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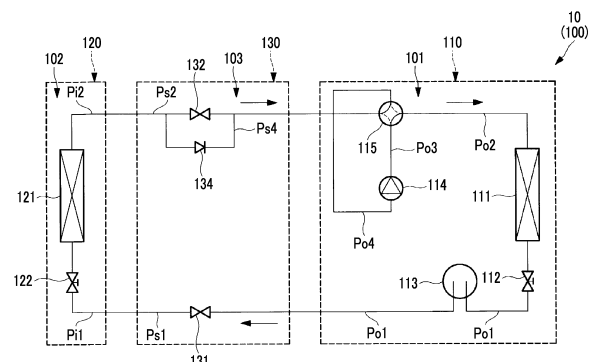
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(54) **SHUT-OFF UNIT, AIR-CONDITIONING DEVICE COMPRISING SAME, AND VACUUM DRAWING METHOD**

(57) The present invention provides a shut-off unit that, with simple control and a simple configuration, reduces pressure loss of a coolant caused by a shut-off valve, makes it possible to draw a vacuum in an indoor unit even in a state where there is no power supply yet at the installment site and the shut-off valve cannot be opened, and is capable of releasing the coolant to the outdoor unit. The present invention comprises: shut-off liquid coolant piping (Ps1) through which a liquid coolant flows; shut-off gas coolant piping (Ps2) through which a gas coolant flows; a liquid shut-off valve (131) which is provided to the shut-off liquid coolant piping (Ps1); a gas shut-off valve (132) which is provided to the shut-off gas coolant piping (Ps2); gas bypass piping (Ps4); and a gas check valve (134) which is provided to the gas bypass piping (Ps4), wherein the gas check valve (134) prevents the flow of coolant from an outdoor unit (110) to an indoor unit (120) and allows the flow of coolant from the indoor unit (120) to the outdoor unit (110).

FIG. 3



Description

Technical Field

[0001] The present disclosure relates to a shut-off unit, an air-conditioning apparatus including the shut-off unit, and a vacuum drawing method.

Background Art

[0002] In an air-conditioning apparatus including an outdoor unit and an indoor unit, when refrigerant detection means detects a leakage of a refrigerant in the indoor unit, it is necessary to shut off the indoor unit and the outdoor unit to keep the amount of the refrigerant leaking from the outdoor unit to the indoor unit to a minimum.

Citation List

Patent Literature

[0003] [PTL 1] Japanese Unexamined Patent Application Publication No. 2020-109342

Summary of Invention

Technical Problem

[0004] As the shut-off unit, it is conceivable to adopt a shut-off unit using a simple shut-off valve or a four-way valve as disclosed in PTL 1.

[0005] Meanwhile, in a case where the shut-off valve is adopted, there is a possibility that the performance during normal operation may be impaired due to a pressure loss caused by the shut-off valve. Meanwhile, in a case where the shut-off unit as in PTL 1 is adopted, the configuration and the control become complicated.

[0006] In addition, in a case where the leakage of the refrigerant is falsely detected in the first place, the refrigerant in the indoor unit is sealed by the shut-off valve, and when the sealed refrigerant is expanded due to some cause, there is a possibility that the piping or the device constituting the indoor unit may be burst or damaged.

[0007] In addition, in a case where the normal close electromagnetic valve is adopted as the shut-off valve, in a situation where there is no power supply yet at the installation location when the air-conditioning apparatus is installed, the shut-off valve cannot be opened and thus it is not possible to draw a vacuum in the refrigerant circuit. Nevertheless, in a case where the normal open electromagnetic valve is adopted, the indoor unit and the outdoor unit, which have original use, respectively, cannot be shut off when the power supply is lost (when not energized).

[0008] The present disclosure has been made in view of such circumstances, and an object thereof is to provide a shut-off unit capable of reducing a pressure loss of a refrigerant caused by a shut-off valve with a simple con-

trol or configuration, capable of releasing the refrigerant to an outdoor unit side, and capable of drawing a vacuum in an indoor unit even in a situation where there is no power supply yet at an installation location and a shut-off valve cannot be opened, an air-conditioning apparatus including the shut-off unit, and a vacuum drawing method.

Solution to Problem

[0009] In order to solve the above problems, a shut-off unit, an air-conditioning apparatus including the shut-off unit, and a vacuum drawing method according to the present disclosure adopt the following means.

[0010] That is, a shut-off unit according to one aspect of the present disclosure includes liquid refrigerant piping that connects an outdoor unit having an outdoor heat exchanger and an indoor unit having an indoor heat exchanger and in which a liquid refrigerant flows, gas refrigerant piping that connects the outdoor unit and the indoor unit and in which a gas refrigerant flows, a liquid shut-off valve that is provided in the liquid refrigerant piping, a gas shut-off valve that is provided in the gas refrigerant piping, gas bypass piping that connects two different locations of the gas refrigerant piping to bypass the gas shut-off valve, and a gas check valve that is provided in the gas bypass piping, in which the liquid check valve and the gas check valve prevent a flow of a refrigerant from the outdoor unit toward the indoor unit and allow a flow of a refrigerant from the indoor unit toward the outdoor unit.

[0011] In addition, an air-conditioning apparatus according to one aspect of the present disclosure includes the above-described shut-off unit, the indoor unit, and the outdoor unit.

[0012] In addition, a vacuum drawing method according to one aspect of the present disclosure is a vacuum drawing method of the above-described air-conditioning apparatus, in which the gas shut-off valve is a normal close electromagnetic valve, the vacuum drawing method includes drawing a vacuum in the gas refrigerant piping from the gas refrigerant piping on an outdoor unit side with respect to the gas shut-off valve.

Advantageous Effects of Invention

[0013] According to the present disclosure, the pressure loss of the refrigerant caused by the shut-off valve can be reduced with a simple control or configuration, a vacuum in the indoor unit can be drawn even in a situation where there is no power supply yet at the installation location and the shut-off valve cannot be opened, and the refrigerant can be released to the outdoor unit side.

Brief Description of Drawings

[0014]

Fig. 1 is a diagram showing a refrigerant circuit of an air-conditioning apparatus according to an embodiment of the present disclosure during cooling operation.

Fig. 2 is a diagram showing a refrigerant circuit of an air-conditioning apparatus according to the embodiment of the present disclosure during heating operation.

Fig. 3 is a diagram showing a refrigerant circuit of an air-conditioning apparatus according to a modification example of the embodiment of the present disclosure.

Fig. 4 is a diagram showing a refrigerant circuit of an air-conditioning apparatus according to the embodiment of the present disclosure during vacuum drawing. Description of Embodiments

[0015] Hereinafter, a shut-off unit, an air-conditioning apparatus including the shut-off unit, and a vacuum drawing method according to an embodiment of the present disclosure will be described with reference to the drawings.

[About Configuration of Apparatus]

[0016] The air-conditioning apparatus 10 is an apparatus that performs air-conditioning of a space such as a room.

[0017] As illustrated in Figs. 1 and 2, the air-conditioning apparatus 10 includes an outdoor unit 110, an indoor unit 120, and a shut-off unit 130.

[0018] In addition, in the air-conditioning apparatus 10, the refrigerant circuit 100 is configured by each device or each piece of refrigerant piping of the outdoor unit 110, the indoor unit 120, and the shut-off unit 130. The refrigerant circuit 100 includes an outdoor circuit 101, an indoor circuit 102, and a shut-off circuit 103. The refrigerant circuit 100 is filled with a refrigerant.

[0019] The outdoor unit 110 includes an outdoor heat exchanger 111, an outdoor expansion valve 112, a compressor 114, and a four-way valve 115.

[0020] These devices are connected by outdoor liquid refrigerant piping Po1, outdoor gas refrigerant piping Po2, discharge piping Po3, and suction piping Po4 to configure an outdoor circuit 101 that is a part of the refrigerant circuit 100.

[0021] The outdoor liquid refrigerant piping Po1 is piping connected to the outdoor heat exchanger 111. The outdoor liquid refrigerant piping Po1 is provided with an outdoor expansion valve 112. The outdoor expansion valve 112 is a shut-off valve in which an opening degree is adjustable. In addition, the outdoor liquid refrigerant piping Po1 may be provided with a receiver 113.

[0022] The outdoor gas refrigerant piping Po2 is piping that connects the outdoor heat exchanger 111 and the four-way valve 115.

[0023] The discharge piping Po3 is piping that connects a discharge port of the compressor 114 and the

four-way valve 115.

[0024] The suction piping Po4 is piping that connects a suction port of the compressor 114 and the four-way valve 115.

[0025] During the cooling operation (Fig. 1), the four-way valve 115 connects the discharge piping Po3 and the outdoor gas refrigerant piping Po2, and connects the shut-off gas refrigerant piping Ps2 (to be described later) and the suction piping Po4.

[0026] In addition, during the heating operation (Fig. 2), the four-way valve 115 connects the discharge piping Po3 and the shut-off gas refrigerant piping Ps2 (to be described later), and connects the outdoor gas refrigerant piping Po2 and the suction piping Po4.

[0027] The indoor unit 120 includes an indoor heat exchanger 121. The indoor liquid refrigerant piping Pi1 and the indoor gas refrigerant piping Pi2 are connected to the indoor heat exchanger 121, configuring the indoor circuit 102 which is a part of the refrigerant circuit 100.

[0028] The indoor liquid refrigerant piping Pi1 is provided with an indoor expansion valve 122. The indoor expansion valve 122 is a shut-off valve in which an opening degree is adjustable.

[0029] The shut-off unit 130 is an apparatus provided between the outdoor unit 110 and the indoor unit 120, and can connect/shut off the outdoor unit 110 (outdoor circuit 101) and the indoor unit 120 (indoor circuit 102).

[0030] The shut-off unit 130 has a liquid shut-off valve 131, a gas shut-off valve 132, a liquid check valve 133, and a gas check valve 134.

[0031] These devices are connected by the shut-off liquid refrigerant piping Ps1, the shut-off gas refrigerant piping Ps2, the liquid bypass piping Ps3, and the gas bypass piping Ps4, and constitute the shut-off circuit 103 which is a part of the refrigerant circuit 100.

[0032] The shut-off liquid refrigerant piping Ps1 is piping that connects the outdoor liquid refrigerant piping Po1 and the indoor liquid refrigerant piping Pi1.

[0033] The shut-off liquid refrigerant piping Ps1 is provided with a liquid shut-off valve 131.

[0034] The shut-off gas refrigerant piping Ps2 is piping that connects the outdoor gas refrigerant piping Po2 and the indoor gas refrigerant piping Pi2.

[0035] The shut-off gas refrigerant piping Ps2 is provided with a gas shut-off valve 132.

[0036] The liquid shut-off valve 131 and the gas shut-off valve 132 are valves that can be in a closed state (opening degree of 0 (zero)%), and, for example, an expansion valve, an electromagnetic valve (ON-OFF valve), or the like is adopted.

[0037] The liquid shut-off valve 131 and the gas shut-off valve 132 are in a closed state when the leakage of the refrigerant is detected in the indoor unit 120.

[0038] In this manner, it is possible to prevent the refrigerant from flowing from the outdoor circuit 101 (outdoor unit 110) to the indoor circuit 102 (indoor unit 120) via the shut-off liquid refrigerant piping Ps1 and the shut-off gas refrigerant piping Ps2, and to avoid further leak-

age of the refrigerant in the indoor unit 120.

[0039] The leakage of the refrigerant is performed by a refrigerant detector (not shown).

[0040] The refrigerant detector transmits a detection signal to an information processing device (not shown), and the information processing device controls the actuators of the liquid shut-off valve 131 and the gas shut-off valve 132.

[0041] For example, the information processing device is configured to include a central processing unit (CPU), a random access memory (RAM), a read only memory (ROM), and a computer-readable storage medium. Then, a series of processing for realizing various functions is stored in a storage medium or the like in the form of a program, as an example, and the CPU reads out this program to a RAM or the like, and executes processing for information processing and calculation, whereby various functions are realized. As the program, a form installed in advance in the ROM or other storage medium, a form of being provided in a state of being stored in the computer-readable storage medium, a form of being delivered via wired or wireless communication means, or the like may be applied. The computer-readable storage medium is a magnetic disk, a magneto-optical disk, a CD-ROM, a DVD-ROM, a semiconductor memory, or the like.

[0042] In addition, the information processing device executes not only control of the liquid shut-off valve 131 and the gas shut-off valve 132 but also control necessary for the operation of the air-conditioning apparatus 10, such as control of each device configuring the refrigerant circuit 100.

[0043] The liquid bypass piping Ps3 is piping that connects two different locations of the shut-off liquid refrigerant piping Ps1 while bypassing the liquid shut-off valve 131. That is, the liquid bypass piping Ps3 is piping that connects the shut-off liquid refrigerant piping Ps1 in front of and behind the liquid shut-off valve 131.

[0044] The liquid check valve 133 is provided in the liquid bypass piping Ps3.

[0045] The gas bypass piping Ps4 is piping that connects two different locations of the shut-off gas refrigerant piping Ps2 while bypassing the gas shut-off valve 132. That is, the gas bypass piping Ps4 is piping that connects the shut-off gas refrigerant piping Ps2 in front of and behind the gas shut-off valve 132.

[0046] The gas check valve 134 is provided in the gas bypass piping Ps4.

[0047] The liquid check valve 133 and the gas check valve 134 are check valves that prevent the flow of the refrigerant from the outdoor unit 110 toward the indoor unit 120 and allow the flow of the refrigerant from the indoor unit 120 toward the outdoor unit 110.

[0048] By configuring the liquid check valve 133 and the gas check valve 134 in this way, when the leakage of the refrigerant is detected in the indoor unit 120, the refrigerant can be prevented from flowing from the outdoor circuit 101 (outdoor unit 110) to the indoor circuit

102 (indoor unit 120) via the liquid bypass piping Ps3 and the gas bypass piping Ps4.

[0049] The closed refrigerant circuit 100 is configured by the outdoor circuit 101, the indoor circuit 102, and the shut-off circuit 103 described above.

[0050] Two or more indoor circuits 102 and the shut-off circuits 103 may be connected to one outdoor circuit 101. That is, the air-conditioning apparatus 10 may be a multi-type.

[0051] In the above description, the names of pieces of refrigerant piping are described separately for each unit (refrigerant circuit) for convenience. However, this does not mean that each piece of refrigerant piping is actually discontinuously configured. For example, the outdoor liquid refrigerant piping Po1, the shut-off liquid refrigerant piping Ps1, and the indoor liquid refrigerant piping Pi1, as well as the shut-off gas refrigerant piping Ps2 and the indoor gas refrigerant piping Pi2 are piping in which flow paths communicate with each other by being continuously connected.

[About Flow of Refrigerant during Cooling Operation]

[0052] As indicated by an arrow in Fig. 1, the refrigerant compressed by the compressor 114 passes through the four-way valve 115 and flows into the outdoor heat exchanger 111. The refrigerant flowing into the outdoor heat exchanger 111 exchanges heat with the outside air and flows out from the outdoor heat exchanger 111.

[0053] The refrigerant flowing out from the outdoor heat exchanger 111 flows into the indoor heat exchanger 121 through the outdoor expansion valve 112, the receiver 113, the liquid shut-off valve 131, and the indoor expansion valve 122. The refrigerant flowing into the indoor heat exchanger 121 exchanges heat with the indoor air and flows out from the indoor heat exchanger 121.

[0054] The refrigerant flowing out from the indoor heat exchanger 121 passes through the four-way valve 115 and is suctioned into the compressor 114.

[0055] In the flow of the refrigerant, the liquid refrigerant flowing from the outdoor heat exchanger 111 toward the indoor heat exchanger 121 flows through the shut-off liquid refrigerant piping Ps1. However, the liquid refrigerant does not flow through the liquid bypass piping Ps3 due to the liquid check valve 133.

[0056] Meanwhile, in the flow of the refrigerant, the gas refrigerant flowing from the indoor heat exchanger 121 toward the compressor 114 flows through both the shut-off gas refrigerant piping Ps2 and the gas bypass piping Ps4.

[0057] For this reason, in a range where the gas bypass piping Ps4 is connected, an effect of expanding the flow path area of the shut-off gas refrigerant piping Ps2 can be obtained. Accordingly, the influence of the pressure loss caused by the gas shut-off valve 132 can be reduced.

[About Flow of Refrigerant during Heating Operation]

[0058] As indicated by an arrow in Fig. 2, the refrigerant compressed by the compressor 114 passes through the four-way valve 115 and flows into the indoor heat exchanger 121. The refrigerant flowing into the indoor heat exchanger 121 exchanges heat with the indoor air and flows out from the indoor heat exchanger 121.

[0059] The refrigerant flowing out from the indoor heat exchanger 121 flows into the outdoor heat exchanger 111 through the indoor expansion valve 122, the liquid shut-off valve 131, the receiver 113, and the outdoor expansion valve 112. The refrigerant flowing into the outdoor heat exchanger 111 exchanges heat with the outside air and flows out from the outdoor heat exchanger 111.

[0060] The refrigerant flowing out from the outdoor heat exchanger 111 passes through the four-way valve 115 and is suctioned into the compressor 114.

[0061] In the flow of the refrigerant, the gas refrigerant flowing from the compressor 114 toward the indoor heat exchanger 121 flows through the shut-off gas refrigerant piping Ps2. However, the gas refrigerant does not flow through the gas bypass piping Ps4 due to the gas check valve 134.

[0062] Meanwhile, in the flow of the refrigerant, the liquid refrigerant flowing from the indoor heat exchanger 121 toward the outdoor heat exchanger 111 flows through both the shut-off liquid refrigerant piping Ps1 and the liquid bypass piping Ps3.

[0063] For this reason, in a range where the liquid bypass piping Ps3 is connected, an effect of expanding the flow path area of the shut-off liquid refrigerant piping Ps1 can be obtained. Accordingly, the influence of the pressure loss caused by the liquid shut-off valve 131 can be reduced.

[0064] In any of the above-described operation modes, the liquid check valve 133 or the gas check valve 134 has an effect of expanding the flow path area of the connected piping, and this effect is particularly advantageous during the cooling operation. The reason is as follows.

[0065] That is, during the cooling operation, the gas refrigerant that has passed through the shut-off gas refrigerant piping Ps2 is directly suctioned into the compressor 114. In addition, the gas refrigerant has a higher flow velocity than the liquid refrigerant, and the influence of the pressure loss due to the valve is greater than that of the liquid refrigerant. For this reason, the flow rate and the density of the gas refrigerant flowing toward the compressor 114 are reduced by providing the gas shut-off valve 132 in the shut-off gas refrigerant piping Ps2. In this case, since the load on the compressor 114 increases, the efficiency as the air-conditioning apparatus 10 decreases.

[0066] Meanwhile, during the heating operation, the liquid refrigerant that has passed through the shut-off liquid refrigerant piping Ps1 is suctioned into the compressor 114 via the receiver 113 or the outdoor heat exchanger

111. In other words, the liquid refrigerant that has passed through the shut-off liquid refrigerant piping Ps1 is not directly suctioned into the compressor 114. In addition, the liquid refrigerant has a lower flow velocity than the gas refrigerant, and the influence of the pressure loss due to the valve is smaller than that of the gas refrigerant. For this reason, even when the liquid shut-off valve 131 is provided in the shut-off liquid refrigerant piping Ps1, the load on the compressor 114 is not affected as much as during the cooling operation, and the decrease in efficiency as the air-conditioning apparatus 10 is unlikely to be manifested.

[0067] Therefore, as illustrated in Fig. 3, as long as at least the gas bypass piping Ps4 and the gas check valve 134 are provided, the air-conditioning apparatus 10 can obtain an effect of expanding the flow path area. For this reason, the liquid bypass piping Ps3 and the liquid check valve 133 can also be omitted.

[About Refrigerant Leakage Detection]

[0068] As described above, when the leakage of the refrigerant is detected in the indoor unit 120, the liquid shut-off valve 131 and the gas shut-off valve 132 are closed, so that the refrigerant can be prevented from flowing from the outdoor circuit 101 to the indoor circuit 102 via the liquid bypass piping Ps3 and the gas bypass piping Ps4.

[0069] At this time, in a case where this is a false detection and the shut-off unit 130 does not include the liquid check valve 133 and the gas check valve 134, the air-conditioning apparatus 10 has the following problems.

[0070] That is, the liquid shut-off valve 131 and the gas shut-off valve 132 are in a closed state, so that the refrigerant filling the indoor unit 120 (indoor circuit 102) is sealed.

[0071] In this case, when the refrigerant piping or the device configuring the indoor circuit 102 is heated due to some cause, there is a possibility that the sealed refrigerant may expand and the refrigerant piping or the device may be burst or damaged.

[0072] In order to avoid the burst and the damage, a method of installing a pressure sensor in the indoor circuit 102 and releasing the refrigerant to the outside when the pressure equal to or higher than a predetermined value is detected is conceivable. However, the method is not preferable because the control is required and the refrigerant is released to the outside.

[0073] Therefore, by providing the liquid check valve 133 and the gas check valve 134 in the shut-off unit 130, the refrigerant can be released from the indoor unit 120 to the outdoor unit 110 via the liquid check valve 133 and the gas check valve 134 even when the liquid shut-off valve 131 and the gas shut-off valve 132 are in a closed state. In this manner, it is possible to avoid the burst or the damage to the refrigerant piping or the device configuring the indoor unit 120.

[0074] In addition, even in a case where the above-described liquid bypass piping Ps3 and the liquid check valve 133 are omitted, the refrigerant can be released from the indoor unit 120 to the outdoor unit 110 via the gas check valve 134. For this reason, the liquid bypass piping Ps3 and the liquid check valve 133 can be omitted.

[0075] However, by providing the liquid bypass piping Ps3 and the liquid check valve 133 in addition to the gas bypass piping Ps4 and the gas check valve 134, the following effects can be obtained.

[0076] That is, when the leakage of the refrigerant is correctly detected in the indoor unit 120, there is a possibility that a sudden problem (for example, an earthquake) has occurred in the building facility in which the indoor unit 120 is installed. In this case, it may not be predictable whether the indoor expansion valve 122 is in a closed state or an open state. In a case where the indoor expansion valve 122 is in a closed state (fully closed state), in a case where the liquid bypass piping Ps3 and the liquid check valve 133 are not provided, there is a possibility that the refrigerant sealed between the indoor expansion valve 122 and the liquid shut-off valve 131 may expand and the refrigerant piping or the device may be burst or damaged. Therefore, by providing the liquid bypass piping Ps3 and the liquid check valve 133, it is possible to avoid the sealing of the refrigerant between the indoor expansion valve 122 and the liquid shut-off valve 131.

[0077] In a case where the liquid bypass piping Ps3 and the liquid check valve 133 are provided, the amount of the refrigerant leakage to the indoor unit 120 can be reduced by closing the indoor expansion valve 122 in conjunction with the operation of closing the liquid shut-off valve 131 in a case where the leakage of the refrigerant is detected.

[0078] The refrigerant capacity of the outdoor unit 110 (outdoor circuit 101) having the receiver 113 or the like is sufficiently larger than the refrigerant capacity of the indoor unit 120 (indoor circuit 102). For this reason, even if the refrigerant is released to the outdoor unit 110, it is allowed.

[About Vacuum Drawing]

[0079] In a case where the installation construction of the air-conditioning apparatus 10 is performed, it is necessary to perform the vacuum drawing of the refrigerant circuit 100 in order to remove impurities such as air and moisture contained in the refrigerant circuit 100.

[0080] As illustrated in Fig. 4, the vacuum drawing is performed by pieces of vacuum drawing piping Pb1 and Pb2 connected to the refrigerant piping on the outdoor unit 110 side with respect to the liquid shut-off valve 131 and the gas shut-off valve 132 and one vacuum pump 140 connected to pieces of vacuum drawing piping Pb1 and Pb2.

[0081] At this time, in a case where the normal close electromagnetic valve is adopted as the liquid shut-off

valve 131 and the gas shut-off valve 132 and the shut-off unit 130 does not include the liquid check valve 133 and the gas check valve 134, there is a following problem in performing the vacuum drawing.

[0082] That is, in a situation where there is no power supply yet at the installation location when the air-conditioning apparatus 10 is installed, the liquid shut-off valve 131 and the gas shut-off valve 132 cannot be opened, and thus it is not possible to draw a vacuum in the indoor circuit 102 (indoor unit 120). Nevertheless, in a case where the normal open electromagnetic valve is adopted as the liquid shut-off valve 131 and the gas shut-off valve 132, the indoor unit 120 and the outdoor unit 110, which have original use, respectively, cannot be continuously shut off when the power supply is lost (when not energized).

[0083] Therefore, by providing the liquid check valve 133 and the gas check valve 134 in the shut-off unit 130, it is possible to draw the vacuum in the indoor circuit 102 (indoor unit 120) via the liquid check valve 133 and the gas check valve 134 even in a situation where the liquid shut-off valve 131 and the gas shut-off valve 132 cannot be opened.

[0084] Even in a case where the above-described liquid bypass piping Ps3 and the liquid check valve 133 are omitted, it is possible to draw the vacuum in the indoor circuit 102 (indoor unit 120) via the gas check valve 134.

[About Type of Shut-Off Valve]

[0085] As the types and combination of the liquid shut-off valve 131 and the gas shut-off valve 132, for example, the following patterns are conceivable.

<Pattern 1>

[0086] A pattern in which any one of the liquid shut-off valve 131 and the gas shut-off valve 132 is an expansion valve and the other is a normal close electromagnetic valve is conceivable.

[0087] In this case, for example, the open state of the expansion valve is maintained at the time of shipment of the shut-off unit 130, so that the vacuum drawing of the indoor circuit 102 can be efficiently performed.

[0088] In general, the expansion valve maintains the opening degree at the moment when the energization state (state controlled in a normal manner) is changed to the non-energization state. For example, in a case where the power supply is lost in a state where the opening degree is 100%, the opening degree is maintained at 100%.

[0089] For this reason, when the outdoor circuit 101 and the indoor circuit 102 are to be shut off at the time of power supply loss, the expansion valve is in a closed state by means of the backup power supply (battery or the like). The air-conditioning apparatus 10 is provided with the backup power supply in advance.

<Pattern 2>

[0090] A pattern in which both the liquid shut-off valve 131 and the gas shut-off valve 132 are expansion valves is conceivable.

[0091] In this case, for example, the open state of the expansion valve is maintained at the time of shipment of the shut-off unit 130, so that the vacuum drawing of the indoor circuit 102 can be more efficiently performed.

<Pattern 3>

[0092] A pattern in which both the liquid shut-off valve 131 and the gas shut-off valve 132 are normal close electromagnetic valves is conceivable.

[0093] In this case, the outdoor unit 110 and the indoor unit 120 can be automatically shut off without using the backup power supply when the power supply is lost.

[0094] The normal close electromagnetic valve is an electromagnetic valve that is in a closed state (opening degree of 0%) when not energized. In addition, the normal open electromagnetic valve is an electromagnetic valve that is in an open state (opening degree of 100%) when not energized.

[0095] According to the present embodiment, the following effects are obtained.

[0096] That is, the liquid bypass piping Ps3, the gas bypass piping Ps4, the liquid check valve 133 provided in the liquid bypass piping Ps3, and the gas check valve 134 provided in the gas bypass piping Ps4 are provided, and the liquid check valve 133 and the gas check valve 134 prevent the flow of the refrigerant from the outdoor unit 110 toward the indoor unit 120 and allow the flow of the refrigerant from the indoor unit 120 toward the outdoor unit 110.

[0097] Accordingly, during the cooling operation, the effect of expanding the flow path of the shut-off gas refrigerant piping Ps2 by means of the gas bypass piping Ps4 can be obtained, and the pressure loss of the refrigerant caused by the gas shut-off valve 132 can be reduced. In addition, during the heating operation, the effect of expanding the flow path of the shut-off liquid refrigerant piping Ps1 by means of the liquid bypass piping Ps3 can be obtained, and the pressure loss of the refrigerant caused by the liquid shut-off valve 131 can be reduced.

[0098] In particular, during the cooling operation, the gas refrigerant flowing through the shut-off gas refrigerant piping Ps2 is directly suctioned into the compressor 114. Therefore, in a case where a load on the compressor 114 is taken into consideration, it is particularly advantageous to reduce the pressure loss of the gas refrigerant to secure the flow rate and the density of the gas refrigerant.

[0099] In addition, even when the leakage of the refrigerant is falsely detected and the liquid shut-off valve 131 and the gas shut-off valve 132 are in the closed state, the indoor unit 120 communicates with the outdoor unit

110 via the shut-off unit 130 (specifically, the liquid check valve 133 and the gas check valve 134). Therefore, even when the refrigerant in the indoor unit 120 is expanded due to some cause, the refrigerant can be released from the indoor unit 120 to the outdoor unit 110. In this manner, it is possible to avoid the burst or the damage to the piping or the device configuring the indoor unit 120.

[0100] In addition, in a case where the air-conditioning apparatus 10 including the shut-off unit 130 is installed, it is possible to draw the vacuum in the indoor unit 120 via the liquid check valve 133 and the gas check valve 134 even in a situation where there is no power supply yet at the installation location and the liquid shut-off valve 131 and the gas shut-off valve 132 cannot be opened. In other words, even when both the liquid shut-off valve 131 and the gas shut-off valve 132 are in a closed state, it is possible to draw the vacuum in the indoor unit 120 via the liquid check valve 133 and the gas check valve 134.

[0101] In addition, in any case, since complicated control or an additional valve is not required, it is possible to simplify the configuration and control and to improve the reliability as an apparatus.

[0102] In addition, by using one or both of the liquid shut-off valve 131 and the gas shut-off valve 132 as an expansion valve and keeping one or both of the liquid shut-off valve 131 and the gas shut-off valve 132 in an open state during the vacuum drawing, it is possible to efficiently perform vacuum drawing in conjunction with the liquid check valve 133 and the gas check valve 134.

[0103] In addition, when the liquid shut-off valve 131 and the gas shut-off valve 132 are used as the normal close electromagnetic valves, the shut-off liquid refrigerant piping Ps1 and the shut-off gas refrigerant piping Ps2 can be automatically shut off when the power supply is lost, and the amount of the refrigerant flowing from the outdoor unit 110 to the indoor unit 120 can be kept to a minimum.

[0104] The shut-off unit, the air-conditioning apparatus including the shut-off unit, and the vacuum drawing method according to the embodiment described above are understood as follows, for example.

[0105] That is, a shut-off unit (130) according to one aspect of the present disclosure includes liquid refrigerant piping (Ps1) that connects an outdoor unit (110) having an outdoor heat exchanger (111) and an indoor unit (120) having an indoor heat exchanger (121) and in which a liquid refrigerant flows, gas refrigerant piping (Ps2) that connects the outdoor unit and the indoor unit and in which a gas refrigerant flows, a liquid shut-off valve (131) that is provided in the liquid refrigerant piping, a gas shut-off valve (132) that is provided in the gas refrigerant piping, gas bypass piping (Ps4) that connects two different locations of the gas refrigerant piping to bypass the gas shut-off valve, and a gas check valve (134) that is provided in the gas bypass piping, in which the liquid check valve and the gas check valve prevent a flow of a refrigerant from the outdoor unit toward the indoor unit and

allow a flow of a refrigerant from the indoor unit toward the outdoor unit.

[0106] According to the shut-off unit in the present aspect, for example, during the cooling operation, the effect of expanding the flow path of the gas refrigerant piping by means of the gas bypass piping can be obtained, and the pressure loss of the refrigerant caused by the gas shut-off valve provided in the gas refrigerant piping can be reduced.

[0107] In addition, if the shut-off unit according to the aspect of the present disclosure further includes liquid bypass piping (Ps3) that connects two different locations of the liquid refrigerant piping to bypass the liquid shut-off valve, and a liquid check valve (133) that is provided in the liquid bypass piping, for example, even during the heating operation, the effect of expanding the flow path of the liquid refrigerant piping by means of the liquid bypass piping can be obtained, and the pressure loss of the refrigerant caused by the liquid shut-off valve provided in the liquid refrigerant piping can be reduced.

[0108] The effect of expanding the flow path can be obtained in either case of during the cooling operation or during the heating operation. However, in particular, during the cooling operation, the gas refrigerant flowing through the gas refrigerant piping is directly suctioned into the compressor. Therefore, in a case where a load on the compressor is taken into consideration, it is particularly advantageous to reduce the pressure loss of the gas refrigerant to secure the flow rate and the density of the gas refrigerant.

[0109] In addition, even when the leakage of the refrigerant is falsely detected and the liquid shut-off valve and the gas shut-off valve are in the closed state, the indoor unit communicates with the outdoor unit via the shut-off unit (specifically, the liquid check valve and the gas check valve). Therefore, even when the refrigerant in the indoor unit is expanded due to some cause, the refrigerant can be released from the indoor unit to the outdoor unit. In this manner, it is possible to avoid the burst or the damage to the piping or the device configuring the indoor unit.

[0110] In addition, in a case where the air-conditioning apparatus including the shut-off unit is installed, it is possible to draw the vacuum in the indoor unit via the liquid check valve and the gas check valve even in a situation where there is no power supply yet at the installation location and the liquid shut-off valve and the gas shut-off valve cannot be opened. In other words, even when both the liquid shut-off valve and the gas shut-off valve are in a closed state, it is possible to draw the vacuum in the indoor unit via the liquid check valve and the gas check valve.

[0111] In addition, in any case, since complicated control or an additional valve is not required, it is possible to simplify the configuration and control and to improve the reliability as an apparatus.

[0112] In addition, in the shut-off unit according to the aspect of the present disclosure, one or both of the liquid shut-off valve and the gas shut-off valve is an expansion

valve.

[0113] According to the shut-off unit in the present aspect, one or both of the liquid shut-off valve and the gas shut-off valve is the expansion valve. Therefore, it is possible to efficiently perform vacuum drawing in conjunction with the liquid shut-off valve and the gas shut-off valve by keeping one or both of the liquid shut-off valve and the gas shut-off valve in an open state during the vacuum drawing.

[0114] In addition, in the shut-off unit according to the aspect of the present disclosure, the liquid shut-off valve and the gas shut-off valve are normal close electromagnetic valves.

[0115] According to the shut-off unit in the present aspect, the liquid shut-off valve and the gas shut-off valve are the normal close electromagnetic valves. Therefore, the liquid refrigerant piping and the gas refrigerant piping can be automatically shut off when the power supply is lost, and the amount of the refrigerant flowing from the outdoor unit to the indoor unit can be kept to a minimum.

[0116] In addition, an air-conditioning apparatus (10) according to one aspect of the present disclosure includes the above-described shut-off unit, the indoor unit, and the outdoor unit.

[0117] In addition, a vacuum drawing method according to one aspect of the present disclosure is a vacuum drawing method of the above-described air-conditioning apparatus, in which the liquid shut-off valve and the gas shut-off valve are normal close electromagnetic valves, the vacuum drawing method includes drawing a vacuum in the liquid refrigerant piping from the liquid refrigerant piping on an outdoor unit side with respect to the liquid shut-off valve, and drawing a vacuum in the gas refrigerant piping from the gas refrigerant piping on the outdoor unit side with respect to the gas shut-off valve.

Reference Signs List

[0118]

- 10: air-conditioning apparatus
- 100: refrigerant circuit
- 101: outdoor circuit
- 102: indoor circuit
- 103: shut-off circuit
- 110: outdoor unit
- 111: outdoor heat exchanger
- 112: outdoor expansion valve
- 113: receiver
- 114: compressor
- 115: four-way valve
- 120: indoor unit
- 121: indoor heat exchanger
- 122: indoor expansion valve
- 130: shut-off unit
- 131: liquid shut-off valve
- 132: gas shut-off valve
- 133: liquid check valve

134: gas check valve
 140: vacuum pump
 Pb1, Pb2: vacuum drawing piping
 Pi1: indoor liquid refrigerant piping
 Pi2: indoor gas refrigerant piping
 Po1: outdoor liquid refrigerant piping
 Po2: outdoor gas refrigerant piping
 Po3: discharge piping
 Po4: suction piping
 Ps1: shut-off liquid refrigerant piping (liquid refrigerant piping)
 Ps2: shut-off gas refrigerant piping (gas refrigerant piping)
 Ps3: liquid bypass piping
 Ps4: gas bypass piping

Claims

1. A shut-off unit comprising:
 - liquid refrigerant piping that connects an outdoor unit having an outdoor heat exchanger and an indoor unit having an indoor heat exchanger and in which a liquid refrigerant flows;
 - gas refrigerant piping that connects the outdoor unit and the indoor unit and in which a gas refrigerant flows;
 - a liquid shut-off valve that is provided in the liquid refrigerant piping;
 - a gas shut-off valve that is provided in the gas refrigerant piping;
 - gas bypass piping that connects two different locations of the gas refrigerant piping to bypass the gas shut-off valve; and
 - a gas check valve that is provided in the gas bypass piping,
 - wherein the gas check valve prevents a flow of a refrigerant from the outdoor unit toward the indoor unit and allows a flow of a refrigerant from the indoor unit toward the outdoor unit.
2. The shut-off unit according to Claim 1, further comprising:
 - liquid bypass piping that connects two different locations of the liquid refrigerant piping to bypass the liquid shut-off valve; and
 - a liquid check valve that is provided in the liquid bypass piping,
 - wherein the liquid check valve prevents the flow of the refrigerant from the outdoor unit toward the indoor unit and allows the flow of the refrigerant from the indoor unit toward the outdoor unit.
3. The shut-off unit according to Claim 1 or 2, wherein one or both of the liquid shut-off valve and

the gas shut-off valve is an expansion valve.

4. The shut-off unit according to Claim 1 or 2, wherein the liquid shut-off valve and the gas shut-off valve are normal close electromagnetic valves.
5. An air-conditioning apparatus comprising:
 - the shut-off unit according to Claim 1 or 2;
 - the indoor unit; and
 - the outdoor unit.
6. A vacuum drawing method of the air-conditioning apparatus according to Claim 5, in which the liquid shut-off valve and the gas shut-off valve are normal close electromagnetic valves, the vacuum drawing method comprising:

drawing a vacuum in the liquid refrigerant piping from the liquid refrigerant piping on an outdoor unit side with respect to the liquid shut-off valve; and
 drawing a vacuum in the gas refrigerant piping from the gas refrigerant piping on the outdoor unit side with respect to the gas shut-off valve.

FIG. 1

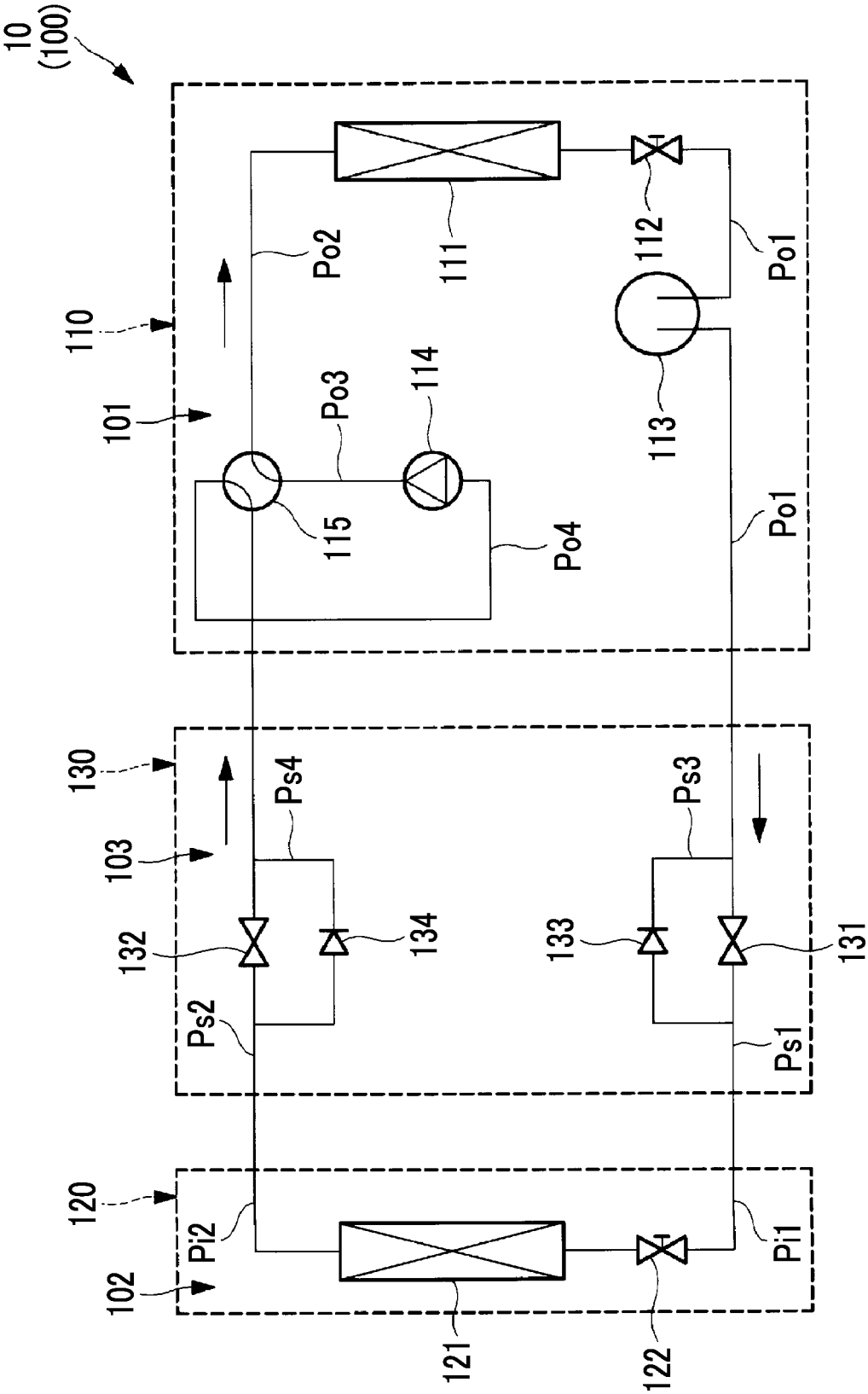


FIG. 2

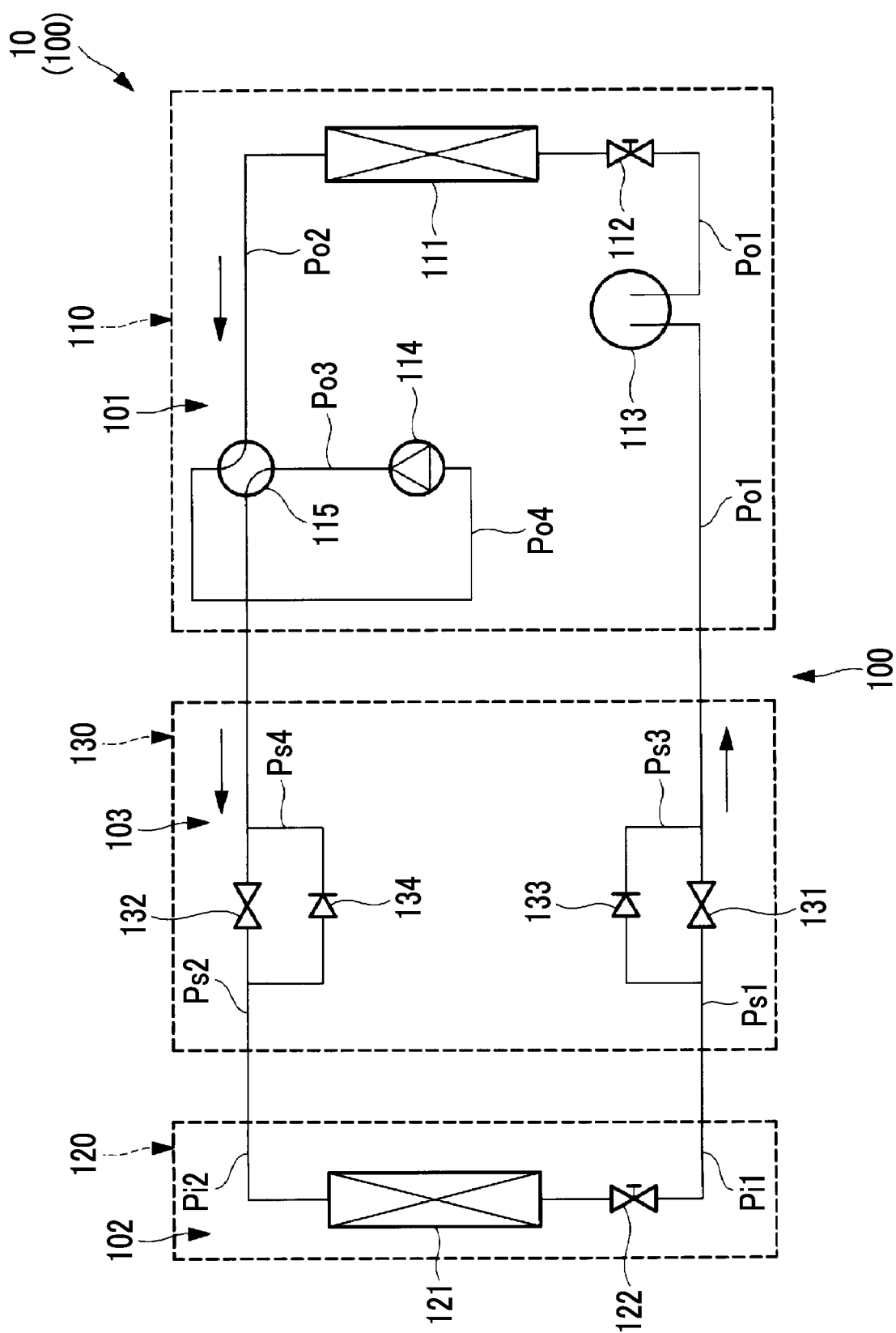


FIG. 3

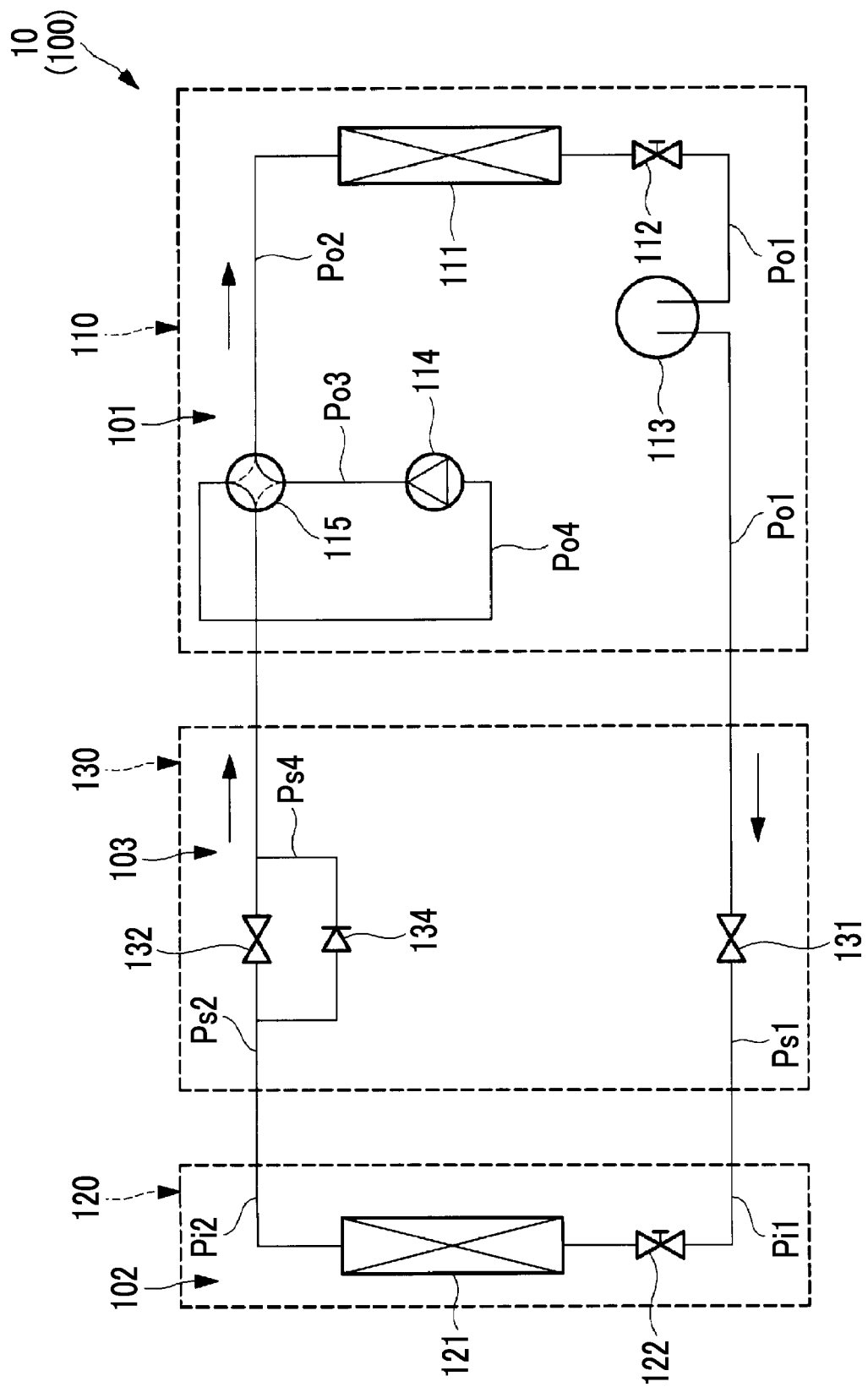
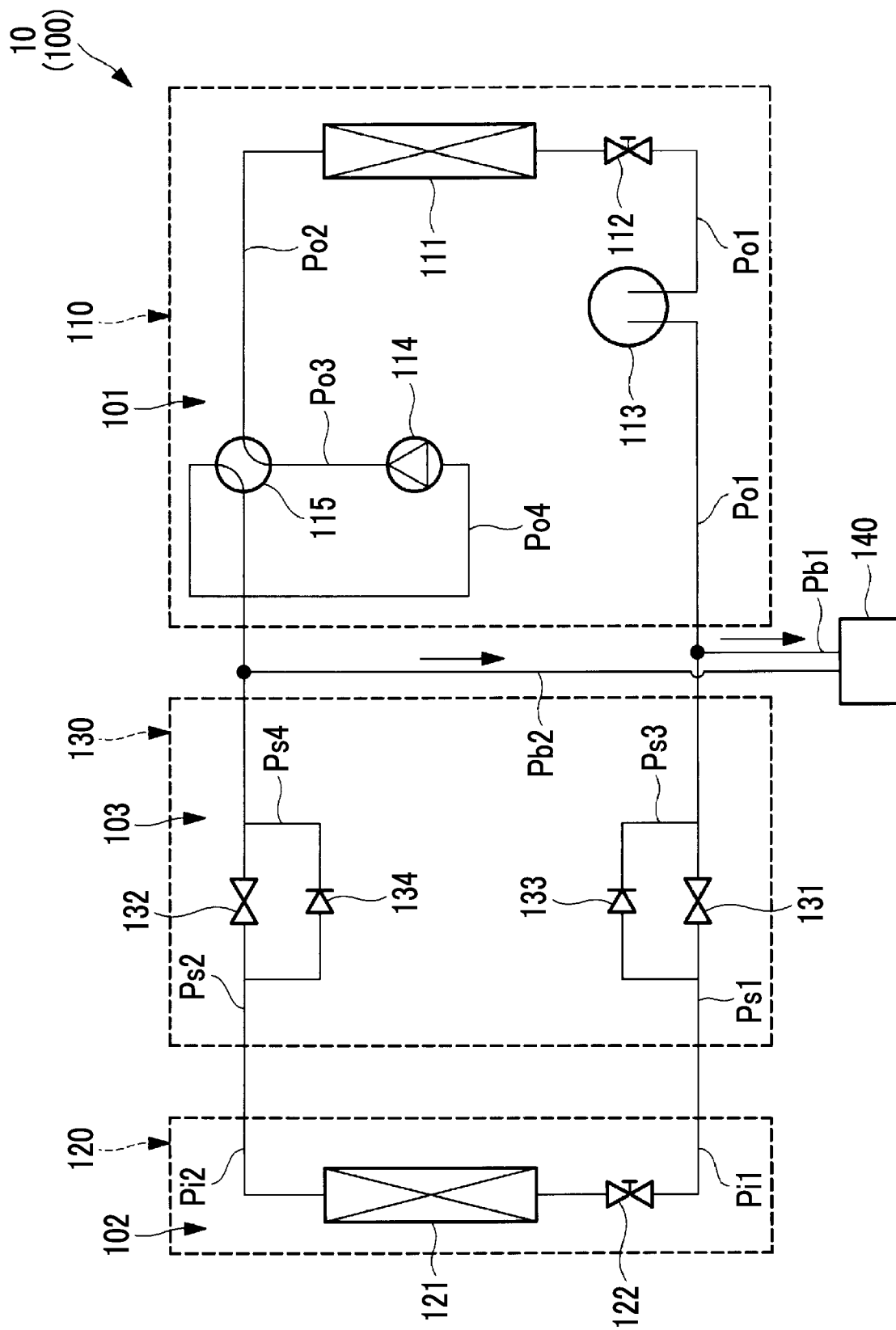


FIG. 4



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/042910

A. CLASSIFICATION OF SUBJECT MATTER

F25B 41/24(2021.01)i; **F24F 1/32**(2011.01)i; **F24F 11/36**(2018.01)i; **F25B 1/00**(2006.01)i; **F25B 49/02**(2006.01)i
FI: F25B41/24; F24F1/32; F24F11/36; F25B1/00 101Z; F25B49/02 520M

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)

F25B1/00-49/04; F24F1/00-13/32

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 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

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	WO 2020/202548 A1 (MITSUBISHI ELECTRIC CORPORATION) 08 October 2020 (2020-10-08) paragraphs [0014]-[0018], [0042], fig. 1, 9	1-6
Y	WO 2018/062528 A1 (DAIKIN INDUSTRIES, LTD.) 05 April 2018 (2018-04-05) paragraphs [0073], [0131]-[0135], [0190]-[0200], fig. 14	1-6
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 134789/1981 (Laid-open No. 39468/1983) (MITSUBISHI HEAVY IND LTD) 15 March 1983 (1983-03-15), p. 4, lines 1-18, fig. 1	1
A	JP 2009-145026 A (HITACHI APPLIANCES INC) 02 July 2009 (2009-07-02) paragraphs [0020], [0028]-[0031], fig. 1	2
P, X	JP 2022-106400 A (PANASONIC IP MAN CORP) 20 July 2022 (2022-07-20) paragraphs [0013], [0019], [0025], [0029], fig. 1	1, 4-5
E, X	JP 2022-181077 A (PANASONIC IP MAN CORP) 07 December 2022 (2022-12-07) paragraphs [0033]-[0036], fig. 1	1-2, 5

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

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Date of the actual completion of the international search

13 December 2022

Date of mailing of the international search report

27 December 2022

Name and mailing address of the ISA/JP

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Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/042910

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2020/202548 A1	08 October 2020	(Family: none)	
WO 2018/062528 A1	05 April 2018	US 2019/0234660 A1 paragraphs [0086], [0145]- [0149], [0202]-[0213], fig. 14 EP 3521731 A1 CN 109791009 A	
JP 58-39468 U1	15 March 1983	(Family: none)	
JP 2009-145026 A	02 July 2009	(Family: none)	
JP 2022-106400 A	20 July 2022	(Family: none)	
JP 2022-181077 A	07 December 2022	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2020109342 A [0003]