTION PIPE
S11
STEP OF REPLACING WITH REPLACEMENT GAS
S12
STEP OF REPLACING WITH CARBON DIOXIDE GAS
S13
STEP OF TRANSFERRING LIQUEFIED CARBON DIOXIDE
S14
END

FIG. 6



1(10)
20
21
2
3B
11
22
30
12(13, 14)
15
23
3A
12j(13j, 14j)
50
106
100
105
101
102

FIG. 7

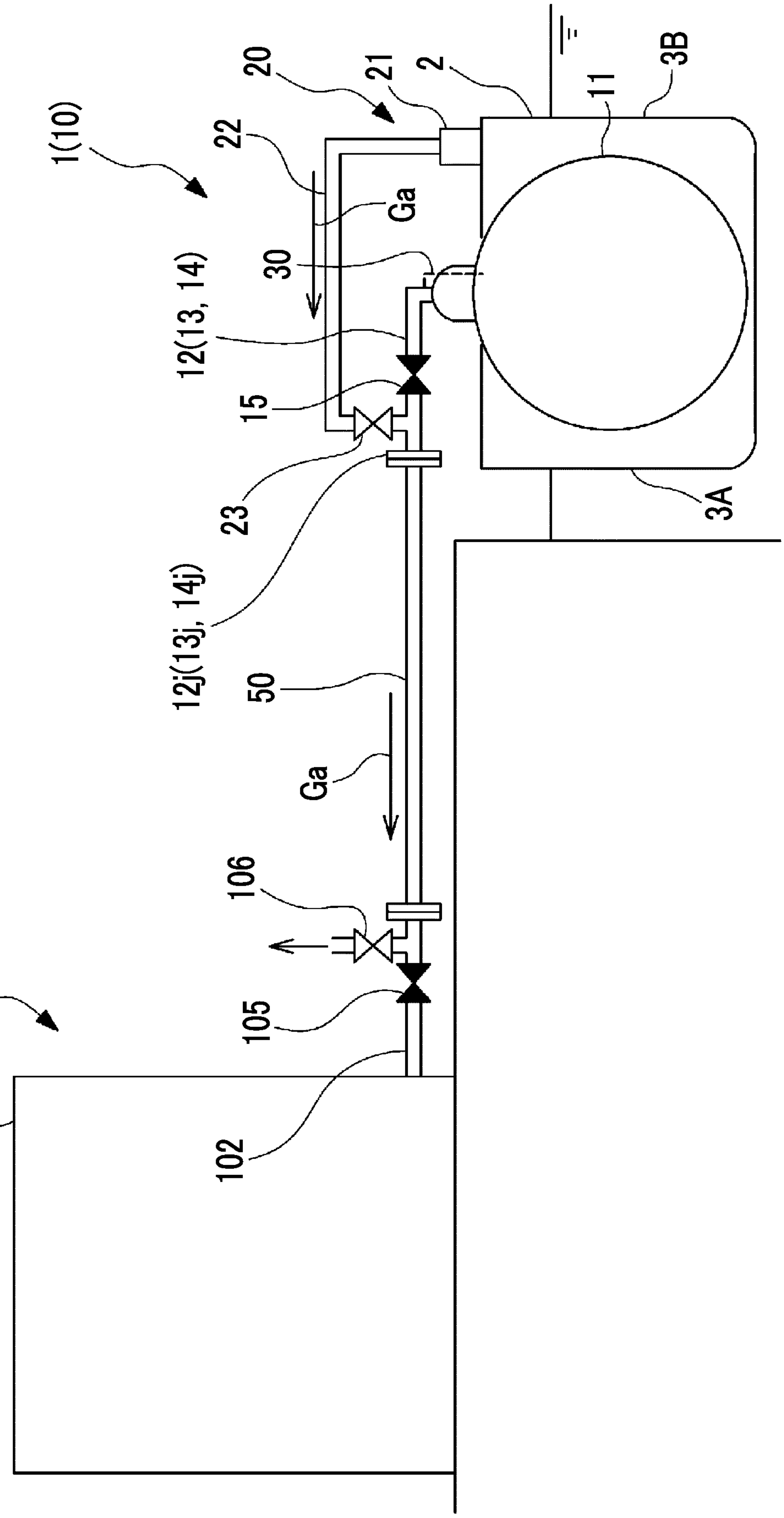

1(10)
20
21
2
3B
11
22
Ga
30
12(13, 14)
15
23
3A
12j(13j, 14j)
50
Ga
106
100
105
101
102

FIG. 8

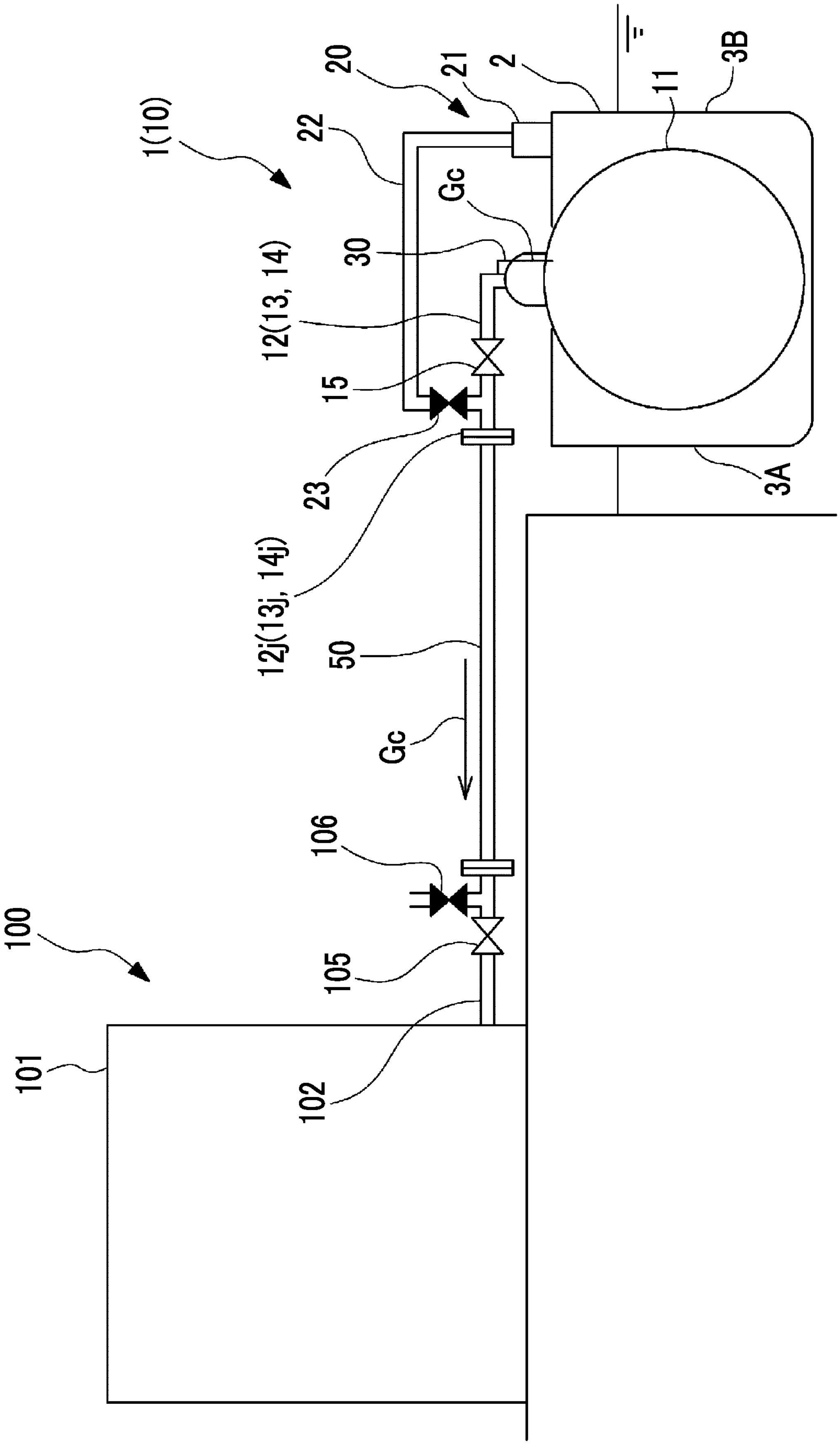
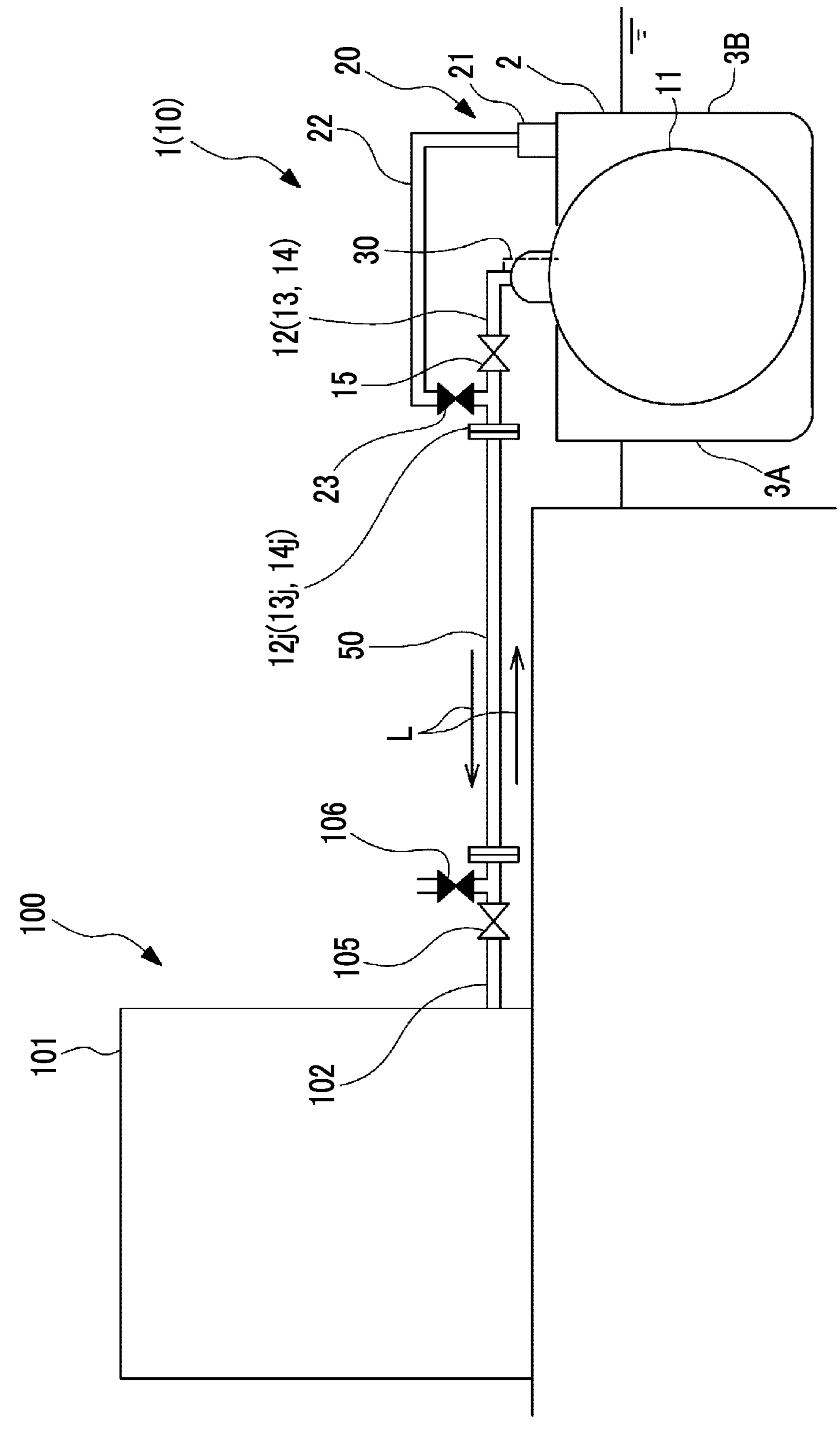

1(10)
20
21
2
11
3B
22
Gc
30
12(13, 14)
15
23
3A
12j(13j, 14j)
50
Gc
106
100
105
101
102

FIG. 9


1(10)
20
21
2
11
3B
22
30
12(13, 14)
15
23
3A
12j(13j, 14j)
50
L
106
100
105
101
102

INTERNATIONAL SEARCH REPORT

International application No. **PCT/JP2021/039858**

A. CLASSIFICATION OF SUBJECT MATTER

F17C 13/00(2006.01)i; ***B63B 25/08***(2006.01)i; ***B63B 27/24***(2006.01)i
FI: F17C13/00 302D; B63B25/08 B; B63B27/24 B; B63B27/24 D

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F17C13/00; B63B25/08; B63B27/24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2021
Registered utility model specifications of Japan 1996-2021
Published registered utility model applications of Japan 1994-2021

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-2012-0126994 A (DAEWOO SHIPBUILDING & MARINE ENGINEERING CO., LTD.) 21 November 2012 (2012-11-21) paragraphs [0001]-[0066], fig. 1	1-6
A	JP 59-173127 A (HOKKAI CAN CO., LTD.) 01 October 1984 (1984-10-01) page 2, upper right column, line 16 to page 4, lower right column, line 9, fig. 1	1-6
A	JP 2013-032839 A (NIPPON SHARYO SEIZO KK) 14 February 2013 (2013-02-14) paragraphs [0070]-[0092], fig. 6	1-6
A	JP 2002-349793 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 04 December 2002 (2002-12-04) paragraph [0046]	1-6
A	JP 2006-142238 A (MIWA SEISAKUSHO KK) 08 June 2006 (2006-06-08) paragraphs [0027], [0028], [0091]	2-3, 5-6
A	JP 2006-242350 A (TOKYO GAS CO., LTD.) 14 September 2006 (2006-09-14) claim 6	3, 6

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 December 2021	**18 January 2022**

Name and mailing address of the ISA/JP	Authorized officer
Japan Patent Office (ISA/JP) **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/039858

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
KR 10-2012-0126994 A	21 November 2012	(Family: none)	
JP 59-173127 A	01 October 1984	(Family: none)	
JP 2013-032839 A	14 February 2013	(Family: none)	
JP 2002-349793 A	04 December 2002	(Family: none)	
JP 2006-142238 A	08 June 2006	(Family: none)	
JP 2006-242350 A	14 September 2006	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2020180560 A **[0002]**
- JP 2010503132 W **[0004]**