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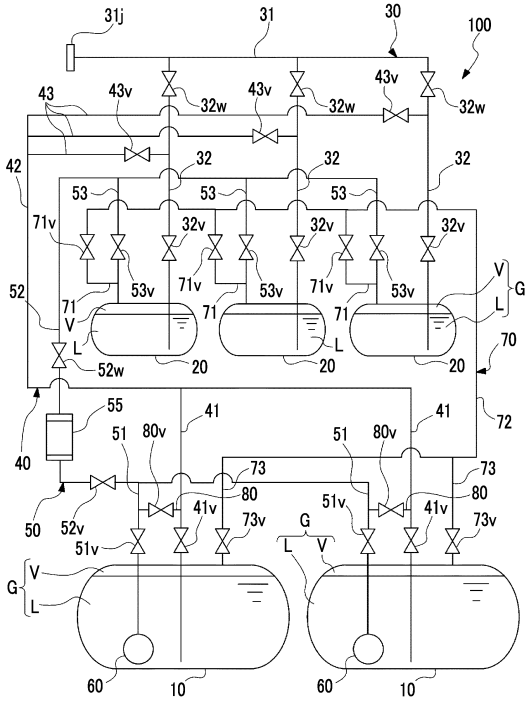
(54) **SHIP**

(57) A ship comprising: a hull having a pair of broadsides; a main tank provided inside the hull and storing liquid or gaseous cargo; a sub-tank that has less capacity than the main tank and has greater pressure resistance than the main tank; a transport line that is connected to the sub-tank and has a section for connection to outside the ship; a first line connecting the main tank and the sub-tank; a second line connecting the main tank and the sub-tank; a vaporizer that, out of the first line and the second line, is provided only in the second line, vaporizes cargo liquid which is a liquid phase of the cargo, and generates a cargo gas; and a pumping unit that selects either the first line or the second line and pumps the cargo liquid from the main tank to the sub-tank.

FIG. 2



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Description

Technical Field

[0001] The present disclosure relates to a ship.

[0002] The present application claims priority with respect to Japanese Patent Application No. 2019-229207 filed in Japan on December 19, 2019, the content of which is incorporated herein by reference.

Background Art

[0003] PTL 1 discloses using a cargo pump in discharging liquefied gas stored in a tank from the tank in a ship that carries the liquefied gas as a cargo.

Citation List

Patent Literature

[0004] [PTL 1] Japanese Patent No. 5769445

Summary of Invention

Technical Problem

[0005] In the configuration described in PTL 1, pressure for pumping the liquefied gas is applied to the pump in addition to the pressure of the liquefied gas stored in the tank. Accordingly, the pump is required to have a large pressure capacity in a case where the pressure of the liquefied gas stored in the tank is high.

[0006] The liquefied gas in the tank may be discharged by applying pressure to the gas phase in the tank from the outside of the tank. However, in this case, the pressure from the outside is applied to the tank in addition to the pressure of the liquefied gas stored in the tank. Accordingly, the tank itself is required to have a large pressure capacity in a case where the pressure of the liquefied gas stored in the tank is high.

[0007] Increasing the pressure capacity of a tank or a pump as described above leads to an increase in cost. Further, an increase in tank size is hindered by the tank itself being required to have a large pressure capacity.

[0008] The present disclosure has been made in view of the above, and an object of the present disclosure is to provide a ship in which it is possible to enable an increase in tank size while suppressing an increase in cost.

Solution to Problem

[0009] In order to achieve the above object, a ship according to the present disclosure includes a hull, a main tank, a sub tank, a transportation line, a first line, a second line, a vaporizer, and a pumping unit. The hull has a pair of broadsides. The main tank is provided in the hull. The main tank stores a liquid or gas cargo. The sub tank is smaller in capacity than the main tank and higher in pressure resistance than the main tank. The transportation line is connected to the sub tank. The transportation line has an outboard connection portion. The first line connects the main tank and the sub tank. The second line connects the main tank and the sub tank. The vaporizer is provided on the second line and is not provided on the first line. The vaporizer evaporates a cargo liquid, which is a liquid phase of the cargo, to generate a cargo gas. The pumping unit selects either the first line or the second line to pump the cargo liquid from the main tank to the sub tank. Advantageous Effects of Invention

[0010] According to the ship of the present disclosure, it is possible to enable an increase in tank size while suppressing an increase in cost.

Brief Description of Drawings

[0011]

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

Fig. 2 is a diagram illustrating the configurations of a main tank, a sub tank, and a main tank-sub tank connection pipe system provided in the ship according to the embodiment of the present disclosure.

Fig. 3 is a diagram illustrating the gas flow in a case where a cargo liquid is transferred from the main tank to the sub tank in the ship according to the embodiment of the present disclosure.

Fig. 4 is a diagram illustrating the gas flow in a case where the cargo liquid in the sub tank is discharged by a cargo gas in the ship according to the embodiment of the present disclosure.

Fig. 5 is a diagram illustrating the gas flow in a case where the sub tank is reduced in pressure and the cargo liquid is pumped by the pressure that is supplied from the sub tank in the ship according to the embodiment of the present disclosure.

Fig. 6 is a diagram illustrating the gas flow in a case where the cargo liquid is transferred from the main tank to the sub tank by the pressure that is supplied from the sub tank in the ship according to the embodiment of the present disclosure.

Description of Embodiments

[0012] Hereinafter, a ship according to an embodiment of the present disclosure will be described with reference to Figs. 1 to 6.

(Configuration of Hull of Ship)

[0013] A ship 1 of the embodiment of the present disclosure illustrated in Fig. 1 carries a fluid cargo G such as liquefied carbon dioxide. The ship 1 includes at least a hull 2, a main tank 10, a sub tank 20, and a pipe system 100 (see Fig. 2).

(Hull Configuration)

[0014] As illustrated in Fig. 1, the hull 2 has a pair of broadsides 3A and 3B, a ship bottom (not illustrated), and an exposed deck 5, which form the outer shell of the hull 2. The broadsides 3A and 3B are provided with a pair of broadside skins respectively forming the left and right broadsides. The ship bottom (not illustrated) is provided with a ship bottom skin connecting the broadsides 3A and 3B. By the pair of sides 3A and 3B and the ship bottom (not illustrated), the outer shell of the hull 2 has a U shape in a cross section orthogonal to a ship stern direction Da. The exposed deck 5 is a whole deck exposed to the outside. In the hull 2, an superstructure 7 having an accommodation space is formed on the exposed deck 5 on a stern 2b side.

[0015] In the hull 2, a cargo tank storage compartment (hold) 8 is formed closer to a bow 2a side than the superstructure 7. The cargo tank storage compartment 8 is recessed toward the ship bottom (not illustrated) below the exposed deck 5 and is open upward.

(Tank Configuration)

[0016] The main tank 10 and the sub tank 20 are disposed in the cargo tank storage compartment 8. In this embodiment, two main tanks 10 as an example are disposed in the cargo tank storage compartment 8. Three sub tanks 20 as an example are disposed in the cargo tank storage compartment 8. The main tank 10 and the sub tank 20 are not limited in any manner in terms of layout and installation number in the cargo tank storage compartment 8.

[0017] The sub tank 20 is smaller in capacity and higher in pressure resistance than the main tank 10. In other words, the sub tank 20 is a small high-pressure tank. On the other hand, the main tank 10 is a so-called large low-pressure tank larger in capacity and lower in pressure resistance than the sub tank 20.

[0018] In this embodiment, each of the main tank 10 and the sub tank 20 has, for example, a horizontally extending cylindrical shape. Stored in the main tank 10 and the sub tank 20 is a liquefied gas to be carried (hereinafter, simply referred to as the cargo G) such as liquefied carbon dioxide. A cargo liquid L, which is the liquid phase of the cargo G, is stored in the lower portions in the main tank 10 and the sub tank 20. A cargo gas V, which is the gas phase of the cargo G resulting from the evaporation of the cargo liquid L or the like, is stored in the upper portions in the main tank 10 and the sub tank 20. The main tank 10 and the sub tank 20 are not limited to cylindrical tanks and may be spherical.

(Configuration of Pipe System)

[0019] As illustrated in Fig. 2, the pipe system 100 includes a transportation line 30, a first line 40, a second line 50, a vaporizer 55, a pumping unit 60, and a pressurizing line 70.

(Configuration of Transportation Line)

[0020] The transportation line 30 is connected to the sub tank 20. The transportation line 30 includes an external connection pipe 31 and sub tank connection pipes 32.

[0021] The external connection pipe 31 has an outboard connection portion 31j at one end thereof. The connection portion 31j has a flange or the like, and a delivery pipe (not illustrated) for sending out the cargo G (cargo liquid L) to an outboard liquefied gas storage facility or the like is detachably connected.

[0022] The sub tank connection pipes 32 are respectively connected to the sub tanks 20. Each sub tank connection pipe 32 branches (or merges) from the external connection pipe 31 and reaches the inside of the sub tank 20. The lower end of each sub tank connection pipe 32 is open to the lower portion in the sub tank 20. Each sub tank connection pipe 32 is provided with two opening-closing valves 32v and 32w, which are at an interval in the axis direction of the pipe.

(Configuration of First line)

[0023] The first line 40 connects the main tank 10 and the sub tank 20 (in this embodiment, the sub tank connection pipe 32). The first line 40 includes first main tank connection pipes 41, a first merging pipe 42, and first branch pipes 43.

[0024] The first main tank connection pipe 41 is provided in each main tank 10. Each first main tank connection pipe 41 reaches the inside of the main tank 10 from the outside of the main tank 10. The lower end of the first main tank connection pipe 41 is open to the lower portion in the main tank 10. Each first main tank connection pipe 41 is provided with an opening-closing valve 41v outside the main tank 10.

[0025] The plurality of first main tank connection pipes 41 connected to the main tanks 10 are connected to the first merging pipe 42. As a result, in this embodiment, the two first main tank connection pipes 41 extending from the two main tanks 10 are connected to one end side of the first merging pipe 42.

[0026] The first branch pipe 43 is equal in number to the sub tank 20. In this embodiment, three first branch pipes 43 are provided. Each first branch pipe 43 branches and extends from the other end side of the first merging pipe 42. The first branch pipes 43 are connected to the sub tank connection pipes 32 extending from the sub tanks 20. Specifically, each first branch pipe 43 is connected to the intermediate portion between the opening-closing valve 32v and the opening-closing valve 32w on the sub tank connection pipe 32. Each first branch pipe 43 is provided with an opening-closing valve 43v.

[0027] The first line 40 communicates with the inside of the main tank 10 and the inside of the sub tank 20

when the opening-closing valves 41v, 43v, and 32v are open. The first branch pipe 43 may be directly connected to the sub tank 20 without being connected to the sub tank connection pipe 32. In Fig. 2, every opening-closing valve is illustrated in white. In Figs. 3 to 6, the opening-closing valve that is open is illustrated in white and the opening-closing valve that is closed is illustrated in black.

(Configuration of Second line)

[0028] The second line 50 connects the main tank 10 and the sub tank 20. The second line 50 includes second main tank connection pipes 51, a second merging pipe 52, and second branch pipes 53.

[0029] The second main tank connection pipes 51 are respectively connected to the main tanks 10. Each second main tank connection pipe 51 reaches the inside of the main tank 10 from the outside of the main tank 10. Each second main tank connection pipe 51 is provided with an opening-closing valve 51v outside the main tank 10.

[0030] The second main tank connection pipes 51 extending from the main tanks 10 are connected to the second merging pipe 52. In other words, in this embodiment, two second main tank connection pipes 51 extending from two main tanks 10 are merged and connected to one end side of one second merging pipe 52.

[0031] The second branch pipe 53 is equal in number to the sub tank 20. In this embodiment, three second branch pipes 53 are provided. Each second branch pipe 53 branches and extends from the other end side of the second merging pipe 52. The second branch pipes 53 are respectively connected to the sub tanks 20. The lower end of each second branch pipe 53 is open to the upper portion in the sub tank 20 (for example, uppermost end portion). Each second branch pipe 53 is provided with an opening-closing valve 53v.

(Configuration of Vaporizer)

[0032] The vaporizer 55 is provided on the second line 50 and is not provided on the first line 40. Exemplified in this embodiment is a case where the vaporizer 55 is provided on the second merging pipe 52 of the second line 50. The vaporizer 55 generates the cargo gas V by vaporizing the cargo liquid L flowing in the second line 50 (adiabatic expansion). The vaporizer 55 evaporates the cargo liquid L by using seawater collected from the outside of the ship, steam generated in the hull 2, or the like as a heat source. Opening-closing valves 52v and 52w are provided in front of and behind the vaporizer 55 on the second merging pipe 52.

[0033] The second line 50 communicates with the inside of the main tank 10 and the inside of the sub tank 20 when the opening-closing valves 51v, 52v, 52w, and 53v are open.

(Configuration of Pumping Unit)

[0034] The pumping unit 60 sends out the cargo liquid L stored in the main tank 10 to the second main tank connection pipe 51. A pump such as a rotary pump can be used as the pumping unit 60. The pumping unit 60 is connected to the second main tank connection pipe 51 of the second line 50. More specifically, the pumping unit 60 is provided at the lower end of the second main tank connection pipe 51 in the main tank 10. The pumping unit 60 suctions up the cargo liquid L in the main tank 10 and pumps the cargo liquid L.

[0035] A connection line 80 is provided between the first line 40 and the second line 50. The connection line 80 connects the first line 40 and the second line 50. One end of the connection line 80 in this embodiment is connected to the second main tank connection pipe 51 between the pumping unit 60 and the vaporizer 55 on the second line 50. More specifically, one end of the connection line 80 is connected to the second main tank connection pipe 51 between the opening-closing valve 51v and the opening-closing valve 52v. The other end of the connection line 80 is connected to the first main tank connection pipe 41 of the first line 40. The other end of the connection line 80 is connected to the first main tank connection pipe 41 on a side closer to the sub tank 20 than the opening-closing valve 41v. The connection line 80 is provided with an opening-closing valve 80v, and it is possible to switch between communication and non-communication between the second main tank connection pipe 51 and the first main tank connection pipe 41 (connectable and disconnectable).

(Configuration of Pressurizing Line)

[0036] The pressurizing line 70 connects the main tank 10 and the sub tank 20 so as to be capable of communicating with each other. By this pressurizing line 70, the upper portion in the sub tank 20 and the upper portion in the main tank 10 are capable of communicating with each other. The pressurizing line 70 includes sub tank side pressurizing pipes 71, a pressurizing merging pipe 72, and main tank side pressurizing pipes 73.

[0037] The sub tank side pressurizing pipe 71 is equal in number to the sub tank 20. In other words, in this embodiment, three sub tank side pressurizing pipes 71 are provided. Each sub tank side pressurizing pipe 71 in this embodiment branches from the second branch pipe 53. More specifically, each sub tank side pressurizing pipe 71 is connected to the second branch pipe 53 between the sub tank 20 and the opening-closing valve 53v. Each sub tank side pressurizing pipe 71 is provided with an opening-closing valve 71v. The sub tank side pressurizing pipe 71 may be directly connected to the sub tank 20 instead of the second branch pipe 53.

[0038] Each sub tank side pressurizing pipe 71 is connected to the pressurizing merging pipe 72. In other words, in this embodiment, three sub tank side pressu-

rizing pipes 71 extending from three sub tanks 20 are merged and connected to one end side of one pressurizing merging pipe 72.

[0039] The main tank side pressurizing pipe 73 is equal in number to the main tank 10. In other words, in this embodiment, two main tank side pressurizing pipes 73 are provided. Each main tank side pressurizing pipe 73 branches from the other end side of the pressurizing merging pipe 72. The main tank side pressurizing pipes 73 are respectively connected to the main tanks 10. The lower end of each main tank side pressurizing pipe 73 is open to the upper portion in the sub tank 20 (for example, uppermost end portion). Each main tank side pressurizing pipe 73 is provided with an opening-closing valve 73v outside the main tank 10.

[0040] In the ship 1, by the pipe system 100 being provided as described above, two or more (three in this embodiment) sub tanks 20 are connected to one main tank 10 via the first line 40, the second line 50, and the pressurizing line 70. In addition, two or more (two in this embodiment) main tanks 10 are connected to each of the sub tanks 20 via the first line 40, the second line 50, and the pressurizing line 70.

(Cargo Liquid Transfer from Main Tank to Sub Tank)

[0041] As illustrated in Fig. 3, when the cargo liquid L in the main tank 10 is sent out to the second main tank connection pipe 51 by the pumping unit 60 with the opening-closing valves 51v and 80v open and the opening-closing valves 41v and 52v closed, the cargo liquid L flows into the first line 40 via the second main tank connection pipe 51 and the connection line 80. Then, this cargo liquid L is sent to the sub tank 20 side as it is through the first line 40.

[0042] On the sub tank 20 side, on condition that the opening-closing valves 43v and 32v are opened and the opening-closing valve 32w is closed, the cargo liquid L sent through the first line 40 can be supplied into the sub tank 20. As a result, the cargo liquid L in the main tank 10 can be moved into the sub tank 20 with its liquid state maintained.

[0043] By closing the opening-closing valve 43v, it is possible to block the cargo liquid L sent through the first line 40 from being supplied into the sub tank 20. As a result, it is possible to transfer the cargo liquid L from the main tank 10 to a part of the sub tanks 20 without transferring the cargo liquid L to the rest.

[0044] Although the cargo liquid L is transferred from one main tank 10 to two sub tanks 20 in the example illustrated in Fig. 3, the cargo liquid L may be moved to one sub tank 20 or to every sub tank 20.

(Discharge of Cargo Liquid in Sub Tank by Cargo Gas)

[0045] As illustrated in Fig. 4, when the cargo liquid L in the main tank 10 is sent out to the second main tank connection pipe 51 by the pumping unit 60 with the opening-closing valves 51v, 52v, and 52w open and the opening-closing valves 41v and 80v closed, the cargo liquid L is sent to the sub tank 20 side through the second line 50. The cargo liquid L is vaporized by the vaporizer 55 provided on the second merging pipe 52, and the cargo gas V is generated. The generated cargo gas V is sent to the sub tank 20 side through the second line 50.

[0046] On the sub tank 20 side, on condition that the opening-closing valve 53v is opened, the cargo gas V sent through the first line 40 is introduced into the sub tank 20.

[0047] The volume of the cargo gas V generated from the cargo liquid L considerably increases as compared with the state where the cargo liquid L is yet to become the cargo gas V. The pressure in the sub tank 20 increases when the cargo gas V is introduced into the sub tank 20. As a result, the cargo liquid L is pushed out of the sub tank 20 and discharged to the outside of the ship through the transportation line 30.

[0048] Here, by closing the opening-closing valve 53v, it is possible to block the cargo gas V sent through the first line 40 from being introduced into the sub tank 20. As a result, it is possible to achieve a configuration in which the cargo gas V from the main tank 10 is introduced into a part of the sub tanks 20 without being transferred to the rest.

[0049] Although the cargo gas V is sent into two sub tanks 20 from one main tank 10 in the example illustrated in Fig. 4, the cargo gas V may be discharged from the sub tank 20 after the cargo gas V is sent into one sub tank 20 or every sub tank 20 (that is, three or more sub tanks 20).

(Sub Tank Pressure Reduction)

[0050] After the cargo liquid L in the sub tank 20 is discharged as described above, the cargo gas V remains in the sub tank 20. In the sub tank 20, a high-pressure state is maintained by the cargo gas V. With the pressure in the sub tank 20 higher than the pressure in the main tank 10 as described above, the opening-closing valves 71v and 73v are opened and the opening-closing valves 32v and 52v are closed as illustrated in Fig. 5. Then, the upper portion in the sub tank 20 and the upper portion in the main tank 10 communicate with each other via the pressurizing line 70, and the cargo gas V in the sub tank 20 flows into the main tank 10. As a result, the inside of the sub tank 20 can be reduced in pressure.

(Cargo Liquid Pumping by Pressure Supplied from Sub Tank)

[0051] When the cargo gas V in the sub tank 20 flows into the main tank 10 by the sub tank 20 being depressurized as described above, the pressure of the gas phase in the main tank 10 (cargo gas V) increases. Then, the pressurized cargo gas V pushes down the cargo liquid L positioned below the cargo gas V in the main tank 10.

[0052] At this time, in a case where the cargo gas V is generated by the cargo liquid L pumped by the pumping unit 60 being vaporized by the vaporizer 55 as in Fig. 4, the generated cargo gas V is sent into the sub tank 20 that is not in the process of depressurization as illustrated in Fig. 5. Then, the cargo liquid L in the sub tank 20 into which the cargo gas V is sent is pressurized and the cargo liquid L can be discharged to the outside of the ship.

[0053] In this case, by using the pressure of the cargo gas V from the sub tank 20 reduced in pressure, the pressure applied to the cargo liquid L by the pumping unit 60 is smaller than in a case where the pumping unit 60 performs pumping alone.

(Cargo Liquid Transfer from Main Tank to Sub Tank by Pressure Supplied from Sub Tank)

[0054] In addition, as illustrated in Fig. 6, the cargo gas V may be sent from the sub tank 20 in the process of depressurization into the other main tank 10 (main tank 10 on the right side in Fig. 6) that is not the main tank 10 (main tank 10 on the left side in Fig. 6) in the process of discharge of the sub tank 20 by the pumping unit 60. To this end, the opening-closing valves 71v, 73v, 41v, and 43v are opened in the other main tank 10. Then, in the other main tank 10, the pressure of the cargo gas V flowing from the inside of the sub tank 20 into the main tank 10 pushes down the cargo liquid L positioned below the cargo gas V in the main tank 10. As a result, the cargo liquid L is sent out through the first line 40 from the main tank 10. After being sent out, the cargo liquid L is sent into the other sub tank 20 (left side in Fig. 6) that is not the sub tank 20 (sub tank 20 at the center in the left-right direction in Fig. 6) in the process of depressurization and the sub tank 20 (sub tank 20 on the right side in Fig. 6) in the process of pumping by the pumping unit 60.

(Action and Effect)

[0055] The ship 1 of the above embodiment includes the hull 2, the main tank 10, the sub tank 20, the transportation line 30, the first line 40, the second line 50, the vaporizer 55, and the pumping unit 60. Further, the sub tank 20 is smaller in capacity and higher in pressure resistance than the main tank 10. The first line 40 connects the main tank 10 and the sub tank 20. The second line 50 connects the main tank 10 and the sub tank 20. The vaporizer 55 is provided on the second line 50 and is not provided on the first line 40. The vaporizer 55 evaporates the cargo liquid L, which is the liquid phase of the cargo G, to generate the cargo gas V. The pumping unit 60 selects either the first line 40 or the second line 50 and pumps the cargo liquid L from the main tank 10 to the sub tank 20.

[0056] With this configuration, on condition that the cargo liquid L is pumped from the main tank 10 to the sub tank 20 through the second line 50 by the pumping unit 60, the pumped cargo liquid L is evaporated by the vaporizer 55 and the cargo gas V is generated. Then, the pressure in the sub tank 20 increases when the cargo gas V generated by the vaporizer 55 is sent from the second line 50 into the sub tank 20. As a result, the cargo liquid L in the sub tank 20 is pushed out and discharged to the outside of the ship through the transportation line 30. Since the cargo liquid L in the sub tank 20 is discharged by the pressure of the cargo gas V pumped from the main tank 10 side in this manner, the cargo liquid L can be pumplessly discharged from the sub tank 20.

[0057] In addition, the sub tank 20 is smaller in capacity than the main tank 10. Accordingly, even if the sub tank 20 is highly pressure-resistant to the pressure of the cargo gas V, pressure resistance can be easily ensured and low-cost manufacturing can be performed as compared with enhancing the pressure resistance of the large-capacity main tank 10 to the same level. On the other hand, since the main tank 10 is lower in pressure resistance than the sub tank 20, it is possible to easily realize an increase in the size of the main tank 10. In addition, the pumping unit 60 only pumps the cargo liquid L for generating the cargo gas V by vaporization by means of the vaporizer 55. Accordingly, the pumping capacity required for the pumping unit 60 is smaller than in a case where the cargo liquid L is directly discharged from the main tank 10 to the outside of the ship. As a result, the pumping unit 60 can be reduced in cost.

[0058] In addition, when the cargo liquid L is pumped from the main tank 10 to the sub tank 20 through the first line 40 by the pumping unit 60, the pumped cargo liquid L is sent into the sub tank 20 with its liquid state maintained. As a result, the cargo liquid L stored in the main tank 10 can be transferred to the sub tank 20. The cargo liquid L transferred to the sub tank 20 is discharged by the pressure of the cargo gas V pumped from the main tank 10 side as described above. In other words, it is possible to discharge the entire amount of the cargo liquid L in the main tank 10 and the sub tank 20 by sequentially repeating the transfer of the cargo liquid L from the main tank 10 to the sub tank 20 and the discharge of the cargo liquid L from the sub tank 20 by the pressure of the cargo gas V pumped from the main tank 10 side.

[0059] Accordingly, by means of the ship 1, it is possible to enable an increase in tank size while suppressing a rise in cost.

[0060] The ship 1 of the above embodiment further includes the pressurizing line 70 that connects the upper portion in the sub tank 20 and the upper portion in the main tank 10 and pressurizes the inside of the main tank 10 by the pressure in the sub tank 20.

[0061] As a result, when the upper portion in the sub tank 20 and the upper portion in the main tank 10 communicate with each other via the pressurizing line 70, the gas phase in the main tank 10 (cargo gas V) is pressurized by the pressure in the sub tank 20. Then, the cargo liquid L positioned in the lower portion in the main tank 10 is pressurized by the pressurized cargo gas V, and the cargo liquid L can be transferred from the main tank

10 to the sub tank 20 through the first line 40 and the second line 50. In addition, as a result, it is possible to reduce the pressure of the cargo gas V in the sub tank 20.

[0062] In the ship 1 of the above embodiment, two or more sub tanks 20 are connected to one main tank 10 via the first line 40, the second line 50, and the pressurizing line 70.

[0063] As a result, it is possible to transfer the cargo liquid L from the main tank 10 by the pumping unit 60 and send in the cargo gas V through the vaporizer 55 with respect to the other sub tank 20 while pressurizing the inside of the main tank 10 by the pressure of the cargo gas V in the sub tank 20 in a part of the sub tanks 20.

[0064] In addition, when the cargo liquid L is pumped by the pumping unit 60 while pressurizing the main tank 10 by the pressure of the cargo gas V in the sub tank 20, the pressure applied to the cargo liquid L by the pumping unit 60 can be reduced as compared with a case where the pumping unit 60 performs pumping alone. As a result, less energy is required to operate the pumping unit 60.

[0065] In the ship 1 of the above embodiment, three or more sub tanks 20 are provided, and the main tanks 10 are connected to each of the sub tanks 20 via the first line 40, the second line 50, and the pressurizing line 70. In such a configuration, by pressurizing the main tank 10 with the pressure in one of the three or more sub tanks 20, it is possible to generate the cargo gas V while transferring the cargo liquid L to another of the sub tanks 20 and discharge the cargo liquid L in the other sub tank 20 to the outside of the ship through the transportation line 30.

[0066] In this manner, different processes can be performed in parallel in the sub tanks 20. As a result, the cargo liquid L stored in the main tank 10 and the sub tank 20 can be efficiently discharged to the outside of the ship.

[0067] The ship 1 of the above embodiment further includes the connection line 80 that disconnectably connects the first line 40 and the second line 50.

[0068] As a result, the cargo liquid L pumped by the pumping unit 60 can be sent out with either the first line 40 or the second line 50 selected.

(Other Embodiments)

[0069] Although an embodiment of the present disclosure has been described in detail with reference to the drawings, the specific configuration is not limited to this embodiment and also includes, for example, design changes within the gist of the present disclosure.

[0070] Although two main tanks 10 and three sub tanks 20 are provided in the above embodiment, the number of the main tanks 10 may be two or more and the number of the sub tanks may be three or more. In addition, although it may be impossible to execute the different processes in parallel, the main tank 10 and the sub tank 20 may be provided one by one.

[0071] In addition, the procedure for discharging the cargo liquid L illustrated in the above embodiment is merely an example and can be changed as appropriate.

[0072] <Additional Notes>

[0073] The ship 1 described in the embodiment is, for example, grasped as follows.

(1) A ship 1 according to a first aspect includes: a hull 2 having a pair of broadsides 3A and 3B; a main tank 10 provided in the hull 2 and storing a liquid or gas cargo G; a sub tank 20 smaller in capacity than the main tank 10 and higher in pressure resistance than the main tank; a transportation line 30 connected to the sub tank 20 and having an outboard connection portion 31j; a first line 40 connecting the main tank 10 and the sub tank 20; a second line 50 connecting the main tank 10 and the sub tank 20; a vaporizer 55 provided on the second line 50, not provided on the first line 40, and evaporating a cargo liquid L, which is a liquid phase of the cargo G, to generate a cargo gas V; and a pumping unit 60 selecting either the first line 40 or the second line 50 and pumping the cargo liquid L from the main tank 10 to the sub tank 20.

[0074] An example of the pumping unit 60 is a pump.

[0075] As for the ship 1, when the cargo liquid L is pumped from the main tank 10 to the sub tank 20 through the second line 50 by the pumping unit 60, the pumped cargo liquid L is evaporated by the vaporizer 55 and the cargo gas V is generated. The volume of the cargo gas V generated from the cargo liquid L considerably increases as compared with the state where the cargo liquid L is yet to become the cargo gas V. The pressure in the sub tank 20 increases when the cargo gas V is sent into the sub tank 20 from the second line 50. As a result, the cargo liquid L in the sub tank 20 is pushed out and discharged to the outside of the ship through the transportation line 30.

[0076] In this manner, the cargo liquid L in the sub tank 20 is discharged by the pressure of the cargo gas V pumped from the main tank 10 side, and thus the cargo liquid L can be pumplessly discharged from the sub tank 20. In addition, the sub tank 20 is smaller in capacity than the main tank 10. Accordingly, even if the sub tank 20 is highly pressure-resistant to the pressure of the cargo gas V, pressure resistance can be easily ensured and low-cost manufacturing can be performed as compared with enhancing the pressure resistance of the large-capacity main tank 10 to the same level. On the other hand, since the main tank 10 is lower in pressure resistance than the sub tank 20, it is possible to easily realize an increase in the size of the main tank 10. In addition, the pumping unit 60 only pumps the cargo liquid L for generating the cargo gas V by vaporization by means of the vaporizer 55. Accordingly, the pumping capacity required for the pumping unit 60 is smaller than in a case where the cargo liquid L is directly discharged from the main tank 10 to the outside of the ship. As a result, the pumping unit 60 can be reduced in cost.

[0077] In addition, when the cargo liquid L is pumped from the main tank 10 to the sub tank 20 through the first line 40 by the pumping unit 60, the pumped cargo liquid L is sent into the sub tank 20 with its liquid state maintained. As a result, the cargo liquid L stored in the main tank 10 can be transferred to the sub tank 20. The cargo liquid L transferred to the sub tank 20 is discharged by the pressure of the cargo gas V pumped from the main tank 10 side as described above. In other words, it is possible to discharge the entire amount of the cargo liquid L in the main tank 10 and the sub tank 20 by sequentially repeating the transfer of the cargo liquid L from the main tank 10 to the sub tank 20 and the discharge of the cargo liquid L from the sub tank 20 by the pressure of the cargo gas V pumped from the main tank 10 side.

[0078] Accordingly, by means of the ship 1, it is possible to enable an increase in tank size while suppressing a rise in cost.

[0079] (2) The ship 1 according to a second aspect, which is the ship 1 of (1), further includes a pressurizing line 70 connecting an upper portion in the sub tank 20 and an upper portion in the main tank 10 and pressurizing an inside of the main tank 10 by pressure in the sub tank 20.

[0080] When the upper portion in the sub tank 20 and the upper portion in the main tank 10 communicate with each other via the pressurizing line 70 in this manner, the inside of the main tank 10 is pressurized by the pressure in the sub tank 20. Then, the cargo liquid L positioned in the lower portion in the main tank 10 is pressurized by the pressurized cargo gas V, and the cargo liquid L can be transferred from the main tank 10 to the sub tank 20 through the first line 40 and the second line 50. In addition, as a result, it is possible to reduce the pressure of the cargo gas V in the sub tank 20.

[0081] (3) In the ship 1 according to a third aspect, which is the ship 1 of (2), a plurality of the sub tanks 20 are connected to one main tank 10 via the first line 40, the second line 50, and the pressurizing line 70.

[0082] As a result, it is possible to transfer the cargo liquid L through the first line 40 from the main tank 10 by the pumping unit 60 and send in the cargo gas V through the second line 50 and the vaporizer 55 from the main tank 10 by the pumping unit 60 with respect to the other sub tank 20 from the main tank 10 while pressurizing the inside of the main tank 10 by the pressure of the cargo gas V in the sub tank 20 in one or more of the sub tanks 20.

[0083] In addition, when the cargo liquid L is pumped by the pumping unit 60 while pressurizing the main tank 10 by the pressure of the cargo gas V in the sub tank 20, the pressure applied to the cargo liquid L by the pumping unit 60 can be reduced as compared with a case where the pumping unit 60 performs pumping alone. As a result, less energy is required to operate the pumping unit 60.

[0084] (4) In the ship 1 according to a fourth aspect, which is the ship 1 of (3), the sub tanks 20 are three or more in number, and a plurality of the main tanks 10 are connected to each of the sub tanks 20 via the first line 40, the second line 50, and the pressurizing line 70.

[0085] With such a configuration, in three or more sub tanks 20, it is possible to release the residual pressure, transfer the cargo liquid L from the main tank 10, and discharge the cargo liquid L to the outside of the ship in parallel. By sequentially performing these operations between the three or more sub tanks 20, the cargo liquid L stored in the main tank 10 and the sub tank 20 can be efficiently discharged to the outside of the ship.

[0086] (5) In the ship according to a fifth aspect, which is the ship 1 of any one of (1) to (4), the pumping unit 60 is provided by being connected to the second line 50, and the ship further includes a connection line 80 provided to disconnectably connect the first line 40 and the second line 50 between the pumping unit 60 and the vaporizer 55.

[0087] As a result, the cargo liquid L pumped by the pumping unit 60 can be sent out with either the first line 40 or the second line 50 selected.

Industrial Applicability

[0088] According to the ship of the present disclosure, it is possible to enable an increase in tank size while suppressing an increase in cost.

Reference Signs List

[0089]

1: ship
2: hull
2a: bow
2b: stern
3A, 3B: broadside
5: exposed deck
7: superstructure
8: cargo tank storage compartment
10: main tank
20: sub tank
30: transportation line
31: external connection pipe
31j: connection portion
32: sub tank connection pipe
32v, 32w, 41v, 43v, 51v, 52v, 52w, 53v, 71v, 73v, 80v: opening-closing valve
40: first line
41: first main tank connection pipe
42: first merging pipe
43: first branch pipe
50: second line
51: second main tank connection pipe
52: second merging pipe
53: second branch pipe
55: vaporizer
60: pumping unit
70: pressurizing line
71: sub tank side pressurizing pipe

72: pressurizing merging pipe
73: main tank side pressurizing pipe
80: connection line
100: pipe system
G: cargo
L: cargo liquid
V: cargo gas

Claims

1. A ship comprising:

a hull having a pair of broadsides;
a main tank provided in the hull and storing a liquid or gas cargo;
a sub tank smaller in capacity than the main tank and higher in pressure resistance than the main tank;
a transportation line connected to the sub tank and having an outboard connection portion;
a first line connecting the main tank and the sub tank;
a second line connecting the main tank and the sub tank;
a vaporizer provided on the second line, not provided on the first line, and evaporating a cargo liquid, which is a liquid phase of the cargo, to generate a cargo gas; and
a pumping unit selecting either the first line or the second line and pumping the cargo liquid from the main tank to the sub tank.

2. The ship according to Claim 1, further comprising a pressurizing line connecting an upper portion in the sub tank and an upper portion in the main tank and pressurizing an inside of the main tank by pressure in the sub tank.

3. The ship according to Claim 2, wherein a plurality of the sub tanks are connected to one main tank via the first line, the second line, and the pressurizing line.

4. The ship according to Claim 3, wherein the sub tanks are three or more in number, and a plurality of the main tanks are connected to each of the sub tanks via the first line, the second line, and the pressurizing line.

5. The ship according to any one of Claims 1 to 4, wherein

the pumping unit is provided by being connected to the second line, and
the ship further comprises a connection line provided to disconnectably connect the first line and the second line between the pumping unit and the vaporizer.

FIG. 1

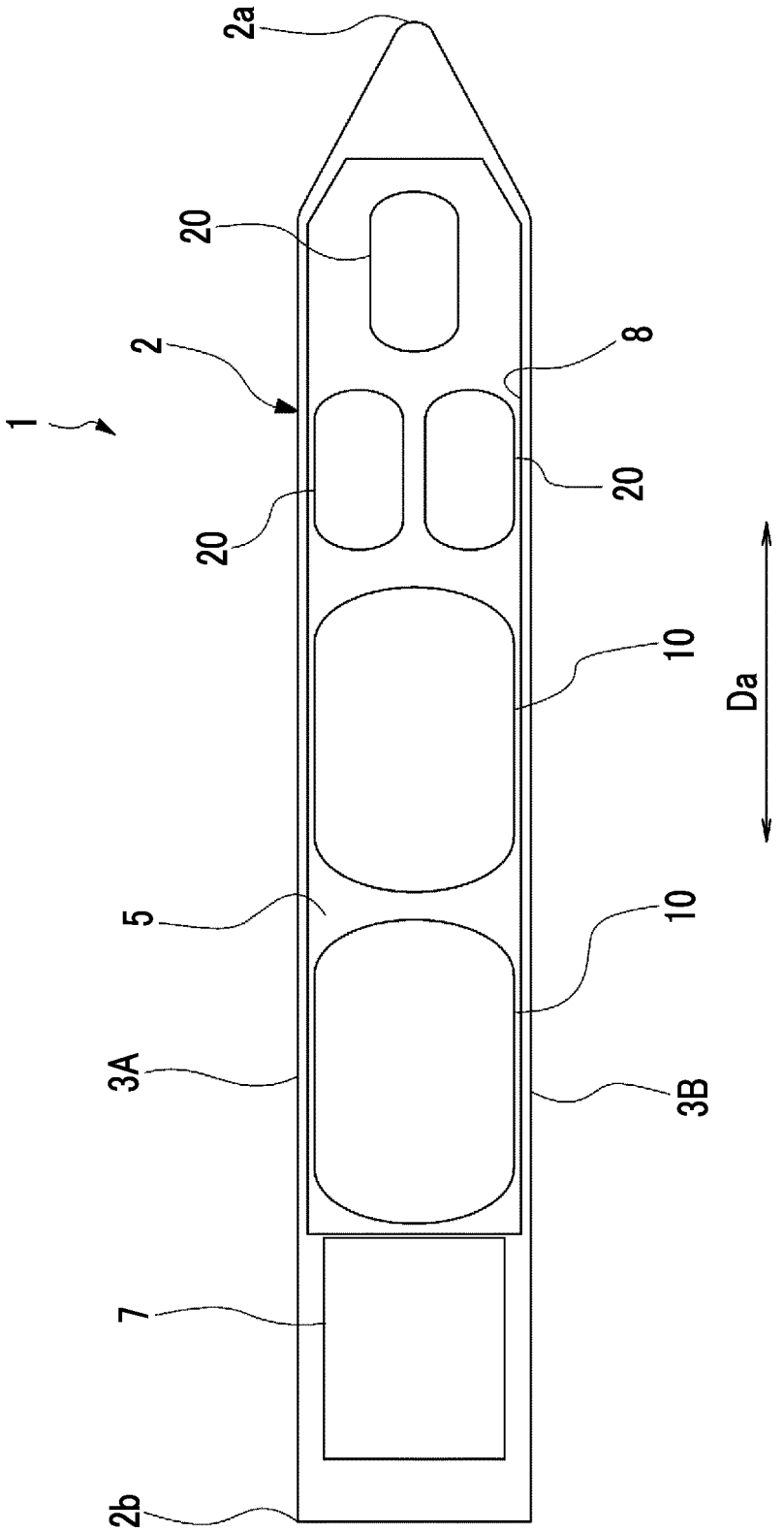

FIG. 2

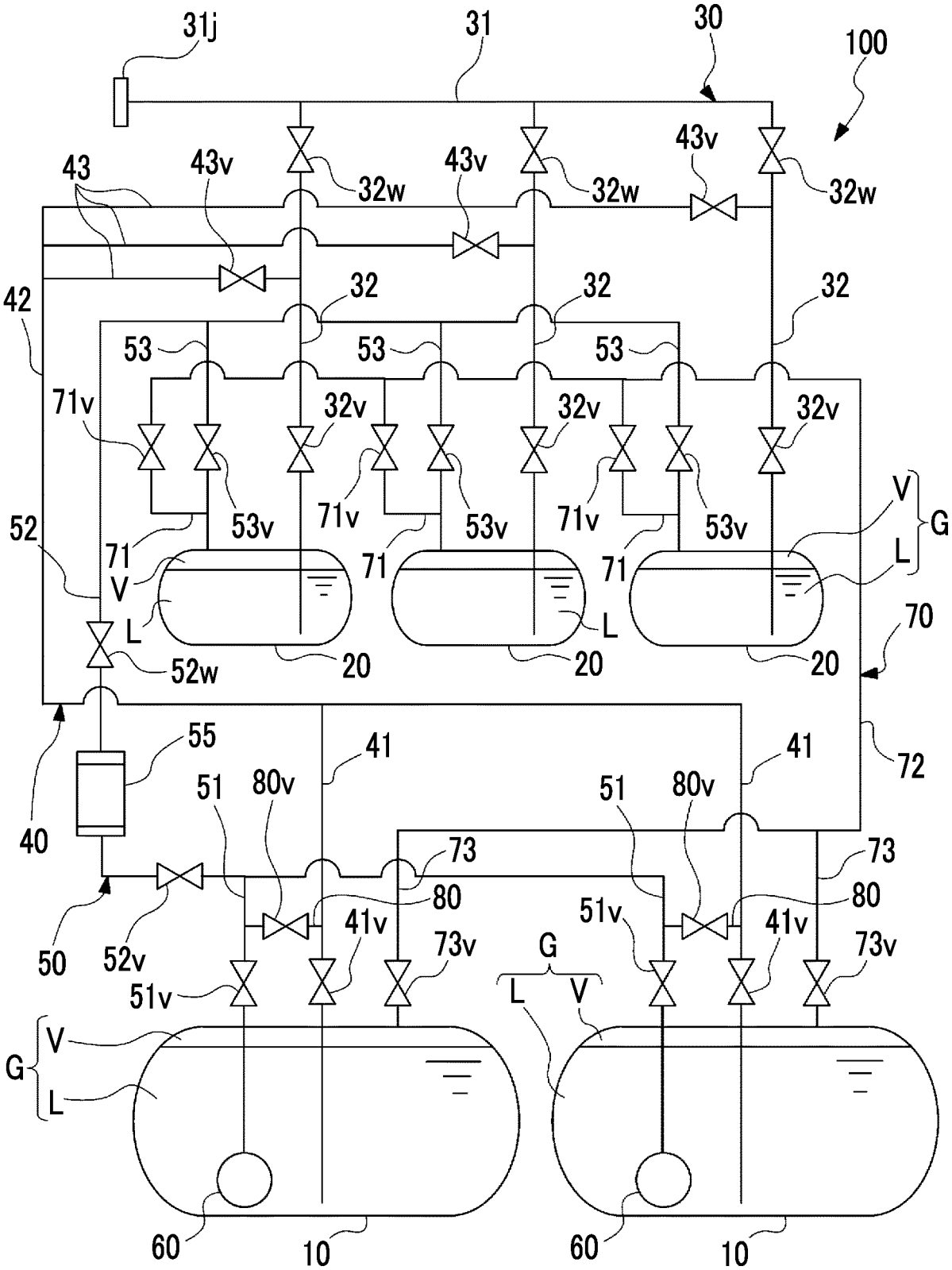
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FIG. 3

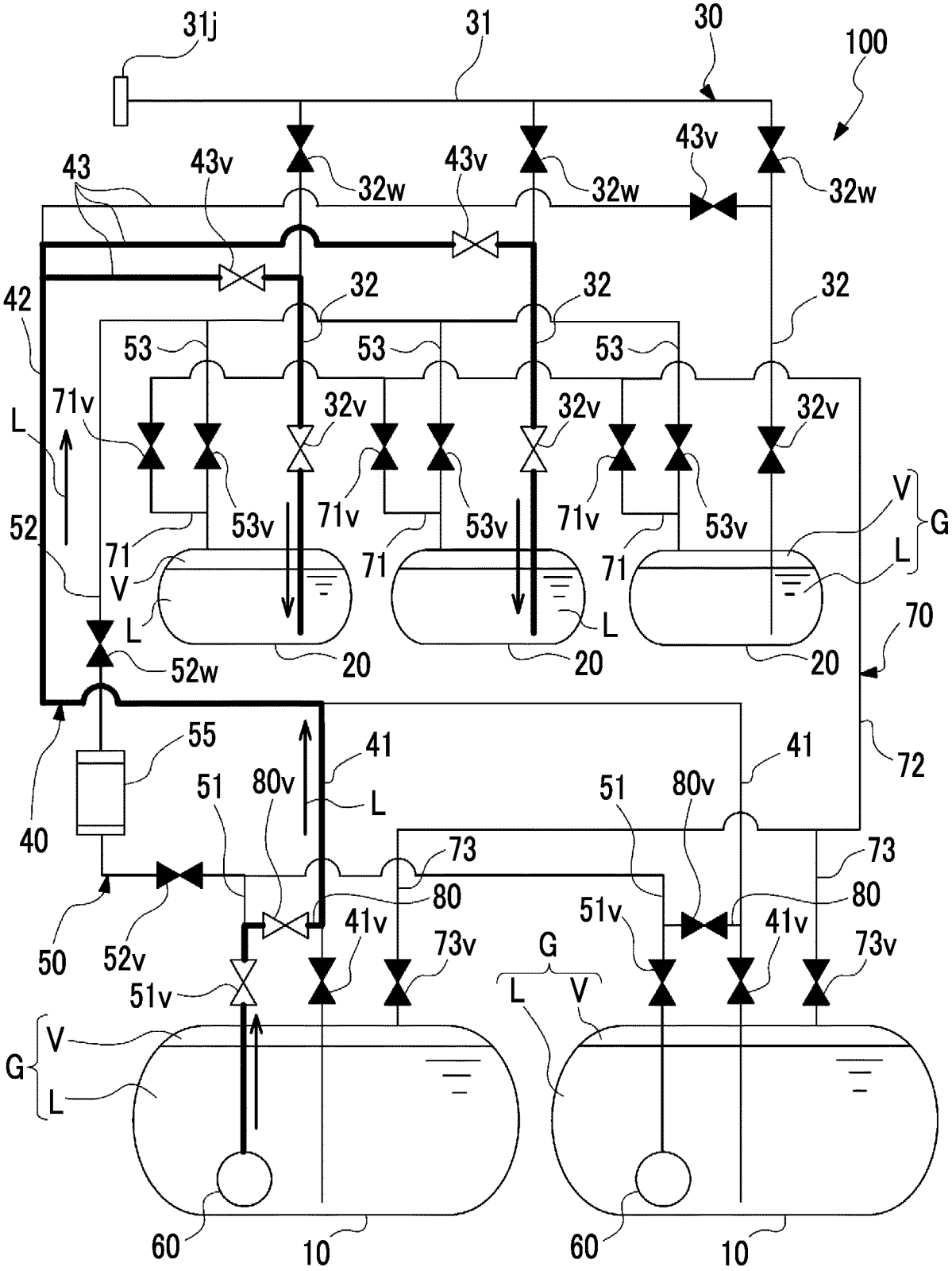
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FIG. 4

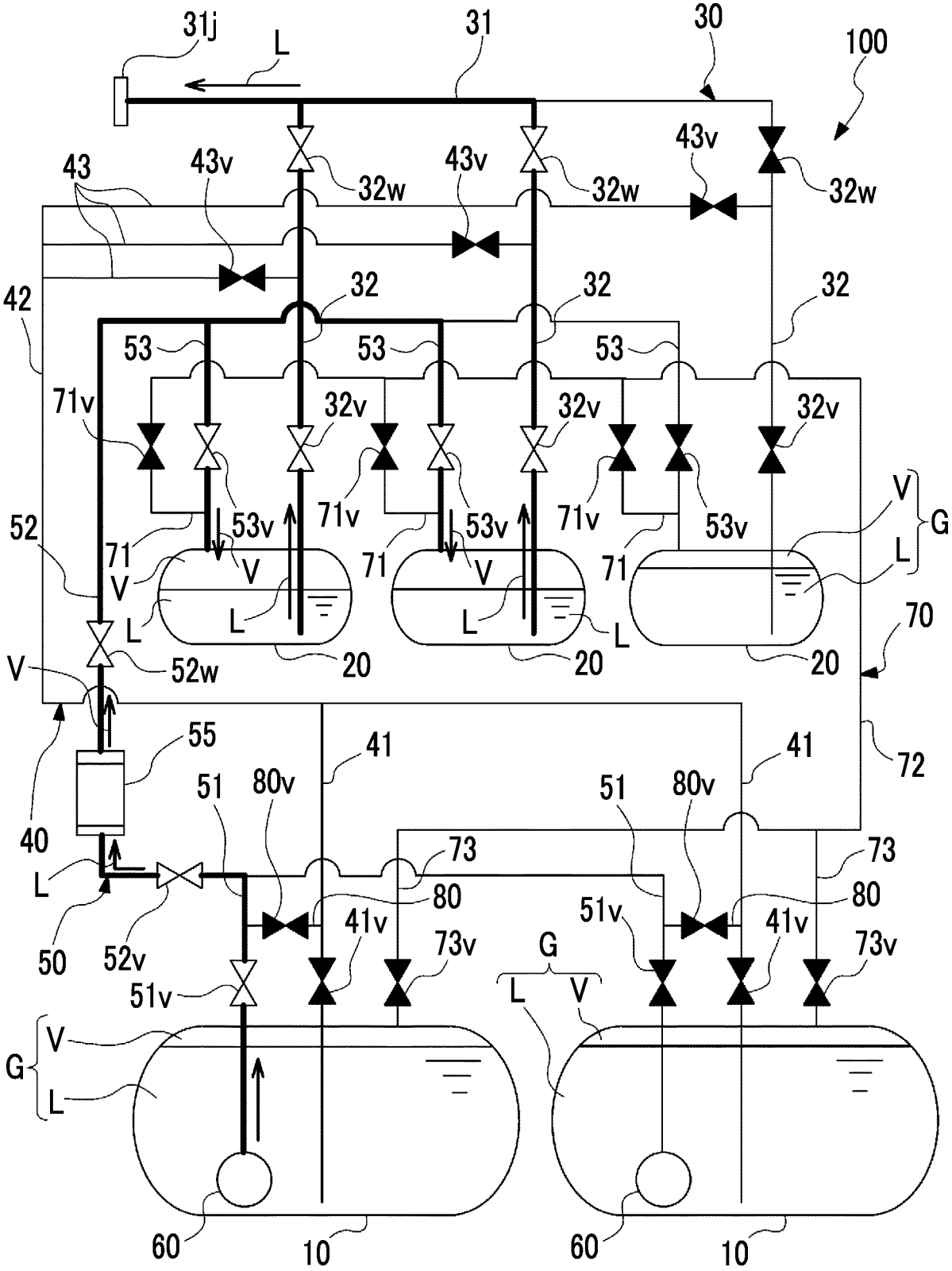
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FIG. 5

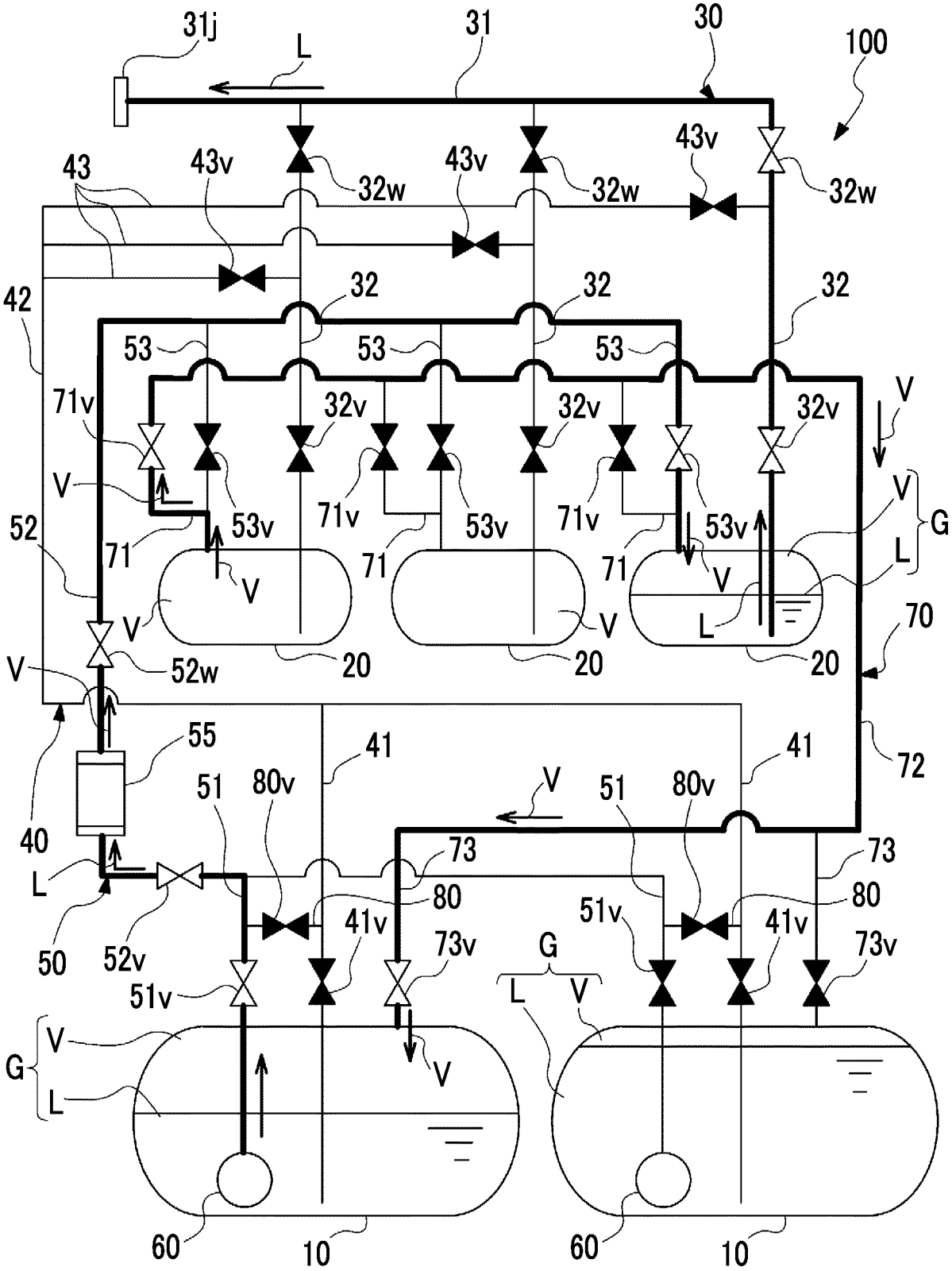
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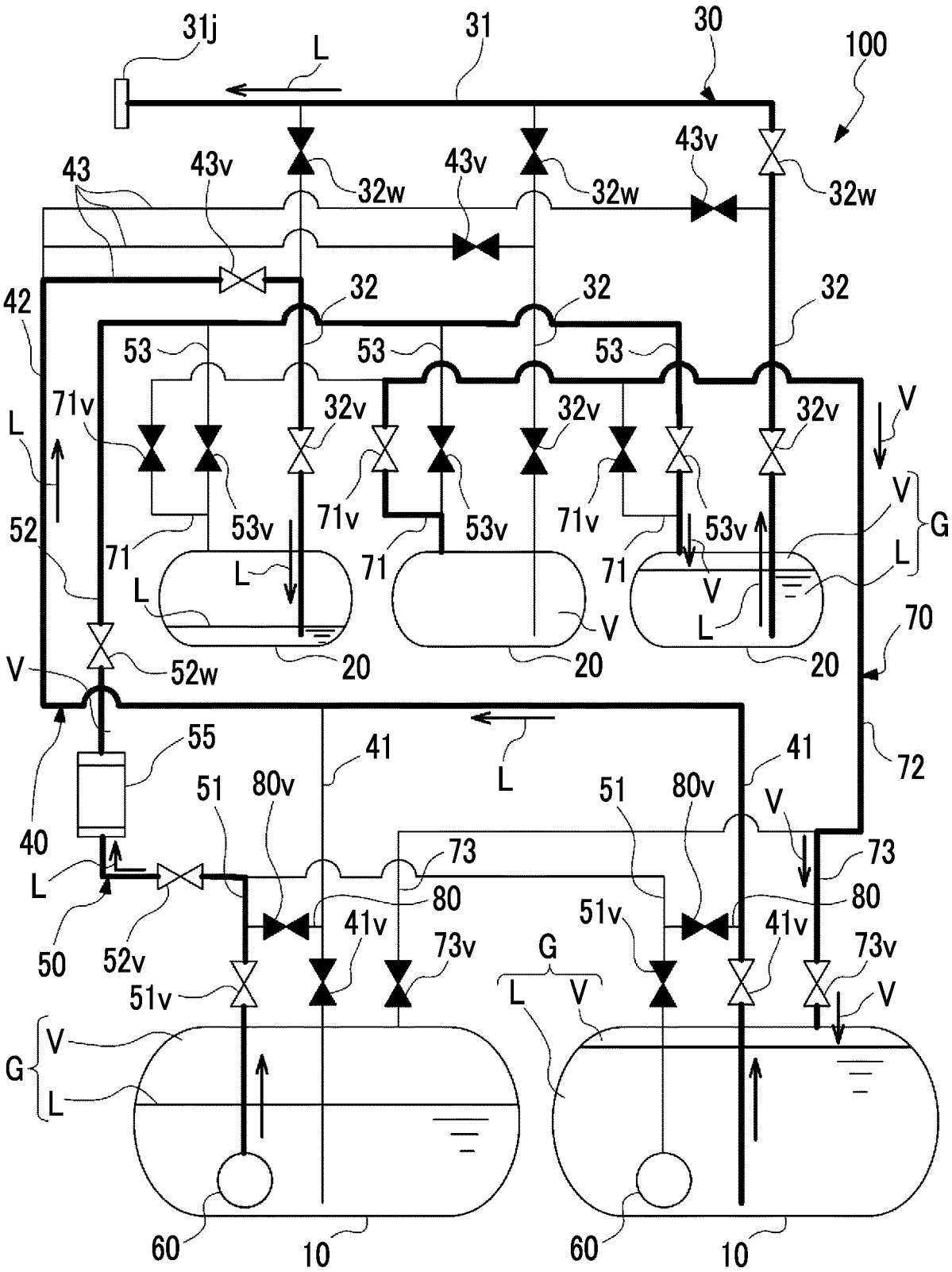
FIG. 6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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/033748

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. B63B25/08(2006.01)i, B63B25/14(2006.01)i, B63B25/16(2006.01)i, F17C9/00(2006.01)i
FI: B63B25/08 A, F17C9/00 A, B63B25/14, B63B25/16 P
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)
Int. Cl. B63B25/08, B63B25/14, B63B25/16, F17C9/00

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 1971-2020
Registered utility model specifications of Japan 1996-2020
Published registered utility model applications of Japan 1994-2020

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.
Y A	JP 2007-9981 A (N ENERGY KK) 18 January 2007, paragraphs [0018]-[0031], fig. 1, paragraphs [0018]-[0031], fig. 1	1-4 5
Y A	JP 2016-520468 A (EXCELERATE LIQUEFACTION SOLUTIONS LLC) 14 July 2016, paragraphs [0014]-[0030], fig. 1, paragraphs [0014]-[0030], fig. 1	1-4 5
A	JP 2013-209000 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 10 October 2013	1-5
A	KR 10-1280893 B1 (SAMSUNG HEAVY IND. CO., LTD.) 02 July 2013	1-5

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22.10.2020	02.11.2020

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

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/033748

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2009-500579 A (PRAXAIR TECHNOLOGY INC.) 05 January 2009	1-5

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/033748

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
JP 2007-9981 A	18.01.2007	(Family: none)	
JP 2016-520468 A	14.07.2016	WO 2014/168843 A1 page 5, line 1 to page 9, line 5, fig. 1	
JP 2013-209000 A	10.10.2013	(Family: none)	
KR 10-1280893 B1	02.07.2013	KR 10-2013-0057169 A	
JP 2009-500579 A	08.01.2009	WO 2007/008453 A1	

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2019229207 A **[0002]**
- JP 5769445 B **[0004]**