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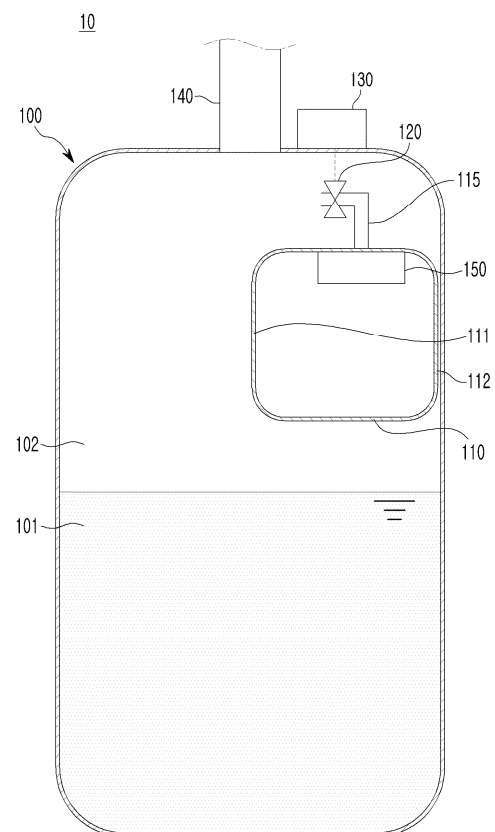
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(54) **REFRIGERANT STORAGE CONTAINER AND REFRIGERANT STORAGE METHOD USING THE SAME**

(57) The present disclosure relates to a refrigerant storage container (10) and a refrigerant storage method. A refrigerant storage container (10) according to an embodiment of the present disclosure includes a main body (100) including a storage space (101) that is adapted to store a refrigerant, and a headspace (102) on top of the storage space (101), a headspace adjustment part (110) disposed in the headspace (102) and provided with a gas-phase refrigerant communication port (115) communicating with the headspace (102), and an opening/closing control device (120) coupled to the gas-phase refrigerant communication port (115) and configured to selectively open or close the headspace adjustment part with respect to the headspace (102).

FIG. 1



Description

[BACKGROUND OF THE INVENTION]

1. Technical Field

[0001] The embodiments of the present disclosure relate to a refrigerant storage container and a refrigerant storage method using the same.

2. Description of the Related Art

[0002] A refrigerant is a substance that absorbs heat in a heat pump applied to air conditioners, refrigerators, cooling towers, or similar devices included in thermal management systems.

[0003] Recently, the types of heat pumps used indoors and outdoors have been diversified, and due to the development of electric vehicles and related electrically powered technologies, miniaturized heat pumps are required. Accordingly, combinations of refrigerants that may have a coefficient of performance optimized for each heat pump are being developed.

[0004] For example, when a combination of two or more types of refrigerants is used, a change in its composition may cause a difference in the coefficient of performance of the heat pump. However, in the case of a non-azeotropic refrigerant mixture, which is a mixture of two or more types of refrigerants having different characteristics such as different boiling points, the composition of the refrigerant may change during processes such as storage and transportation.

[0005] Therefore, there is a need to develop a refrigerant storage container that may suppress a change in the composition of a non-azeotropic refrigerant mixture during subdivided storage of the same.

[SUMMARY OF THE INVENTION]

[0006] Embodiments of the present disclosure provide a refrigerant storage container that may suppress a change in composition of a refrigerant mixture during small-batch storage.

[0007] Embodiments of the present disclosure provide a refrigerant storage method using the refrigerant storage container.

[0008] According to a first general aspect of the present disclosure, a refrigerant storage container includes: a main body including a storage space that is adapted for storing a refrigerant, and a headspace on top of the storage space; a headspace adjustment part disposed in the headspace and provided with a gas-phase refrigerant communication port communicating with the headspace; and an opening/closing control device coupled to the gas-phase refrigerant communication port and configured to selectively open or close the headspace adjustment part with respect to the headspace.

[0009] In an embodiment, the storage space of the main body may be charged with the refrigerant in an amount of 30 volume% or more with respect to an internal volume of the main body. Preferably, the storage space of the main body is charged with the refrigerant in an amount of 90 volume% or less relative to an internal volume of the main body.

[0010] In an embodiment, the headspace adjustment part may have a sealed internal space with a fixed volume when closed by the opening/closing control device. In an embodiment, the internal space of the headspace adjustment part may be have 1 volume% or more, preferably 2 volume% or more, more preferably 3 volume% or more, even more preferably 4 volume% or more, most preferably 5 volume% or more, and 20 volume% or less, preferably 19 volume% or less, more preferably 18 volume% or less, even more preferably 16 volume% or less, most preferably 15 volume% or less with respect to the internal volume of the main body. In an embodiment, the gas-phase refrigerant communication port may be positioned on top of the headspace adjustment part to communicate with an upper region of the headspace.

[0011] In an embodiment, the headspace adjustment part may include a first wall that is arranged to partition the headspace and an internal space of the headspace adjustment part, and a second wall formed by or coupled to an inner wall of the main body, and may include the internal space between the first wall and the second wall.

[0012] In an embodiment, the second wall may be integrally formed with the inner wall of the main body, and the first wall may be disposed to be spaced apart from an inner side of the second wall.

[0013] In an embodiment, the headspace adjustment part may include a plurality of internal partition walls that are arranged to divide the internal space into a plurality of compartments.

[0014] In an embodiment, the plurality of internal partition walls may extend downward from an upper inner wall of the headspace adjustment part, and a lower end of each of the internal partition walls may be connected to a lower inner wall of the headspace adjustment part.

[0015] In an embodiment, each of the plurality of compartments may be provided with a gas-phase refrigerant communication port and have an opening/closing control device coupled to each of the gas-phase refrigerant communication ports.

[0016] In an embodiment, the refrigerant storage container may further include a liquid inflow prevention part coupled to an end of the gas-phase refrigerant communication port and configured to allow gas to pass through and block an inflow of a liquid refrigerant.

[0017] In an embodiment, the refrigerant storage container may further include a rib protruding from the inner wall of the main body and configured to support the headspace adjustment part.

[0018] In an embodiment, the refrigerant storage

container may include a controller that is connected to the opening/closing control device.

[0019] In an embodiment, the opening/closing control device may be in a closed position when a discharge amount of the refrigerant is 10 wt% or more of an initial charging amount.

[0020] In an embodiment, the refrigerant may include a non-azeotropic refrigerant mixture.

[0021] In an embodiment, the non-azeotropic refrigerant mixture may include a first refrigerant, and a second refrigerant having a boiling point difference of 10 °C or more from the boiling point of the first refrigerant. Preferably, said boiling point difference is 12 °C or more, more preferably 15 °C or more, and even more preferably 20 °C or more. Optionally, the first refrigerant is selected from one or more of the group consisting of carbon dioxide (R-744), difluoromethane (R-32) and 1,1-difluoroethylene (R-1132a).

[0022] According to another general aspect of the present disclosure, a refrigerant storage method using a refrigerant storage container is provided, which includes: charging a refrigerant into a storage space of a main body to form a headspace on top of the storage space; maintaining a headspace adjustment part in an open state with respect to the headspace through a gas-phase refrigerant communication port of the headspace adjustment part disposed in the headspace; checking a discharge amount of the refrigerant stored in the storage space according to use of the refrigerant; and closing the headspace adjustment part with respect to the headspace when the discharge amount of the refrigerant is 10 wt% or more of an initial charging amount.

[0023] In an embodiment, the closing of the headspace adjustment part with respect to the headspace may include switching an opening/closing control device coupled to the gas-phase refrigerant communication port to a closed position, by a controller.

[0024] In an embodiment, a liquid inflow prevention part coupled to an end of the gas-phase refrigerant communication port allows gas to pass through and block an inflow of a liquid refrigerant.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0025] The above and other objects, features and other advantages of the embodiments of the present disclosure will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic view of a refrigerant storage container according to an embodiment of the present disclosure;

FIG. 2 is a schematic view of a refrigerant storage container according to another embodiment of the present disclosure;

FIG. 3 is a schematic view of a refrigerant storage

container according to another embodiment of the present disclosure;

FIG. 4 is a schematic view of a refrigerant storage container according to another embodiment of the present disclosure; and

FIG. 5 is a flowchart of a refrigerant storage method according to an embodiment of the present disclosure.

10 [DETAILED DESCRIPTION OF THE INVENTION]

[0026] Hereinafter, exemplary embodiments of the present disclosure will be described in detail with reference to the accompanying drawing so that those skilled in the art may readily practice the present disclosure.

[0027] The refrigerants included in the refrigerant mixture may be, e.g., natural refrigerants, chlorofluorocarbon (CFC)-based refrigerants, hydrochlorofluorocarbon (HCFC)-based refrigerants, hydrofluorocarbon (HFC)-based refrigerants, hydrofluoroolefin (HFO)-based refrigerants, or any combinations thereof.

[0028] The natural refrigerant is a substance that exists naturally on earth and is not an artificial compound. The natural refrigerant may include, e.g., ammonia (R-717), carbon dioxide (R-744), propane (R-290), propylene (R-1270), butane (R-600a), or other documented natural refrigerants such as water (R-718), or any combinations thereof.

[0029] The chlorofluorocarbon (CFC)-based refrigerant is a refrigerant composed of chlorine atoms (Cl), fluorine atoms (F), and carbon atoms (C). The chlorofluorocarbon (CFC)-based refrigerant may include, e.g., trichlorofluoromethane (R-11), dichlorodifluoromethane (R-12), 1,1,2-trichlorotrifluoroethane (R-113), 1,2-dichlorotetrafluoroethane (R-114), chloropentafluoroethane (R-115), or other compounds that have been used in refrigeration and comprise Cl, F, and C, or any combinations thereof.

[0030] The hydrochlorofluorocarbon (HCFC)-based refrigerant is a refrigerant composed of hydrogen atoms (H), chlorine atoms (Cl), fluorine atoms (F), and carbon atoms (C). The hydrochlorofluorocarbon (HCFC)-based refrigerant may include, e.g., difluorochloromethane (R-22), 2,2-dichloro-1,1,1-trifluoroethane (R-123), chlorotetrafluoroethane (R-124), 1-chloro-1,1-difluoroethane (R-142b), or other documented compounds that can be assigned to the group of HCFC-based refrigerants, or any combinations thereof.

[0031] The hydrofluorocarbon (HFC)-based refrigerant is a refrigerant composed of hydrogen atoms (H), fluorine atoms (F), and carbon atoms (C). The hydrofluorocarbon (HFC)-based refrigerant may include, e.g., difluoromethane (R-32), trifluoriodomethane (R-131i), 1,1-difluoroethane (R-152a), pentafluoroethane (R-125), 1,1,1-trifluoroethane (R-143a), trifluoromethane (R-23), fluoroethane (R-161), 1,1,1,2,3,3,3-heptafluoropropane (R-227ea), 1,1,1,2,3,3,3-hexafluoropropane (R-236ea), 1,1,1,3,3,3-

hexafluoropropane (R-236fa), 1,1,1,3,3-pentafluoropropane (R-245fa), 1,1,1,3,3-pentafluorobutane (R-365mfc), or other documented compounds that can be assigned to the group of HFC-based refrigerants, or any combinations thereof.

[0032] The hydrofluoroolefin (HFO)-based refrigerant is a refrigerant composed of hydrogen atoms (H), fluorine atoms (F), and carbon atoms (C), and having at least one double bond between the carbon atoms. The hydrofluoroolefin (HFO)-based refrigerant may include, e.g., 1,1,2-trifluoroethylene (R-1123), 2,3,3,3-tetrafluoropropene (R-1234yf), 1,3,3,3-tetrafluoropropene (R-1234ze), 1,2,3,3-tetrafluoropropene (R-1234ye), 3,3,3-trifluoropropene (R-1243zf), 1,1-difluoroethylene (R-1132a), 1,2,3,3,3-pentafluoropropene (R-1225ye), or other documented compounds that can be assigned to the group of HFO-based refrigerants, or any combinations thereof.

[0033] The refrigerant mixture may be classified into an azeotropic refrigerant mixture and a non-azeotropic refrigerant mixture (also referred to as a zeotropic refrigerant mixture).

[0034] An azeotropic refrigerant mixture may refer to a constant refrigerant in which the boiling points of the respective refrigerants before mixing are the same, and its composition does not change in all states. For example, an azeotropic refrigerant mixture may refer to a refrigerant mixture whose composition does not change during the condensation or evaporation process of the refrigerant mixture. In the case of an azeotropic refrigerant mixture, since the boiling point is fixed at a constant temperature, the composition may not be separated during storage and transport of the refrigerant, but its applicability may be poor because it can only be used with a fixed composition ratio. In addition, since many azeotropic refrigerant mixtures are based on hydrochlorofluorocarbon (HCFC)-based refrigerants or chlorofluorocarbon (CFC)-based refrigerants containing chlorine (Cl), they may cause ozone layer depletion. Accordingly, a non-azeotropic refrigerant mixture with a low Global Warming Potential (GWP) may be used instead of an azeotropic refrigerant mixture.

[0035] A non-azeotropic refrigerant mixture (i.e., a zeotropic refrigerant mixture) may refer to a refrigerant in which the boiling points of the respective refrigerants before mixing are different from each other, and which has properties different from those of the refrigerants before mixing. For example, a non-azeotropic refrigerant mixture may refer to a refrigerant mixture whose composition changes during the condensation or evaporation process of the refrigerant mixture. The non-azeotropic refrigerant mixture has a lower GWP than the azeotropic refrigerant mixture, and has the advantage of being easily optimized for a heat pump in which the refrigerant mixture is used by freely designing the composition of the refrigerant mixture.

[0036] However, due to the characteristics of the non-azeotropic refrigerant mixture, a change in compo-

sition may easily occur because the boiling points of the respective refrigerants included in the refrigerant mixture are different. In particular, a change in the composition of the refrigerant mixture may occur during the storage process of the refrigerant mixture, which may reduce the performance of the refrigerant.

[0037] A refrigerant storage container according to example embodiments of the present disclosure may store a refrigerant mixture, e.g., a non-azeotropic refrigerant mixture, while keeping the change in its composition small during the storage and/or transportation of refrigerants, or during their use or application in refrigeration processes.

[0038] FIG. 1 is a schematic diagram of a refrigerant storage container according to an embodiment of the present disclosure; FIG. 2 is a schematic diagram of a refrigerant storage container according to another embodiment of the present disclosure; FIG. 3 is a schematic diagram of a refrigerant storage container according to another embodiment of the present disclosure; and FIG. 4 is a schematic diagram of a refrigerant storage container according to another embodiment of the present disclosure.

[0039] Referring to FIGS. 1 to 4, a refrigerant storage container 10 according to an embodiment of the present disclosure includes a main body 100 including a storage space 101 in which a refrigerant is stored and a headspace 102 formed in an upper portion of the main body 100 above the storage space 101; a headspace adjustment part 110 disposed in the headspace 102 and having a gas-phase refrigerant communication port 115 communicating with the headspace 102; and an opening/closing control device 120 coupled to the gas-phase refrigerant communication port 115 to selectively open or close the headspace adjustment part 110 with respect to the headspace 102.

[0040] A main body 100 according to an embodiment of the present disclosure may include a storage space 101 in which a liquid refrigerant is stored, and a headspace 102 formed in an upper portion of the storage space 101.

[0041] The main body 100 may provide a region in which a refrigerant is accommodated and a region in which the refrigerant is not accommodated, distinguished from each other. The storage space 101 is a region in which a liquid refrigerant is accommodated, and the headspace 102 may be a region that is continuously formed in an upper portion of the storage space 101 and in which the refrigerant is vaporized and exists in a gas state. Hereinafter, the refrigerant existing in the gas state may be referred to as a "gas-phase refrigerant".

[0042] The main body 100 may be formed in a sealed container structure such as a cylindrical or prismatic shape, and the storage space 101 and the headspace 102 may be naturally partitioned based on the liquid level of the refrigerant without a separate partition wall.

[0043] According to an embodiment, a refrigerant in-

let/outlet 140, through which the refrigerant enters and exits, may be disposed on one side of the main body 100.

[0044] The refrigerant inlet/outlet 140 may be a passage through which the refrigerant flows into or is discharged from the storage space 101 of the main body 100. Accordingly, the main body 100 may communicate with the outside (for example, a heat pump, etc.) through the refrigerant inlet/outlet 140.

[0045] According to an embodiment, depending on the design of a refrigerant system, the refrigerant inlet/outlet 140 may be connected to the storage space 101, and may also be connected to the headspace 102. For example, when connected to the storage space 101, the refrigerant inlet/outlet 140 may be formed on a lower side of the main body 100, and when connected to the headspace 102, the refrigerant inlet/outlet 140 may be formed on an upper side of the main body 100.

[0046] Referring to FIG. 1, in an embodiment, the refrigerant inlet/outlet 140 may be disposed in an upper portion of the main body 100. According to an embodiment, the refrigerant inlet/outlet 140 may be an opening formed through an upper wall of the main body 100. For example, the refrigerant inlet/outlet 140 may be connected to an external pipe. In this case, an on/off valve may be coupled to the refrigerant inlet/outlet 140 so that charging and discharging of the refrigerant may be controlled.

[0047] According to an embodiment of the present disclosure, the refrigerant may be charged through the refrigerant inlet/outlet 140 in an amount of 30 volume% or more with respect to the internal volume of the main body 100. In addition, the refrigerant stored in the storage space 101 may be discharged to the outside through the refrigerant inlet/outlet 140.

[0048] When the charging rate or quantity of the refrigerant is less than 30 volume%, the volume of the headspace excessively increases, and thus the absolute amount of vaporized refrigerant increases. Therefore, even if the opening and closing control of the opening/closing control device is performed, the possibility of accumulation of a compositional imbalance, in which the composition ratio of the refrigerant changes, may increase.

[0049] In addition, when the charging rate of the refrigerant is excessively high (e.g., 90 volume% or more), the liquid-state refrigerant expands according to a temperature change, which may cause the refrigerant storage container to rupture. Therefore, it should be avoided to charge an excessive amount of refrigerant in order to ensure safe and stable operation.

[0050] According to an embodiment, the refrigerant may be charged in an amount of 30 volume% to 90 volume%, 40 volume% to 90 volume%, 50 volume% to 90 volume%, 60 volume% to 90 volume%, 70 volume% to 90 volume%, or 80 volume% to 90 volume%, based on the internal volume of the main body 100.

[0051] According to an embodiment, the refrigerant may be a non-azeotropic refrigerant mixture. For example, the refrigerant mixture may include refrigerants with a large difference in boiling point. Herein, a large difference in boiling point may refer to a difference of at least 10 °C, more preferably at least 12 °C, even more preferably at least 15 °C, and most preferably at least 20 °C.

[0052] According to an embodiment, a refrigerant A has the lowest boiling point among a plurality of refrigerant components constituting the non-azeotropic refrigerant mixture. Other refrigerants have a higher boiling point than the low-boiling refrigerant A. Here, the non-azeotropic refrigerant mixture may be formed of a composition including the refrigerant A with a low boiling point and another refrigerant having a boiling point difference of 10 °C or more from the refrigerant A. In this case, the non-azeotropic refrigerant mixture may exhibit different composition ratios of each component in a liquid state and a gas state.

[0053] According to an embodiment, the refrigerant with the lowest boiling point among the refrigerant mixtures may have a boiling point that is 10 °C, 12 °C, 15 °C, or 20 °C or more lower than those of other refrigerants.

[0054] For example, the refrigerant mixture may include a refrigerant with the lowest boiling point and a refrigerant having a boiling point difference of 10 °C, 12 °C, 15 °C, or 20 °C or more from the refrigerant with the lowest boiling point.

[0055] In some embodiments, the boiling point difference between other refrigerants, excluding the refrigerant with the lowest boiling point among the refrigerant mixtures, may be within 8 °C, within 5 °C, within 3 °C, or within 1 °C.

[0056] According to an embodiment, the refrigerant A with the lowest boiling point may be carbon dioxide (R-744), difluoromethane (R-32), or 1,1-difluoroethylene (R-1132a), etc. The refrigerant A may also be referred to as the first refrigerant A.

[0057] For example, the refrigerant with the lowest boiling point may be carbon dioxide (R-744). Carbon dioxide is a type of natural refrigerant, has an ozone Depleting Potential (ODP) of 0, a GWP of 1, and may be non-toxic, and non-explosive. Accordingly, while the eco-friendliness and stability of a refrigerant mixture including carbon dioxide (R-744) are improved, the cooling/heating capacity of a heat pump using the refrigerant mixture may be improved.

[0058] For example, the refrigerant A with the lowest boiling point may be difluoromethane (R-32). Difluoromethane (R-32) is a type of hydrofluorocarbon (HFC)-based refrigerant, has an ODP of 0, and may have high heat transfer performance and energy efficiency. Accordingly, while the eco-friendliness and stability of a refrigerant mixture including difluoromethane (R-32) are improved, the cooling/heating capacity of a heat pump using the refrigerant mixture may be im-

proved.

[0059] For example, the refrigerant with the lowest boiling point may be 1,1-difluoroethylene (R-1132a). 1,1-Difluoroethylene (R-1132a) is a type of hydrofluoroolefin (HFO)-based refrigerant, has an ODP of 0, and a GWP of less than 1. Accordingly, while the eco-friendliness of a refrigerant mixture including 1,1-difluoroethylene (R-1132a) is improved, the cooling/heating capacity of a heat pump using the refrigerant mixture may be improved.

[0060] According to an embodiment, when the amount of the refrigerant accommodated in the storage space 101 decreases, the region corresponding to the headspace 102 may increase. More specifically, a volume of the headspace 102 is increased with respect to a total volume of the storage space 101 and the headspace 102, the former storage space 101 and the latter headspace 102 being filled with liquid and gas, respectively. In this case, the amount of the gas-phase refrigerant increases, and thus the equilibrium condition between the refrigerant and the gas-phase refrigerant may change.

[0061] In general, among the refrigerants included in a liquid-state refrigerant mixture, the vaporization amount of a refrigerant with a relatively low boiling point is greater than the vaporization amount of a refrigerant with a relatively high boiling point.

[0062] Accordingly, when the amount of the gas-phase refrigerant increases and thus an area corresponding to the headspace 102 increases, a composition ratio of a refrigerant with a relatively low boiling point among refrigerants included in the gas-phase refrigerant increases, and a composition ratio of the refrigerant with a relatively low boiling point among the refrigerants included in the refrigerant may decrease.

[0063] Accordingly, the composition ratio between the refrigerants included in the refrigerant deviates from a composition ratio range between the refrigerants at the time of initial manufacturing. Accordingly, when a heat pump is operated using the refrigerant stored in the refrigerant storage container 10, cooling or heating efficiency may be reduced.

[0064] The refrigerant storage container 10 according to an embodiment of the present disclosure may maintain a composition ratio between refrigerants included in a liquid-state refrigerant mixture by separately providing a headspace adjustment part 110 in the headspace 102.

[0065] For example, as an amount of the refrigerant stored in the refrigerant storage container 10 decreases, a volume of the headspace 102 may increase, and a component with the lowest boiling point among the refrigerants may be vaporized or evaporated. To prevent a change in the composition of the refrigerant due to this, the volume of the headspace 102 may be adjusted through opening/closing of the headspace adjustment part 110 to maintain the gas-phase refrigerant without a change in composition, and as the composi-

tion of the gas-phase refrigerant is maintained, the composition of the refrigerant may also be maintained.

[0066] The headspace adjustment part 110 according to an embodiment of the present disclosure is disposed in the headspace 102 inside the main body 100 and may include a gas-phase refrigerant communication port 115 that communicates with the headspace 102.

[0067] The headspace adjustment part 110 includes a sealable internal space therein and may be disposed in an upper region inside the main body 100. For example, based on a height direction, a centerline of the headspace adjustment part 110 (perpendicular to the height direction) may be located above a centerline of the main body 100 (perpendicular to the height direction).

[0068] According to an embodiment, the headspace adjustment part 110 is located inside the headspace 102 and may be coupled to an inner wall of the main body 100 or disposed to be spaced apart from the inner wall of the main body 100.

[0069] The gas-phase refrigerant communication port 115 may be a passage connecting the internal space of the headspace adjustment part 110 and the headspace 102. According to an embodiment, the gas-phase refrigerant communication port 115 may be formed in an upper portion of the headspace adjustment part 110. For example, the gas-phase refrigerant communication port 115 may be disposed upward to communicate with an upper region of the headspace 102. According to an embodiment, the gas-phase refrigerant communication port 115 may be a path through which a gas-state refrigerant moves, and may be located in an upper portion of the headspace adjustment part 110 to prevent a liquid-state refrigerant from flowing in.

[0070] According to an embodiment of the present disclosure, when the headspace adjustment part 110 is closed by the opening/closing control device 120, it may have a fixed volume with a sealed internal space. Accordingly, the volume inside the headspace adjustment part 110 may be kept constant against an external force or an internal pressure change.

[0071] According to an embodiment, the headspace adjustment part 110 may be formed in a structure in which a volume of its own internal space is not deformed regardless of whether the gas-phase refrigerant communication port 115 is open or closed. According to an embodiment, the headspace adjustment part 110 may be formed of a rigid material, e.g., any one of a metal material, a synthetic resin material, and a composite material.

[0072] The internal space of the headspace adjustment part 110 according to an embodiment of the present disclosure may be formed to be 1 volume% or more and 20 volume% or less with respect to the internal volume of the main body 100.

[0073] According to an embodiment, the internal volume of the main body 100 may be set as a reference volume, and a volume of the internal space of the head-

space adjustment part 110 may be designed as a ratio to the reference volume.

[0074] For example, the internal space of the headspace adjustment part 110 may be formed to be 1 volume% or more and 20 volume% or less, 2 volume% or more and 19 volume% or less, 3 volume% or more and 18 volume% or less, 4 volume% or more and 17 volume% or less, or 5 volume% or more and 15 volume% or less, with respect to the internal volume of the main body 100.

[0075] Within the above range, it is possible to prevent a change in the composition of the refrigerant stored in the refrigerant storage container 10 while also preventing an increase in refrigerant transportation costs that occurs as an amount of refrigerant that can be stored in the refrigerant storage container 10 decreases.

[0076] For example, the headspace adjustment part 110 may be closed when the headspace 102 occupies 5 volume% or more, 6 volume% or more, 7 volume% or more, 8 volume% or more, 9 volume% or more, 10 volume% or more, 11 volume% or more, 12 volume% or more, 13 volume% or more, 14 volume% or more, or 15 volume% or more with respect to the internal volume of the main body 100. Accordingly, it is possible to reduce the volume of the headspace 102 that increases due to the use of the refrigerant, thereby preventing a change in the composition of the refrigerant stored in the refrigerant storage container 10.

[0077] According to an embodiment of the present disclosure, the gas-phase refrigerant communication port 115 may be formed in an upper portion of the headspace adjustment part 110 and disposed to communicate with an upper region of the headspace 102. Accordingly, the space inside the headspace adjustment part 110 may be opened to the headspace 102 through the gas-phase refrigerant communication port 115. In addition, it is possible to prevent the gas-phase refrigerant existing in the headspace 102 from being mixed with a liquid-state refrigerant.

[0078] According to an embodiment, the gas-phase refrigerant communication port 115 may be formed as a through-hole, a tubular passage, or a nozzle-type passage. According to an embodiment, the gas-phase refrigerant communication port 115 may be integrally formed on a top wall surface of the headspace adjustment part 110. According to an embodiment, the gas-phase refrigerant communication port 115 may be formed by being coupled as a separate member to an upper end of the headspace adjustment part 110.

[0079] The headspace adjustment part 110 according to an embodiment of the present disclosure includes a first wall 111 that partitions the headspace 102 and the internal space of the headspace adjustment part 110, and a second wall 112 that is formed by or coupled to the inner wall of the main body 100, and may include an internal space between the first wall 111 and the second wall 112.

[0080] For example, the first wall 111 may have a flat plate shape, a curved surface shape, or a cylindrical curved surface shape. The second wall 112 may be the inner wall of the main body 100 itself or may be formed by being joined to the inner wall of the main body 100. For example, the second wall 112 may be welded or mechanically connected to the inner wall of the main body 100.

[0081] According to an embodiment, the internal space may be a sealed space formed between the first wall 111 and the second wall 112.

[0082] Referring to FIG. 2, according to an embodiment of the present disclosure, the second wall 112 is integrally formed with the inner wall of the main body 100, and the first wall 111 may be disposed spaced apart inside the second wall 112.

[0083] According to an embodiment, the second wall 112 may be integrally formed with the inner wall of the main body 100. For example, the second wall 112 may be continuously formed of the same material as the inner wall of the main body 100 so that no joint boundary is formed between the main body 100 and the second wall 112.

[0084] In addition, the second wall 112 may be molded simultaneously with the inner wall of the main body 100. For example, the second wall 112 may be integrally formed with the inner wall of the main body 100 by injection molding, extrusion molding, or casting. Accordingly, when the second wall 112 is integrally formed with the inner wall of the main body 100, the headspace adjustment part 110 may be structurally more stable, and sealing performance may be stably maintained.

[0085] According to an embodiment, the first wall 111 may be disposed concentrically inside the second wall 112. That is, it may be formed such that a central axis of the first wall 111 and a central axis of the second wall 112 coincide.

[0086] According to an embodiment, when the main body 100 is formed as a rectangular tube, the second wall 112 and the first wall 111 may be disposed inside, spaced apart from the second wall 112 by a predetermined distance.

[0087] Accordingly, an internal space may be formed between the first wall 111 and the second wall 112. According to an embodiment, the internal space may be uniformly formed along an inner circumference of the main body 100. Thereby, a change in internal pressure due to opening/closing of the gas-phase refrigerant communication port 115 may be uniformly propagated in a circumferential direction. As a result, the volume of the headspace 102 may be quickly adjusted, and a change in the composition of the refrigerant may be suppressed.

[0088] Referring to FIG. 3, a headspace adjustment part 110 according to an embodiment of the present disclosure may include a plurality of internal partition walls 113 that divide an internal space into a plurality of

compartments 113a.

[0089] According to an embodiment, the plurality of internal partition walls 113 may partition the internal space of the headspace adjustment part 110 into a plurality of mutually independent compartments 113a. Each compartment 113a may be formed in a sealed structure such that gas (e.g., a gas-phase refrigerant) does not communicate with other compartments.

[0090] According to an embodiment, the plurality of internal partition walls 113 may be disposed connected to an inner wall of the headspace adjustment part 110. According to an embodiment, the plurality of internal partition walls 113 may extend downward from an upper inner wall of the headspace adjustment part 110, and a lower end of the internal partition walls 113 may be connected to a lower inner wall of the headspace adjustment part 110. According to an embodiment, they may extend from a sidewall of the headspace adjustment part 110 toward a center. Thereby, the compartments 113a may be arranged in parallel.

[0091] According to an embodiment, the plurality of internal partition walls 113 may be formed in a radial shape so that the compartments may be arranged radially.

[0092] According to an embodiment, each compartment 113a may be formed as a sealed space. According to an embodiment, an upper portion, a side portion, and a lower portion of each compartment 113a may be formed to be surrounded by a wall to maintain each compartment 113a as an independent sealed space. The volume of each compartment 113a may be formed to be the same, and may be formed to have different volumes as needed.

[0093] As such, as an effective volume of each compartment 113a (for example, the volume of the internal space communicating with the headspace) is independently set by the plurality of internal partition walls 113, the number of compartments 113a to be opened/closed may be adjusted according to a discharge amount of the refrigerant. Thereby, the effective volume of the internal space is changed stepwise in proportion to the discharge amount, so that the volume of the headspace 102 may be adjusted corresponding to the discharge amount.

[0094] Referring to FIG. 3, a plurality of compartments 113a according to an embodiment of the present disclosure may each include a gas-phase refrigerant communication port 115, and may include an opening/closing control device 120 coupled to each of the gas-phase refrigerant communication ports 115.

[0095] According to an embodiment, the plurality of compartments 113a may each include a gas-phase refrigerant communication port 115. According to an embodiment, a gas-phase refrigerant communication port 115 may be formed in an upper region of each compartment 113a.

[0096] According to an embodiment, the plurality of compartments 113a may each include an opening/clos-

ing control device 120 coupled to the gas-phase refrigerant communication port 115. Each opening/closing control device 120 may selectively open or close a corresponding compartment 113a with respect to the headspace 102.

[0097] Thereby, the effective volume of the internal space may be adjusted stepwise in proportion to the discharge amount, so that the volume of the headspace 102 may be adjusted corresponding to the discharge amount. Accordingly, the composition of the gas-phase refrigerant existing in the headspace 102 is maintained constant, and the composition of the refrigerant may also be maintained.

[0098] Referring to FIGS. 1 to 4, a refrigerant storage container 10 according to an embodiment of the present disclosure may further include a liquid inflow prevention part 150 coupled to a distal end of the gas-phase refrigerant communication port 115 to allow gas to pass through and block inflow of the refrigerant in a liquid state. Accordingly, inflow of the refrigerant into the headspace adjustment part 110 is prevented, and only the gas-phase refrigerant may flow in.

[0099] For example, in the liquid inflow prevention part 150, a porous filter structure or a check valve that allows only gas to pass through may be installed.

[0100] The inflow of the refrigerant into the headspace adjustment part 110 is prevented so that the effective volume of the headspace adjustment part 110 may be maintained constant. Accordingly, the volume of the headspace 102 may be stably adjusted. Accordingly, the composition of the gas-phase refrigerant existing in the headspace 102 is maintained constant, and the composition of the refrigerant may also be maintained.

[0101] Referring to FIG. 4, the refrigerant storage container 10 according to an embodiment of the present disclosure may include a rib 103 formed to protrude from the inner wall of the main body 100 to support the headspace adjustment part 110.

[0102] As illustrated in FIG. 4, according to an embodiment, the rib 103 may be disposed to contact a lower surface of the headspace adjustment part 110. According to another embodiment (not shown), rib 103 may be disposed to contact at least one portion of an outer circumferential surface of the headspace adjustment part 110. That is, the rib 103 may be disposed to support a lower portion of the headspace adjustment part 110 or to surround an outer circumferential surface of the headspace adjustment part 110.

[0103] The rib 103 according to an embodiment may be formed integrally with an inner wall of main body 100 of the refrigerant storage container 10. The rib 103 according to an embodiment may be formed by being coupled to the inner wall of the main body. According to an embodiment, the rib 103 may be formed to protrude in a horizontal direction from the inner wall of the main body. According to an embodiment, when the main body 100 is cylindrical, the rib 103 may be formed

in an annular shape along the inner wall of the main body 100 leaving a central portion of the internal space of the refrigerant storage container open. The annular shape rib 103 may extend around the entire circumference of the main body 100. Alternatively, the ring 103 may be a localized protrusion extending only partially along the inner wall of the main body 100.

[0104] Thereby, the headspace adjustment part 110 may be stably fixed at a predetermined position inside the main body 100.

[0105] An opening/closing control device 120 according to an embodiment of the present disclosure may be coupled to a gas-phase refrigerant communication port 115 to selectively open or close the headspace adjustment part 110 with respect to a headspace 102.

[0106] The opening/closing control device 120 may be a valve (for example, a solenoid valve, a hydraulic valve, etc.), but is not particularly limited thereto. The opening/closing control device 120 may allow an internal space of the headspace adjustment part 110 and the headspace 102 to communicate with each other in an open position, and may isolate the internal space of the headspace adjustment part 110 from the headspace 102 in a closed position.

[0107] Referring to FIGS. 1 to 4, a refrigerant storage container 10 according to an embodiment of the present disclosure may include a controller 130 that generates a control signal for opening or closing the opening/closing control device 120. For example, the controller 130 may be disposed outside the main body 100. Accordingly, the opening/closing control device 120 may be controlled by the controller 130 disposed outside the main body 100. According to an embodiment, the controller 130 may control the opening/closing control device 120 electrically or fluidically (for example, pneumatically or hydraulically).

[0108] According to an embodiment, the controller 130 may generate a control signal based on an input signal. According to an embodiment, the controller 130 may generate the control signal based on state information of the refrigerant (for example, the amount of refrigerant charged when charging the refrigerant, etc.) or discharge amount information of the refrigerant. That is, when the charged refrigerant is discharged, the controller 130 may sense the discharged amount and close the headspace adjustment part 110 if the amount of the discharged refrigerant exceeds a predetermined value.

[0109] According to an embodiment, the controller 130 may be configured as a processor in which a program is stored or a circuit board. For example, the controller 130 may be configured as a microcontroller, a microprocessor, or a logic circuit.

[0110] According to an embodiment of the present disclosure, the controller 130 may control the opening/closing control device 120 to a closed position when the discharge amount of the refrigerant is 10 wt% or more of the initial charging amount.

[0111] According to an embodiment, the controller

130 may receive information for checking the discharge amount of the refrigerant and store the initial charging amount as a reference value. According to an embodiment, the controller 130 may determine whether the discharge amount of the refrigerant is 10 wt% or more of the initial charging amount, and if the determination result is 10 wt% or more, may output a control signal for switching the opening/closing control device 120 to the closed position.

[0112] In an embodiment, the discharge amount of the refrigerant at which the headspace adjustment part 110 is closed may be 5 wt% or more, 6 wt% or more, 7 wt% or more, 8 wt% or more, 9 wt% or more, 10 wt% or more, 11 wt% or more, 12 wt% or more, 13 wt% or more, 14 wt% or more, or 15 wt% or more of the amount of the initially charged refrigerant. In the above range, the composition of the refrigerant remaining inside the main body 100 may be maintained without change.

[0113] In an embodiment, the headspace adjustment part 110 may not be dissolved in the refrigerant or may not react with the refrigerant. Accordingly, the headspace adjustment part 110 may also be in direct contact with a storage space 101. Accordingly, a sufficient amount of refrigerant may be stored in the refrigerant storage container 10, thereby preventing an increase in costs required for transporting the refrigerant.

[0114] As described above, the refrigerant storage container 10 according to an embodiment of the present disclosure may include the headspace adjustment part 110. Accordingly, a change in the composition of the refrigerant that occurs during the storage process of the refrigerant may be suppressed.

[0115] FIG. 5 is a flowchart illustrating a refrigerant storage method according to an embodiment of the present disclosure. In the refrigerant storage method according to an embodiment of the present disclosure, a detailed description of some overlapping parts with the above-described refrigerant storage container may be omitted.

[0116] Referring to FIG. 5, a refrigerant storage method according to an embodiment of the present disclosure, which is a method for storing a refrigerant using a refrigerant storage container, includes: an operation of charging the refrigerant into a storage space of a main body to form a headspace in an upper portion of the storage space S210; an operation of maintaining a headspace adjustment part in an open state with respect to the headspace through a gas-phase refrigerant communication port of the headspace adjustment part disposed in the headspace S220; an operation of checking a discharge amount of the refrigerant stored in the storage space according to the use of the refrigerant S230; and an operation of closing the headspace adjustment part with respect to the headspace when the discharge amount of the refrigerant is 10 wt% or more of an initial charging amount S240.

[0117] According to an embodiment of the present

disclosure, a refrigerant is charged into a storage space of a main body to form a headspace in an upper portion of the storage space S210.

[0118] First, a refrigerant to be stored in a refrigerant tank is determined. In an embodiment, the refrigerant may be a mixed refrigerant in a liquid state. For example, the mixed refrigerant in the liquid state may be a non-azeotropic refrigerant mixture. In an embodiment, the mixed refrigerant comprises a plurality of refrigerants and may include the refrigerant with the lowest boiling point among them.

[0119] For example, the mixed refrigerant with the lowest boiling point among the refrigerants included in the refrigerant may be carbon dioxide (R-744), difluoromethane (R-32), 1,1-difluoroethylene (R-1132a), or other refrigerants that show a lower boiling point than, for instance, water (R-718), or any combinations thereof.

[0120] According to an embodiment, the refrigerant is charged into the storage space of the main body. For example, the refrigerant may be charged into the main body through a refrigerant inlet/outlet. According to an embodiment, a headspace is formed in an upper portion of the storage space according to the charging of the refrigerant.

[0121] In example embodiments, the headspace may be formed to be 5 volume% or more, 6 volume% or more, 7 volume% or more, 8 volume% or more, 9 volume% or more, 10 volume% or more, 11 volume% or more, 12 volume% or more, 13 volume% or more, 14 volume% or more, or 15 volume% or more with respect to the internal volume of the main body.

[0122] According to an embodiment of the present disclosure, the headspace adjustment part is maintained in an open state with respect to the headspace through the gas-phase refrigerant communication port of the headspace adjustment part disposed in the headspace S220.

[0123] The headspace and the internal space of the headspace adjustment part are brought into communication through the gas-phase refrigerant communication port. In this state, the opening/closing control device is maintained in an open position to keep the headspace adjustment part in an open state with respect to the headspace.

[0124] According to an embodiment of the present disclosure, a discharge amount of the refrigerant stored in the storage space is checked according to the use of the refrigerant S230.

[0125] According to an embodiment, an amount of the discharged refrigerant is sensed according to the discharge of the refrigerant. In an embodiment, the controller senses the discharged amount when the charged refrigerant is discharged. The controller calculates the discharge amount of the refrigerant by comparing the sensed discharge amount with the initial charging amount.

[0126] According to an embodiment of the present

disclosure, when the discharge amount of the refrigerant is 10 wt% or more of the initial charging amount, the headspace adjustment part is closed with respect to the headspace S240.

[0127] According to an embodiment, the controller determines whether the discharge amount of the refrigerant is 10 wt% or more of the initial charging amount. In an embodiment, the discharge amount of the refrigerant at which the headspace adjustment part is closed may be 5 wt% or more, 6 wt% or more, 7 wt% or more, 8 wt% or more, 9 wt% or more, 10 wt% or more, 11 wt% or more, 12 wt% or more, 13 wt% or more, 14 wt% or more, or 15 wt% or more of the amount of the initially charged refrigerant.

[0128] In some embodiments, when the headspace becomes 5 volume% or more, 6 volume% or more, 7 volume% or more, 8 volume% or more, 9 volume% or more, 10 volume% or more, 11 volume% or more, 12 volume% or more, 13 volume% or more, 14 volume% or more, or 15 volume% or more with respect to the internal volume of the main body, the headspace adjustment part may be closed with respect to the headspace through the opening/closing control device.

[0129] In an embodiment, the opening/closing control device is operated by the controller to close the headspace adjustment part. The controller controls the opening/closing control device to a closed position when the amount of the discharged refrigerant exceeds a predetermined value.

[0130] As described above, the refrigerant storage method according to an embodiment of the present disclosure may suppress a change in the composition of the refrigerant by selectively closing the headspace adjustment part based on the discharge amount of the refrigerant.

[0131] The refrigerant storage container and the refrigerant storage method according to an embodiment of the present disclosure may suppress a change in the composition of the refrigerant that occurs during the storage process of the refrigerant by selectively adjusting the volume of the headspace through the opening or closing of the headspace adjustment part to maintain the headspace constant.

[0132] In addition, the refrigerant storage container and the refrigerant storage method according to an embodiment of the present disclosure may stably maintain the pressure and composition of the gas-phase refrigerant in the headspace even when the refrigerant includes a non-azeotropic refrigerant mixture, and accordingly, may minimize the occurrence of concentration deviation of the refrigerant to stably maintain the quality of the refrigerant.

[0133] In addition, the refrigerant storage container and the refrigerant storage method of the present disclosure may be used for storing an eco-friendly refrigerant mixture that has a low GWP and is suitable for preventing ozone layer depletion.

Claims**1.** A refrigerant storage container (10), comprising:

a main body (100) comprising a storage space (101) that is adapted for storing a refrigerant, and a headspace (102) on top of the storage space (101);
 a headspace adjustment part (110) disposed in the headspace (102) and provided with a gas-phase refrigerant communication port (115) communicating with the headspace (102); and
 an opening/closing control device (120) coupled to the gas-phase refrigerant communication port (115) and configured to selectively open or close the headspace adjustment part (110) with respect to the headspace (102).

2. The refrigerant storage container (10) according to claim 1, wherein the storage space (101) of the main body (100) is charged with the refrigerant in an amount of 30 volume% or more relative to an internal volume of the main body (100), preferably wherein the storage space (101) of the main body (100) is charged with the refrigerant in an amount of 90 volume% or less relative to an internal volume of the main body (100).**3.** The refrigerant storage container (10) according to claim 1 or 2, wherein the headspace adjustment part (110) has a sealed internal space with a fixed volume when closed by the opening/closing control device (120), the internal space of the headspace adjustment part (110) having 1 volume% or more, preferably 2 volume% or more, more preferably 3 volume% or more, even more preferably 4 volume% or more, most preferably 5 volume% or more, and 20 volume% or less, preferably 19 volume% or less, more preferably 18 volume% or less, even more preferably 16 volume% or less, most preferably 15 volume% or less with respect to the internal volume of the main body (100), optionally wherein the gas-phase refrigerant communication port (115) is positioned on top of the headspace adjustment part (110) to communicate with an upper region of the headspace (102).**4.** The refrigerant storage container (10) according to any one of claims 1 to 3, wherein the headspace adjustment part (110) comprises a first wall (111) that is arranged to partition the headspace (102) and an internal space of the headspace adjustment part (110), and a second wall that is formed by an inner wall of the main body (100) or is coupled to the inner wall of the main body (100), and comprises the internal space between the first wall (111) and the second wall (112).**5.** The refrigerant storage container (10) according to claim 4, wherein the second wall is integrally formed with the inner wall of the main body (100), and the first wall (111) is disposed spaced apart inside the second wall (112).**6.** The refrigerant storage container (10) according to any one of claims 1 to 5, wherein the headspace adjustment part (110) comprises a plurality of internal partition walls (113) that are arranged to divide the internal space into a plurality of compartments.**7.** The refrigerant storage container (10) according to claim 6, wherein the plurality of internal partition walls (113) extend downward from an upper inner wall of the headspace adjustment part (110), and a lower end of each of the internal partition walls (113) is connected to a lower inner wall of the headspace adjustment part (110), and/or wherein each of the plurality of compartments is provided with a gas-phase refrigerant communication port (115), and comprises an opening/closing control device (120) coupled to each of the gas-phase refrigerant communication ports (115).**8.** The refrigerant storage container (10) according to any one of claims 1 to 7, further comprising a liquid inflow prevention part (150) coupled to an end of the gas-phase refrigerant communication port (115) and configured to allow gas to pass through and block an inflow of a liquid refrigerant.**9.** The refrigerant storage container (10) according to any one of claims 1 to 8, further comprising a rib (103) protruding from the inner wall of the main body (100) and configured to support the headspace adjustment part (110).**10.** The refrigerant storage container (10) according to any one of claims 1 to 9, comprising a controller (130) that is connected to the opening/closing control device (120), and/or wherein the opening/closing control device (120) is in a closed position when a discharge amount of the refrigerant is 10 wt% or more of an initial charging amount.**11.** The refrigerant storage container (10) according to any one of claims 1 to 10, further comprising a refrigerant inlet/outlet (140) that is disposed on one side of the main body (100).**12.** The refrigerant storage container (10) according to any one of claims 1 to 11, wherein the refrigerant comprises a non-azeotropic refrigerant mixture, the non-azeotropic refrigerant mixture including a first refrigerant (A), and a second refrigerant having a boiling point difference of 10 °C or more from the

boiling point of the first refrigerant (A),

preferably wherein said boiling point difference
is 12 °C or more, more preferably 15 °C or
more, and even more preferably 20 °C or
more, 5
optionally wherein the first refrigerant (A) is se-
lected from one or more of the group consist-
ing of carbon dioxide (R-744), difluoromethane
(R-32), and 1,1-difluoroethylene (R-1132a). 10

13. A refrigerant storage method using a refrigerant
storage container (10), the method comprising:

charging a refrigerant into a storage space 15
(101) of a main body (100) to form a head-
space (102) on top of the storage space (101);
maintaining a headspace adjustment part
(110) in an open state with respect to the
headspace (102) through a gas-phase refriger- 20
ant communication port (115) of the head-
space adjustment part (110) disposed in the
headspace (102);
checking a discharge amount of the refrigerant
stored in the storage space (101) according to 25
use of the refrigerant; and
closing the headspace adjustment part (110)
with respect to the headspace (102) when the
discharge amount of the refrigerant is 10 wt%
or more of an initial charging amount. 30

14. The refrigerant storage method according to claim
13, wherein the closing of the headspace adjust-
ment part (110) with respect to the headspace
(102) comprises switching an opening/closing 35
control device (120) coupled to the gas-phase refriger-
ant communication port (115) to a closed position,
by a controller (130).

15. The refrigerant storage method according to claim 40
13 or 14, wherein a liquid inflow prevention part
(150) coupled to an end of the gas-phase refriger-
ant communication port (115) allows gas to pass
through and block an inflow of a liquid refrigerant. 45

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FIG. 1

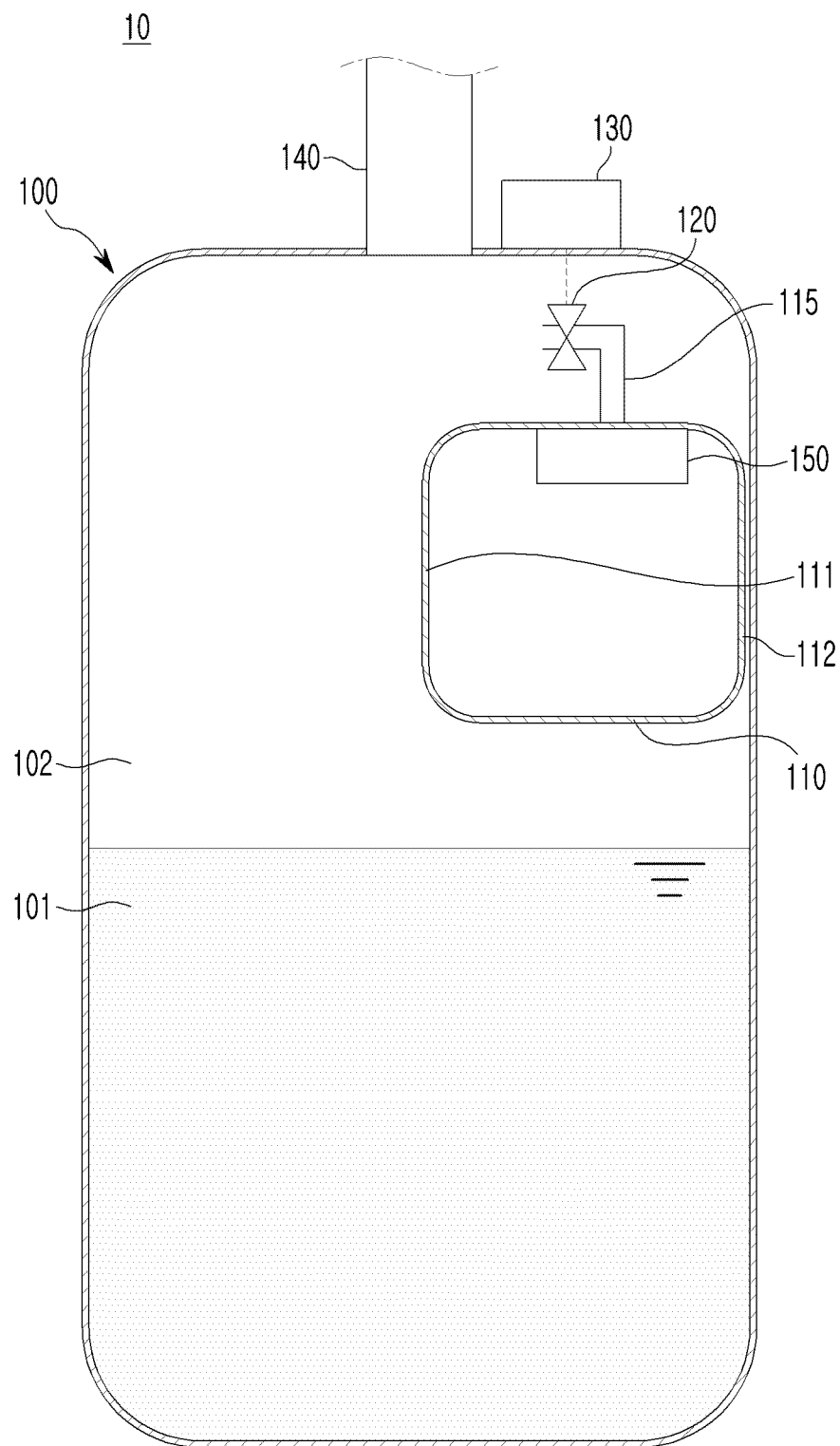


FIG. 2

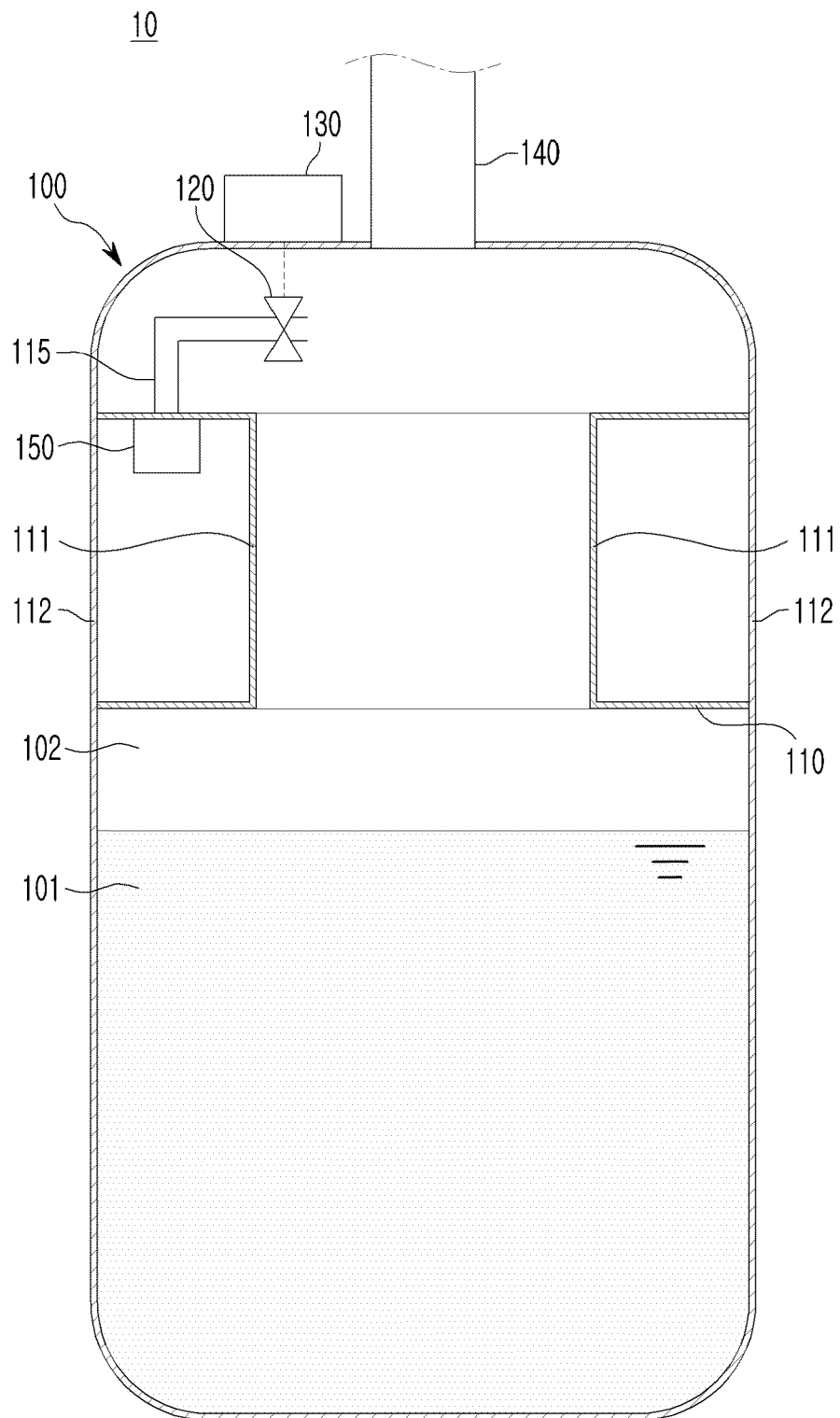


FIG. 3

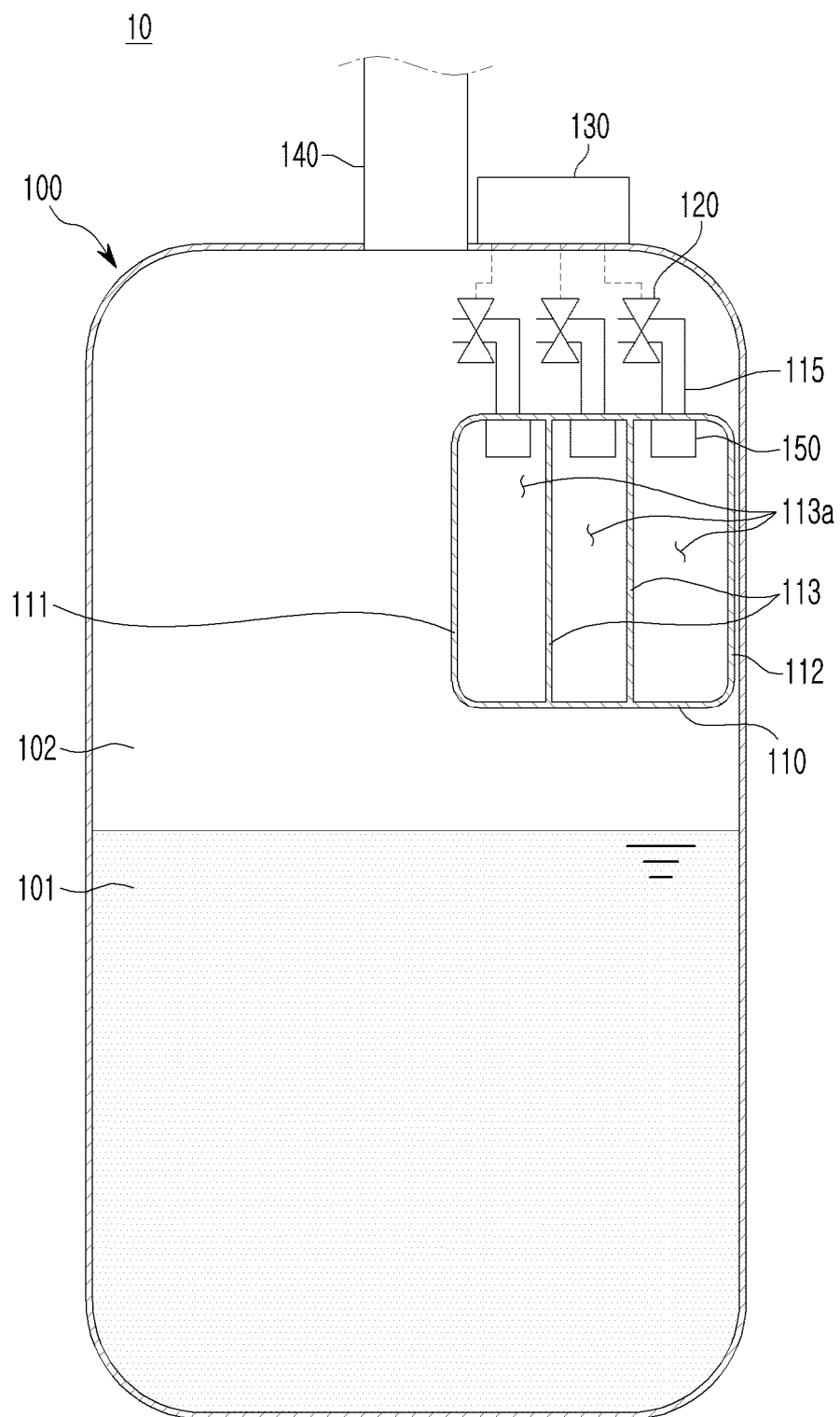


FIG. 4

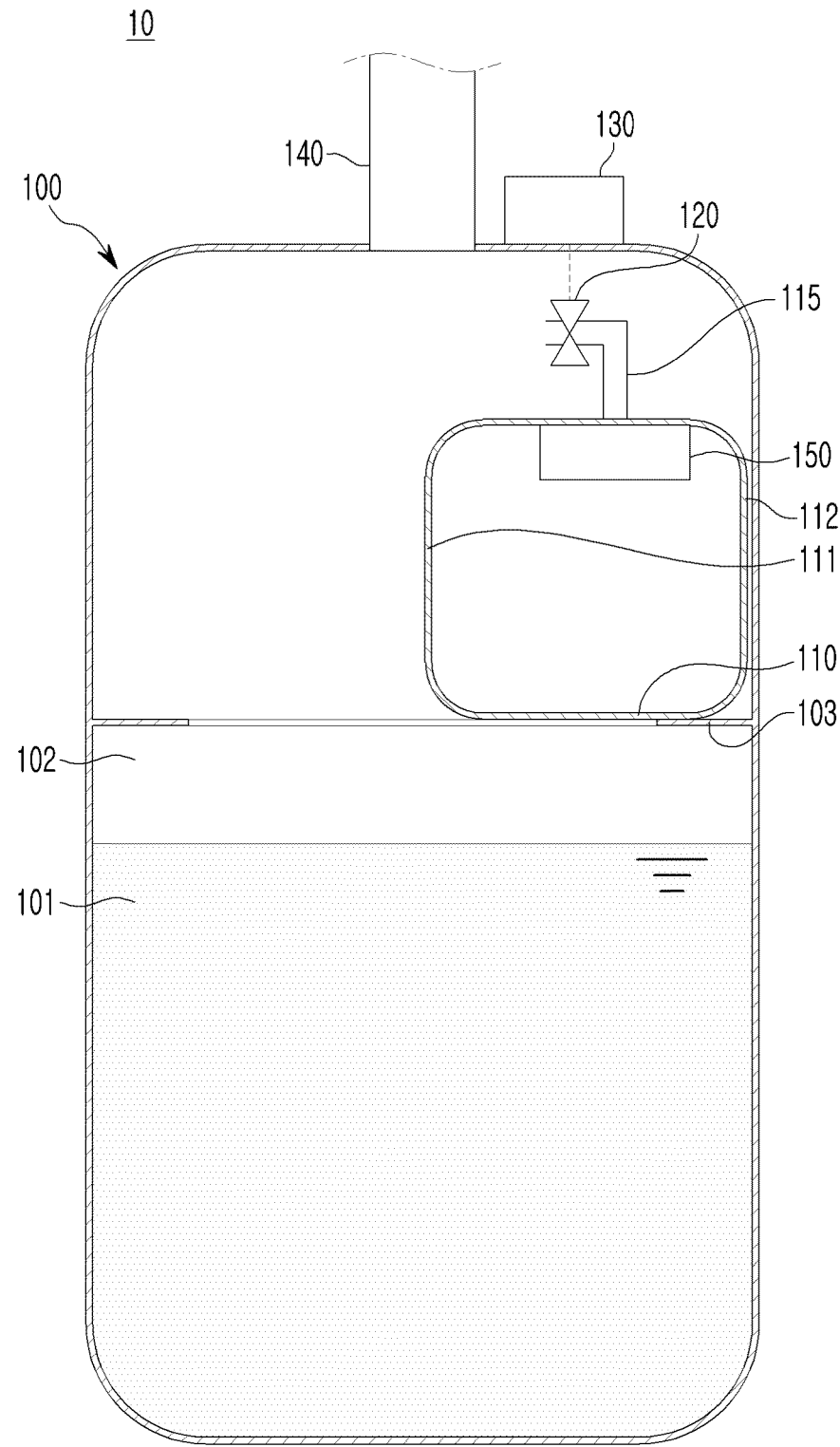
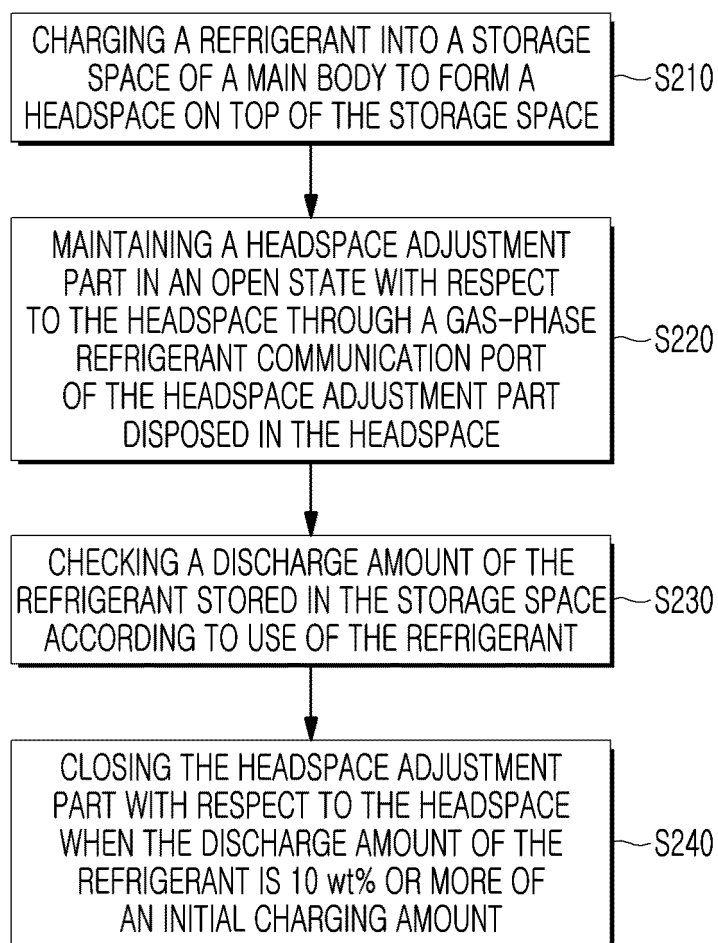


FIG. 5





EUROPEAN SEARCH REPORT

Application Number

EP 26 17 1883

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		1 September 2026	Lucic, Anita
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