

Description

TECHNICAL FIELD

5 [0001] The present invention relates to an air conditioning system. More specifically, the present invention relates to an air conditioning system capable of heating the room.

BACKGROUND ART

10 [0002] As an air conditioning system capable of heating the room, conventionally known is a system configured by connecting room heating devices such as a radiator and a fan convector to a heat source unit having a vapor compression type refrigerant circuit (for example, see patent documents 1, 2, and 3). Such an air conditioning system heats the room by heating a floor and indoor air.

15 [0003] In addition, as a heat source unit of such an air conditioning system, a unit having a refrigerant circuit that uses CO₂ as the refrigerant is used in some cases. In such a heat source unit that uses CO₂ as the refrigerant, the refrigerant temperature on a discharge side of a compressor can be increased, and therefore, for example, when an air conditioning system is configured such that the heat of a heating medium heated in a utilization side heat exchanger in the heat source unit is released into the room by the room heating devices, the temperature level that can be used for heating the room in the room heating devices can be increased. This will achieve comfortable room heating.

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<Patent Document 1>

Japanese Patent Application Publication No. 2003-50050

<Patent Document 2>

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<Patent Document 3>

Japanese Patent Application Publication No. 2003-50035

DISCLOSURE OF THE INVENTION

30 [0004] When an air conditioning system as described above is used for air conditioning in a house with high airtightness, the minimally necessary ventilation in the room needs to be performed in order to maintain indoor air quality (hereinafter referred to as IAQ). However, when the temperature of outdoor air is low such as during the winter season (hereinafter referred to as a low outdoor air temperature period), outdoor air whose temperature is lower than that of indoor air will be supplied to the room as the ventilation air, so that a heat load due to ventilation in the room (hereinafter referred to as a ventilation heat load) will be generated. This ventilation heat load will be treated by the room heating devices after the ventilation air is supplied to the room and mixed with indoor air, which consequently causes the room occupant to feel discomfort due to the supply of low temperature ventilation air (hereinafter referred to as a cold draft). In particular, in recent years, there are more houses having high airtightness and high heat insulation properties, in which high heat insulation properties are added besides high airtightness. In such houses having high airtightness and high heat insulation properties, improved heat insulation properties can reduce the total amount of heat load; however, the ventilation heat load necessary for maintenance of IAQ cannot be reduced. Therefore, the proportion of the ventilation heat load to the total amount of heat load to be treated in the air conditioning system is relatively large. Accordingly, it is desired to prevent a cold draft while treating the ventilation heat load in an air conditioning system capable of heating the room.

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[0005] In addition, when the above described type of a heat source unit that uses CO₂ as the refrigerant is used, the temperature level that can be used in the room heating devices can be increased, however, the temperature difference between an inlet and an outlet of the utilization side heat exchanger will be reduced, resulting in a reduced coefficient of performance (hereinafter referred to as COP) of the heat source unit. Accordingly, it is desired to improve the COP in an air conditioning system capable of heating the room, which uses a heat source unit that uses CO₂ as the refrigerant.

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[0006] Therefore, an object of the present invention is to prevent, in an air conditioning system capable of heating the room, a cold draft due to the ventilation air that is supplied to the room for ventilation in the room.

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[0007] An air conditioning system according to a first aspect of the present invention is an air conditioning system capable of heating a room, comprising a heat source unit, an air supply device, and a heating medium circuit. The heat source unit includes a vapor compression type refrigerant circuit having a compressor, a heat source side heat exchanger, an expansion mechanism, and a utilization side heat exchanger, and is capable of heating, in the utilization side heat exchanger, a heating medium that is used for heating the room. The air supply device supplies an outdoor air to the room as a ventilation air. The heating medium circuit includes at least one room heating device that releases the heat of the heating medium heated in the utilization side heat exchanger into the room, and an outdoor air heating device that heats the ventilation air with the heat of the heating medium heated in the utilization side heat exchanger, and

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circulates the heating medium between the room heating device and the outdoor air heating device, and the utilization side heat exchanger.

[0008] In this air conditioning system, the high temperature and high pressure refrigerant compressed in and discharged from the compressor heats the heating medium in the utilization side heat exchanger. The heating medium heated in this utilization side heat exchanger is sent to at least one room heating device, and used to heat the room by releasing the heat of the heating medium into the room. Also, this heating medium is sent to the outdoor air heating device, and used for heating the outdoor air that is supplied to the room as the ventilation air by the air supply device. Then, the heating medium used in the room heating device and by the outdoor air heating device respectively for heating the room and for heating the ventilation air is again returned to the utilization side heat exchanger. On the other hand, the refrigerant cooled in the utilization side heat exchanger by heating the heating medium is decompressed by the expansion mechanism, heated in the heat source side heat exchanger, converted into a low pressure refrigerant, and then again, sucked into the compressor. Note that the room heating device includes, for example, a radiator, a fan convactor, and a floor heating device. In this way, since this air conditioning system is provided with the outdoor air heating device, the ventilation air can be first heated and then supplied to the room, when heating the room. This will enable prevention of a cold draft due to the ventilation air that is supplied to the room to ventilate the room, therefore improving the comfort of the room.

[0009] An air conditioning system according to a second aspect of the present invention is the air conditioning system according to the first aspect of the present invention, in which the heating medium circuit is connected to the utilization side heat exchanger such that the heating medium heated in the utilization side heat exchanger is sequentially supplied to the room heating devices and the outdoor air heating device.

[0010] In this air conditioning system, the heating medium circuit is connected to the utilization side heat exchanger such that the heating medium heated in the utilization side heat exchanger is sequentially supplied to the room heating devices and the outdoor air heating device. Consequently, the room heating devices can use the heat of a high temperature heating medium that just has been heated in the utilization side heat exchanger, and the outdoor air heating device can use the heat of the heating medium cooled by releasing its heat into the room in the room heating device. Here, the ventilation air that is supplied to the room by the air supply device has a lower temperature than the indoor air, and it is possible to heat the ventilation air by using the heating medium cooled by releasing its heat into the room by the room heating devices. Then, the heating medium used for heating the ventilation air that is supplied to the room by the outdoor air heating device is further cooled by heating the ventilation air, and then returned to the utilization side heat exchanger. In this way, in this air conditioning system, the heating medium cooled by releasing its heat in the room heating devices is supplied to the outdoor air heating device, and used to heat the ventilation air that is supplied to the room. Consequently, the temperature difference between the inlet and the outlet of the utilization side heat exchanger can be increased, therefore improving the COP of the heat source unit.

[0011] An air conditioning system according to a third aspect of the present invention is the air conditioning system according to the second aspect of the present invention, in which the heating medium circuit further includes at least one bypass heating medium circuit that bypasses the room heating devices and the outdoor air heating device.

[0012] In this air conditioning system, the heating medium circuit includes the bypass heating medium circuit that bypasses at least one of the room heating devices and the outdoor air heating device, so that the heating medium can be supplied to only some of the room heating devices and the outdoor air heating device, according to need. Note that, since "at least one" bypass heating medium circuit is included, the bypass heating medium circuit may be provided to each of the room heating devices and the outdoor air heating device, or to only some of these devices. Alternatively, some of the room heating devices and the outdoor air heating device may be collected together such that these devices are bypassed together.

[0013] An air conditioning system according to a fourth aspect of the present invention is the air conditioning system according to the third aspect of the present invention, in which the bypass heating medium circuit includes a heating medium flow control mechanism.

[0014] In this air conditioning system, the bypass heating medium circuit includes the heating medium flow control mechanism, so that it is possible to control the flow of the heating medium that is supplied to at least some of the room heating devices and the outdoor air heating device to which the bypass heating medium circuit is provided. Note that the heating medium flow control mechanism herein refers to a solenoid valve that blocks a heating medium that flows through the bypass heating medium circuit according to need, a motor operated valve that controls the flow of a heating medium that flows through the bypass heating medium circuit, and the like.

[0015] An air conditioning system according to a fifth aspect of the present invention is the air conditioning system according to the first aspect of the present invention, in which the heating medium circuit is constituted by a plurality of divided heating medium circuits that independently circulate the heating medium between at least one of the room heating devices and the outdoor air heating device, and the utilization side heat exchanger.

[0016] In this air conditioning system, the heating medium circuit is constituted by a plurality of divided heating medium circuits that independently circulate the heating medium between at least one of the room heating devices and the outdoor air heating device, and the utilization side heat exchanger, so that it is possible to supply the heating medium

to only some of the room heating devices and the outdoor air heating device, according to need. Note that the divided heating medium circuits "independently circulate the heating medium between at least one of the room heating devices and the outdoor air heating device, and the utilization side heat exchanger," so that the divided heating medium circuits may be provided so as to circulate the heating medium through each of the room heating devices and the outdoor air heating device, or so as to circulate the heating medium through some of the room heating devices and the outdoor air heating device together.

[0017] An air conditioning system according to a sixth aspect of the present invention is the air conditioning system according to the fifth aspect of the present invention, in which the utilization side heat exchanger is constituted by a plurality of divided utilization side heat exchangers divided to correspond to the plurality of divided heating medium circuits.

[0018] An air conditioning system according to a seventh aspect of the present invention is the air conditioning system of the sixth aspect of the present invention, in which the heat source unit further includes at least one bypass refrigerant circuit that bypasses the plurality of divided utilization side heat exchangers.

[0019] In this air conditioning system, the heat source unit further includes at least one bypass refrigerant circuit that bypasses the plurality of divided utilization side heat exchangers, so that it is possible to supply the refrigerant to only some of the plurality of divided utilization side heat exchangers, according to need. Note that since "at least one" bypass refrigerant circuit is included, the bypass refrigerant circuit may be provided to each of the plurality of divided utilization side heat exchangers, or to some of the circuits. Alternatively, some of the plurality of divided utilization side heat exchangers can be collected together such that these heat exchangers are bypassed together.

[0020] An air conditioning system according to an eighth aspect of the present invention is the air conditioning system according to the seventh aspect of the present invention, in which the bypass refrigerant circuit includes a refrigerant flow control mechanism.

[0021] In this air conditioning system, the bypass refrigerant circuit includes the refrigerant flow control mechanism, so that it is possible to control the flow of the refrigerant that is supplied to at least some of the plurality of divided utilization side heat exchangers to which the bypass refrigerant circuit is provided. Note that the refrigerant flow control mechanism herein refers to a solenoid valve that blocks the refrigerant that flows through the bypass refrigerant circuit according to need, a motor operated valve that controls the flow of the refrigerant that flows through the bypass refrigerant circuit, and the like.

[0022] An air conditioning system according to a ninth aspect of the present invention is the air conditioning system according to any one of the fifth to eighth aspects of the present invention, in which the plurality of divided heating medium circuits are connected to the utilization side heat exchanger such that the temperature of the heating medium that is supplied to the outdoor air heating device is equal to or lower than the temperature of the heating medium used in the room heating devices.

[0023] In this air conditioning system, the plurality of divided heating medium circuits are connected to the utilization side heat exchanger such that the temperature of the heating medium that is supplied to the outdoor air heating device is equal to or lower than the temperature of the heating medium used in the room heating devices. Accordingly, the room heating devices can use the heat of a high temperature heating medium that just has been heated in the utilization side heat exchanger, and the outdoor air heating device can use the heat of the heating medium whose temperature is equal to or lower than the temperature of the heating medium used in the room heating devices. Here, the ventilation air that is supplied to the room by the air supply device has a lower temperature than the indoor air, so that it is possible to heat the ventilation air by using the heating medium whose temperature is lower than the temperature of the heating medium cooled by releasing its heat into the room in the room heating devices. Then, the heating medium used by the outdoor air heating device for heating the ventilation air that is supplied to the room is further cooled by heating the ventilation air, and then returned to the utilization side heat exchanger. In this way, in this air conditioning system, the heating medium cooled by releasing its heat in the room heating devices is supplied to the outdoor air heating device, and used to heat the ventilation air to be supplied to the room, so that it will be possible to increase the temperature difference between the inlet and the outlet of the utilization side heat exchanger, therefore improving the COP of the heat source unit.

[0024] An air conditioning system according to a tenth aspect of the present invention is the air conditioning system according to any one of the first to ninth aspects of the present invention, in which some of the room heating devices and the outdoor air heating device use refrigerant that flows through the refrigerant circuit without flowing through the heating medium circuit.

[0025] In this air conditioning system, not only that the heat of the high temperature and high pressure refrigerant that flows through the refrigerant circuit in the heat source unit is supplied to the room heating devices and the outdoor air heating device via the heating medium that circulates in the heating medium circuit, but also the heat of the refrigerant that flows through the refrigerant circuit can be directly released into the room, and the ventilation air that is supplied to the room by the air supply device can be directly heated. As a result, simplification of the heating medium circuit can be achieved.

[0026] An air conditioning system according to an eleventh aspect of the present invention is the air conditioning system according to any one of the first to tenth aspects of the present invention, in which the heating medium circuit

includes a heating medium storage container.

[0027] In this air conditioning system, since the heating medium circuit includes the heating medium storage container, it is possible to prevent problems such as breakage of devices that constitute the heating medium circuit, which may occur when the heating medium circulating in the heating medium circuit expands in volume along with its change in temperature. In addition, an increase in the amount of the heating medium in the heating medium circuit will increase the heat capacity in the entire heating medium circuit, and the temperature of the heating medium that is supplied to the room heating devices and the outdoor air heating device, and the temperature of the heating medium that is returned to the utilization side heat exchanger will become stable. As a result, it will be possible to improve controllability of the refrigerant circuit in the heat source unit and the heating medium circuit.

[0028] An air conditioning system according to a twelfth aspect of the present invention is the air conditioning system according to any one of the first to eleventh aspects of the present invention, further comprising a humidifier that humidifies the ventilation air that is heated by the outdoor air heating device and supplied to the room.

[0029] In this air conditioning system, the ventilation air that is heated by the outdoor air heating device and supplied to the room can be humidified. Therefore, even when the absolute humidity of the ventilation air is lower than the absolute humidity of the room air, it is possible to prevent the room from becoming dry due to the supply of ventilation air to the room.

[0030] An air conditioning system according to a thirteenth aspect of the present invention is the air conditioning system according to the twelfth aspect of the present invention, in which the humidifier includes a moisture permeable film that allows moisture to permeate therethrough, and water that is supplied to the moisture permeable film is caused to contact with the ventilation air via the moisture permeable film, thereby enabling to humidify the ventilation air.

[0031] Since this air conditioning system is provided with the humidifier that uses the moisture permeable film, it is possible to humidify the ventilation air by causing water that is supplied to the moisture permeable film to contact with the ventilation air via the moisture permeable film.

[0032] An air conditioning system according to a fourteenth aspect of the present invention is the air conditioning system according to the twelfth aspect of the present invention, in which the humidifier includes moisture absorbing liquid capable of both absorbing moisture and desorbing the absorbed moisture through heating. Accordingly, it is possible to humidify the ventilation air by using the ventilation air to heat the moisture absorbing liquid in which moisture is absorbed and by desorbing moisture back into the ventilation air.

[0033] Since this air conditioning system is provided with the humidifier that uses the moisture absorbing liquid, it is possible to humidify the ventilation air by using the ventilation air to heat the moisture absorbing liquid in which moisture is absorbed and by desorbing moisture back into the ventilation air.

[0034] An air conditioning system according to a fifteenth aspect of the present invention is the air conditioning system according to the fourteenth aspect of the present invention, in which the humidifier is used to humidify the ventilation air by absorbing, into the moisture absorbing liquid, moisture in the exhaust air that is exhausted from the room to the outside.

[0035] In this air conditioning system, moisture in the exhaust air that is exhausted from the room to the outside is used as moisture to be absorbed into the moisture absorbing liquid, so that it is possible to humidify the ventilation air without the need to supply water to the humidifier.

[0036] An air conditioning system according to a sixteenth aspect of the present invention is the air conditioning system according to the fourteenth aspect of the present invention, in which the humidifier is used to humidify the ventilation air by absorbing moisture in an outdoor air different from the ventilation air into the moisture absorbing liquid.

[0037] In this air conditioning system, moisture in the outdoor air different from the ventilation air is used as moisture to be absorbed into the moisture absorbing liquid, so that it is possible to humidify the ventilation air without the need to supply water to the humidifier.

[0038] An air conditioning system according to a seventeenth aspect of the present invention is the air conditioning system according to the fourteenth aspect of the present invention, in which the humidifier is used to humidify the ventilation air by absorbing, into the moisture absorbing liquid, moisture in mixed air between the exhaust air that is exhausted from the room to the outside and the outdoor air different from the ventilation air.

[0039] In this air conditioning system, moisture in the mixed air between the exhaust air that is exhausted from the room to the outside and an outdoor air different from the ventilation air is used as moisture to be absorbed into the moisture absorbing liquid, so that it is possible to humidify the ventilation air without the need to supply water to the humidifier.

[0040] An air conditioning system according to an eighteenth aspect of the present invention is the air conditioning system according to the twelfth aspect of the present invention, in which the humidifier includes an adsorbent capable of both adsorbing moisture and desorbing the adsorbed moisture. Accordingly, it is possible to humidify the ventilation air by using the ventilation air to heat the adsorbent in which moisture is adsorbed and by desorbing moisture back into the ventilation air.

[0041] Since this air conditioning system is provided with the humidifier that uses the adsorbent, it is possible to humidify the ventilation air by using the ventilation air to heat the adsorbent in which moisture is adsorbed and by desorbing moisture back into the ventilation air.

[0042] An air conditioning system according to a nineteenth aspect of the present invention is the air conditioning system according to the eighteenth aspect of the present invention, in which the humidifier is used to humidify the ventilation air by adsorbing, into the adsorbent, moisture in the exhaust air that is exhausted from the room to the outside.

[0043] In this air conditioning system, moisture in the exhaust air that is exhausted from the room to the outside is used as moisture to be adsorbed into the adsorbent, so that it is possible to humidify the ventilation air without the need to supply water to the humidifier.

[0044] An air conditioning system according to a twentieth aspect of the present invention is the air conditioning system according to the eighteenth aspect of the present invention, in which the humidifier is used to humidify the ventilation air by adsorbing, into the adsorbent, moisture in the outdoor air different from the ventilation air.

[0045] In this air conditioning system, moisture in the outdoor air different from the ventilation air is used as moisture to be adsorbed into the adsorbent, so that it is possible to humidify the ventilation air without the need to supply water to the humidifier.

[0046] An air conditioning system according to a twenty-first aspect of the present invention is the air conditioning system according to the eighteenth aspect of the present invention, in which the humidifier is used to humidify the ventilation air by adsorbing, into the adsorbent, moisture in the mixed air between the exhaust air that is exhausted from the room to the outside and an outdoor air different from the ventilation air.

[0047] In this air conditioning system, as moisture to be adsorbed into the adsorbent, moisture in the mixed air between the exhaust air that is exhausted from the room to the outside and an outdoor air different from the ventilation air is used, so that it is possible to humidify the ventilation air without the need to supply water to the humidifier.

[0048] An air conditioning system according to a twenty-second aspect of the present invention is the air conditioning system according to any one of the first to twenty-first aspects of the present invention, in which the heating medium that flows through the heating medium circuit is water.

[0049] Since this air conditioning system uses water as the heating medium that flows through the heating medium circuit, the heating medium circuit can be configured at low cost.

[0050] An air conditioning system according to a twenty-third aspect of the present invention is the air conditioning system according to any one of the first to twenty-first aspects of the present invention, in which the heating medium flowing through the heating medium circuit is brine that does not freeze below 0 degrees C.

[0051] In this air conditioning system, brine that does not freeze below 0 degrees C is used as the heating medium that flows through the heating medium circuit, so that the heating medium is prevented from freezing in the outdoor air heating device even during the low outdoor air temperature period, and the ventilation air that is supplied to the room by the air supply device will be more reliably heated by using the outdoor air heating device.

[0052] An air conditioning system according to a twenty-fourth aspect of the present invention is the air conditioning system according to any one of the first to twenty-third aspects of the present invention, in which the refrigerant that flows through the refrigerant circuit is CO₂.

[0053] In this air conditioning system, CO₂ is used as the refrigerant that flows through the vapor compression type refrigerant circuit in the heat source unit, so that the refrigerant temperature on the discharge side of the compressor can be increased, and the temperature level that can be used in the room heating devices can be increased. This will achieve comfortable room heating.

BRIEF DESCRIPTION OF THE DRAWINGS

[0054]

Figure 1 is a schematic block diagram of an air conditioning system according to an embodiment of the present invention.

Figure 2 is a temperature-entropy diagram of the operation of the air conditioning system.

Figure 3 is a pressure-enthalpy diagram of the operation of the air conditioning system.

Figure 4 is a psychrometric chart of the operation of the air conditioning system according to an embodiment of the present invention.

Figure 5 is a schematic block diagram of a conventional air conditioning system.

Figure 6 is a psychrometric chart of the operation of a conventional air conditioning system.

Figure 7 is a schematic block diagram of an air conditioning system according to a modified example 1 of the present invention.

Figure 8 is a schematic block diagram of an air conditioning system according to a modified example 2 of the present invention.

Figure 9 is a schematic block diagram of an air conditioning system according to a modified example 3 of the present invention.

Figure 10 is a schematic block diagram of an air conditioning system according to a modified example 4 of the

present invention.

Figure 11 is a schematic block diagram of an air conditioning system according to a modified example 5 of the present invention.

Figure 12 is a schematic block diagram of an air conditioning system according to a modified example 6 of the present invention.

Figure 13 is a schematic block diagram of an air conditioning system according to a modified example 7 of the present invention.

Figure 14 is a schematic block diagram of an air conditioning system according to a modified example 8 of the present invention.

Figure 15 is a schematic block diagram of an air conditioning system according to a modified example 9 of the present invention.

Figure 16 is a schematic block diagram of an air conditioning system according to a modified example 10 of the present invention.

Figure 17 is a psychrometric chart of the operation of the air conditioning system according to the modified example 10 of the present invention.

Figure 18 is a schematic block diagram of an air conditioning system according to a modified example 11 of the present invention.

Figure 19 is a schematic block diagram of an air conditioning system according to a modified example 12 of the present invention.

Figure 20 is a schematic block diagram of an air conditioning system according to the modified example 12 of the present invention.

Figure 21 is a schematic block diagram of an air conditioning system according to a modified example 13 of the present invention.

Figure 22 is a schematic block diagram of an air conditioning system according to the modified example 13 of the present invention.

DESCRIPTION OF THE REFERENCE SYMBOLS

[0055]

101	air conditioning system
102	heat source unit
103	air supply device
104	heating medium circuit
120	refrigerant circuit
121	compressor
122	heating medium - refrigerant heat exchanger (utilization side heat exchanger)
122a, 122b, 122c, 122d	divided heating medium - refrigerant heat exchanger (divided utilization side heat exchangers)
123	expansion mechanism
124	heat source side heat exchanger
141	radiator (room heating device)
142	fan convector (room heating device)
143	floor heating device (room heating device)
144	outdoor air heating device
151, 153, 154	bypass heating medium circuit
151a, 153a, 154a	solenoid valve, motor operated valve (heating medium flow control mechanism)
161, 161a, 161b, 161c	heating medium storage tank (heating medium storage container)
171	bypass refrigerant circuit
171a	solenoid valve, motor operated valve (refrigerant flow control mechanism)
182, 183, 184, 185	humidifier
183a, 184a, 184b	moisture permeable film module (moisture permeable film)
185a	adsorbent

DETAILED DESCRIPTION OF THE INVENTION

[0056] Selected embodiments of an air conditioning system according to the present invention will be now described hereinafter with reference to the drawings.

(1) Configuration of the Air Conditioning System

[0057] Figure 1 is a schematic block diagram of an air conditioning system 101 according to an embodiment of the present invention. The air conditioning system 101 is a system capable of heating the room by operating a vapor compression type refrigerating cycle.

[0058] The air conditioning system 101 mainly comprises a heat source unit 102, an air supply device 103, and a heating medium circuit 104.

<Heat Source Unit>

[0059] The heat source unit 102 is installed outside, for example, is provided with a vapor compression type refrigerant circuit 120 that mainly includes a compressor 121, a heating medium - refrigerant heat exchanger 122 as a utilization side heat exchanger, an expansion mechanism 123, and a heat source side heat exchanger 124; and is capable of heating, in the heating medium - refrigerant heat exchanger 122, a heating medium that is used to heat the room in a building U.

[0060] The compressor 121 is a compressor that is rotatably driven by a drive mechanism such as an electric motor so as to compress a low pressure refrigerant and discharge the refrigerant as the high temperature and high pressure refrigerant.

[0061] The expansion mechanism 123 is an electric expansion valve that decompresses the refrigerant that flows out from the heating medium - refrigerant heat exchanger 122.

[0062] The heat source side heat exchanger 124 is a heat exchanger that evaporates the refrigerant decompressed by the expansion mechanism 123, by exchanging heat between the refrigerant and water or outdoor air as a heat source.

[0063] The heating medium - refrigerant heat exchanger 122 is a heat exchanger that heats the heating medium by exchanging heat between the high temperature and high pressure refrigerant compressed by and discharged from the compressor 121 and the heating medium that circulates in the heating medium circuit 104. In addition, in the present embodiment, the heating medium - refrigerant heat exchanger 122 has passages through which the heating medium flow and the refrigerant flow such that the heating medium and the refrigerant are in counter current flow.

[0064] Here, as an operating refrigerant in the refrigerant circuit 120 in the heat source unit 102, it is possible to use HCFC refrigerant, HFC refrigerant, HC refrigerant, and CO₂. However, in the present embodiment, CO₂ having a low critical temperature is used, and it is possible to provide a supercritical refrigerating cycle in which the pressure of the refrigerant on the discharge side of the compressor 121 is equal to or higher than the critical pressure of the refrigerant. In such a supercritical refrigerating cycle that uses CO₂ as the refrigerant, it is possible to increase the refrigerant temperature on the discharge side of the compressor 121, that is, the refrigerant temperature at a refrigerant inlet of the heating medium - refrigerant heat exchanger 122, due to an increase in the pressure of the refrigerant on the discharge side of the compressor 121. In addition, refrigerant that flows into the heating medium - refrigerant heat exchanger 122 is compressed above its critical pressure by the compressor 121, so that the refrigerant in the supercritical state heats the heating medium in the heating medium - refrigerant heat exchanger 122.

<Air Supply Device>

[0065] The air supply device 103 is a device that supplies the outdoor air (shown as OA in Figure 1) to a room in the building U, and in the present embodiment, mainly includes a supply air outlet (not shown) that supplies the outdoor air from the outside to the room as the ventilation air, an exhaust air outlet (now shown) that exhausts the room air (shown as RA in Figure 1) from the room to the outside, and an exhaust fan 131 which is provided to the exhaust air outlet and which exhausts a portion of the room air as the exhaust air (shown as EA in Figure 1) from the room to the outside. The room can be ventilated by the operation of the exhaust fan 131. Note that, in the present embodiment, the exhaust fan 131 is used to ventilate the room, however, the room may be ventilated by, for example, providing a supply air fan to the supply air outlet, or by providing both the exhaust fan and the supply air fan to the supply air outlet.

<Heating Medium Circuit>

[0066] The heating medium circuit 104 includes a radiator 141, a fan convactor 142, and a floor heating device 143 as room heating devices that release the heat of the heating medium heated in the heating medium - refrigerant heat exchanger 122 into the room, and an outdoor air heating device 144 that heats the ventilation air that is supplied to the room by the air supply device 103 with the heat of the heating medium heated in the heating medium - refrigerant heat exchanger 122. The heating medium circuit 104 is a circuit that circulates the heating medium between the radiator 141, the fan convactor 142, the floor heating device 143 and the outdoor air heating device 144, and the heating medium refrigerant heat exchanger 122.

[0067] The radiator 141 is placed in the room for example, and is a device that mainly releases the heat of the heating medium into the room by radiation heat transfer. In the present embodiment, the radiator 141 includes a radiator heat exchanger 141a through which the heating medium passes and exchanges its heat with surrounding room air (here, the room air that just has been heat-exchanged in the radiator heat exchanger 141a is referred to as SA1 shown in Figure 1).

[0068] The fan convector 142 is placed in the room for example, and is a device that mainly releases the heat of the heating medium into the room by forced convection heat transfer. In the present embodiment, the fan convector 142 includes a convector heat exchanger 142a through which the heating medium passes and exchanges its heat with surrounding air, and a convector fan 142b which supplies the room air to the convector heat exchanger 142a and supplies the indoor air having been heat-exchanged in the convector heat exchanger 142a to the room as the supply air (shown as SA1' in Figure 1).

[0069] The floor heating device 143 is placed under the floor of the building U for example, and is a device that mainly includes a floor heating pipe 143a that releases the heat of the heating medium into the room via a heat transfer panel provided on a floor surface.

[0070] The outdoor air heating device 144 is placed outside for example, and is a device that mainly includes an outdoor air heat exchanger 144a that heats the ventilation air that is supplied to the room by the air supply device 103 with the heat of the heating medium (here, the supply air that is supplied to the room after being heat-exchanged in the outdoor air heat exchanger 144a is referred to as SA3 shown in Figure 1).

[0071] In the present embodiment, the heating medium circuit 104 is connected to the heating medium - refrigerant heat exchanger 122 such that the heating medium heated in the heating medium - refrigerant heat exchanger 122 is sequentially supplied to the radiator heat exchanger 141a in the radiator 141, the convector heat exchanger 142a of the fan convector 142, the floor heating pipe 143a of the floor heating device 143, and the outdoor air heat exchanger 144a of the outdoor air heating device 144. More specifically, the heating medium circuit 104 constitutes a single heating medium circuit connected in series such that the heating medium heated in the heating medium - refrigerant heat exchanger 122 by exchanging its heat with the refrigerant passes from a heating medium outlet of the heating medium - refrigerant heat exchanger 122 sequentially through the radiator heat exchanger 141a, the convector heat exchanger 142a, the floor heating pipe 143a, and then the outdoor air heat exchanger 144a, and returns to a heating medium inlet of the heating medium - refrigerant heat exchanger 122 by a heating medium circulating pump 145 connected to the heating medium outlet of the outdoor air heat exchanger 144a. In other words, the heating medium circuit 104 will be connected in order from the radiator heat exchanger 141a that requires the highest temperature heating medium to the outdoor air heat exchanger 144a that can use even the lowest temperature heating medium.

[0072] The heating medium circulating pump 145 is connected between the heating medium outlet of the outdoor air heat exchanger 144a and the heating medium inlet of the heating medium - refrigerant heat exchanger 122, and is a pump that is rotatably driven by a drive mechanism such as an electric motor so as to circulate the heating medium between the radiator heat exchanger 141a, the convector heat exchanger 142a, the floor heating pipe 143a and the outdoor air heat exchanger 144a, and the heating medium - refrigerant heat exchanger 122.

[0073] Here, as the heating medium that flows through the heating medium circuit 104, water and brine may be used. When water is used as the heating medium, it will be advantageous in that inexpensive devices and pipes can be used to constitute the heating medium circuit 104. In addition, when brine is used as the heating medium, it is preferable to use brine that does not freeze below 0 degrees C even during the low outdoor air temperature period, in order to prevent the heating medium from freezing in the outdoor air heating device 144 (specifically, in the outdoor air heat exchanger 144a). This type of brine includes, for example, calcium chloride aqueous solution, sodium chloride aqueous solution, magnesium chloride aqueous solution, etc.

(2) Operation of the Air Conditioning System

[0074] Next, the operation of the air conditioning system 101 of this embodiment will be described with reference to Figures 1 to 4. Here, Figure 2 is a temperature-entropy diagram of the operation of the air conditioning system 101. Figure 3 is a pressure-enthalpy diagram of the operation of the air conditioning system 101. Figure 4 is a psychrometric chart of the operation of the air conditioning system 101.

[0075] First, the heating medium circulating pump 145 is started to circulate the heating medium in the heating medium circuit 104. Then, the compressor 121 of the heat source unit 102 will be started. Then, the low pressure refrigerant sucked into the compressor 121 (see dot Rc shown in Figures 1 to 3) will be compressed by the compressor 121 and discharged therefrom as the high temperature and high pressure refrigerant (see dot Ri shown in Figures 1 to 3). This high temperature and high pressure refrigerant will flow into the heating medium - refrigerant heat exchanger 122 and heat the heating medium, and the refrigerant itself will be cooled and become a low temperature and high pressure refrigerant (see dot Ro3 shown in Figures 1 to 3). The refrigerant cooled in the heating medium - refrigerant heat exchanger 122 by heating the heating medium will be decompressed by the expansion mechanism 123 and become a low temperature and low pressure refrigerant in a vapor-liquid two-phase state (see dot Re3 in Figures 1 to 3). This

refrigerant in a vapor-liquid two-phase state will be heated in the heat source side heat exchanger 124 by a heat source such as water or outdoor air, and will evaporate into a low temperature and low pressure gas refrigerant (see dot Rc in Figures 1 to 3). Then, this low temperature and low pressure gas refrigerant will be again sucked into the compressor 121.

[0076] Here, the heating medium that circulates in the heating medium circuit 104 flows into the heating medium - refrigerant heat exchanger 122 from the heating medium inlet (see dot Wi3 in Figures 1, 2, and 4), and will be heated in the heating medium - refrigerant heat exchanger 122 by exchanging its heat with the high temperature and high pressure refrigerant compressed in and discharged from the compressor 121 (see dot Wo shown in Figures 1, 2, and 4). Then, a high temperature heating medium heated in the heating medium - refrigerant heat exchanger 122 will flow into the radiator heat exchanger 141a of the radiator 141, release the heat of the heating medium into the room (specifically, the room air surrounding the radiator heat exchanger 141a will be heated), and the heating medium itself will be cooled and the temperature thereof will decrease (for example, the temperature will decrease from about 70 degrees C to about 65 degrees C as shown in Figure 2). At this time, the room air (see RA shown in Figure 4) will be heated in the radiator heat exchanger 141a to a state of dot SA1 shown in Figure 4.

[0077] Next, the heating medium that flowed out from the radiator heat exchanger 141a will flow into the convector heat exchanger 142a of the fan convector 142, and release the heat of the heating medium into the room (specifically, the room air that is supplied by the convector fan 142b will be heated), and the heating medium itself will be cooled and the temperature thereof will decrease (for example, the temperature will decrease from about 65 degrees C to about 55 degrees C as shown in Figure 2). At this time, the room air (see the arrow RA shown in Figure 1) becomes a supply air SA1' by the convector heat exchanger 142a (see Figure 1) and will be supplied to the room.

[0078] Next, the heating medium that flowed out from the convector heat exchanger 142a will flow into the floor heating pipe 143a of the floor heating device 143, and release the heat of the heating medium into the room (specifically, a floor surface will be heated by the floor heating pipe 143a), and the heating medium itself will be cooled and the temperature thereof will decrease (for example, the temperature will decrease from about 55 degrees C to about 40 degrees C as shown in Figure 2).

[0079] Next, the heating medium that flowed out from the floor heating pipe 143a will flow into the outdoor air heat exchanger 144a of the outdoor air heating device 144, and will heat the ventilation air that is supplied to the room by the air supply device 103 with the heat of the heating medium, and the heating medium itself will be cooled and the temperature thereof will decrease (for example, the temperature will decrease from about 40 degrees C to about 5 degrees C as shown in Figure 2). At this time, the ventilation air (see dot OA shown in Figure 4, about -10 degrees C) will be heated to a state of dot SA3 shown in Figure 4 (about 20 degrees C in Figure 4) by the outdoor air heat exchanger 144a. On the other hand, the temperature of the room air RA is heated to about 20 degrees C (see dot RA shown in Figure 4) by the heating operation using the radiator 141, the fan convector 142, and the floor heating device 143. Accordingly, even when the ventilation air heated by the outdoor air heat exchanger 144a is supplied to the room and mixed with the room air RA, the temperature of the room air will hardly change.

[0080] Then, the heating medium that flowed out from the outdoor air heat exchanger 144a again will flow into the heating medium - refrigerant heat exchanger 122 through the heating medium circulating pump 145 (see dot Wi3 in Figures 1, 2, and 4).

(3) Characteristics of the Air Conditioning System

[0081] The air conditioning system 101 of this embodiment has the following characteristics.

(A)

[0082] As shown in Figure 5, there is an air conditioning system 901 that comprises the heat source unit 102 same as those in the air conditioning system 101 of the this embodiment, the air supply device 103, and a heating medium circuit 904 including the radiator 141, the fan convector 142, and the heating medium circulating pump 145. In this type of air conditioning system 901, the heating medium circuit 904 does not have the outdoor air heating device 144, so that when heating the room, the ventilation air (shown as OA in Figure 5) will be supplied to the room as is by the air supply device 103. Therefore, as shown in Figure 6, the room air (see dot RA shown in Figure 6) will be mixed (see dot MA shown in Figure 6) with the ventilation air (see dot OA in Figure 6), and consequently the temperature of this room air will be lower (about 12 degrees C in Figure 6) than the temperature of the room air heated by the heating operation using the radiator 141 and the fan convector 142. Consequently, the ventilation air that is supplied to the room for ventilating the room will cause a cold draft.

[0083] However, since the air conditioning system 101 of this embodiment comprises the outdoor air heating device 144, when heating the room, as shown in Figure 4, the outdoor air OA as the ventilation air that is supplied to the room by the air supply device 103 can be heated and then supplied to the room as the supply air SA3. Consequently, a cold draft due to the ventilation air that is supplied to the room for ventilating the room will be prevented, therefore improving

the comfort of the room.

(B)

[0084] In the conventional air conditioning system 901, the heating medium circuit 904 does not have either the floor heating device 143 or the outdoor air heating device 144. Therefore, as shown in Figures 2, 3, and 5, the heating medium heated by exchanging its heat with the refrigerant in the heating medium - refrigerant heat exchanger 122 will circulate in the heating medium circuit 904 such that the heating medium will change from a state of dot Wo to a state of dot Wi1 and again returned to the heating medium - refrigerant heat exchanger 122. Along with this, as shown in Figures 2 and 3, the refrigerant will circulate in the refrigerant circuit 120 such that the refrigerant changes in order from a state of dot Rc on a suction side of the compressor 121 to a state of dot Ri that corresponds to dot Wo, to a state of dot Ro1 that corresponds to dot Wi1, and then to a state of dot Re1, and again is sucked into the compressor 121. Here, as shown in Figure 3, the COP (based on the evaporation side) of the heat source unit 102 of the conventional air conditioning system 901 is a value obtained by dividing the enthalpy difference Δh_1 on the evaporation side in the refrigerating cycle of dot Rc --> dot Ri --> dot Ro1 --> dot Re1 --> dot Rc by the enthalpy difference Δh_c that corresponds to the power consumption of the compressor 121 ($=\Delta h_1/\Delta h_c$).

[0085] On the other hand, in the air conditioning system 101 of this embodiment, the heating medium circuit 104 includes the floor heating device 143 and the outdoor air heating device 144, and is further connected to the heating medium - refrigerant heat exchanger 122 such that the heating medium heated in the heating medium - refrigerant heat exchanger 122 is sequentially supplied to the radiator 141, the fan convector 142, the floor heating device 143, and the outdoor air heating device 144, so that the heating medium heated by exchanging heat with refrigerant in the heating medium - refrigerant heat exchanger 122 will circulate in the heating medium circuit 104 such that the heating medium changes from a state of dot Wo to a state of dot Wi3 and again is returned to the heating medium - refrigerant heat exchanger 122, as shown in Figures 1, 2, and 3. Along with this, as shown in Figures 2 and 3, the refrigerant will circulate in the refrigerant circuit 120 such that the refrigerant changes in order from a state of dot Rc on the suction side of the compressor 121 to a state of dot Ri that corresponds to dot Wo, to a state of dot Ro3 that corresponds to dot Wi3, and then to a state of Re3, and again is sucked into the compressor 121. Accordingly, the radiator 141, the fan convector 142, and the floor heating device 143 can use the heat of a high temperature heating medium that just has been heated in heating medium - refrigerant heat exchanger 122, and the outdoor air heating device 144 can use the heat of the heating medium cooled by releasing its heat into the room in the radiator 141, the fan convector 142, and the floor heating device 143 (see dot Wi2 in Figures 1 and 2). Here, the ventilation air (shown as OA in Figure 1) that is supplied to the room by the air supply device 103 has a lower temperature than the indoor air (shown as RA in Figure 1), so that the heating medium cooled by releasing its heat into the room in the radiator 141, the fan convector 142, and the floor heating device 143 can be used to heat the ventilation air. Then, the heating medium used for heating the ventilation air that is supplied to the room by the outdoor air heating device 144 is further cooled by heating the ventilation air (see dot Wi3 shown in Figures 1 and 2), and then returned to the heating medium - refrigerant heat exchanger 122. In this way, in the air conditioning system 101, the heating medium cooled by releasing its heat in the radiator 141, the fan convector 142, and the floor heating device 143 is supplied to the outdoor air heating device 144 in order to heat the ventilation air that is supplied to the room. Therefore, compared to the air conditioning system 901, the temperature difference between the inlet and the outlet of the heating medium - refrigerant heat exchanger 122 (in other words, the temperature difference between the temperature of the heating medium in a state of dot Wo and the temperature of the heating medium in a state of dot Wi3) can be increased. Accordingly, as shown in Figure 3, the COP (based on the evaporation side) of the heat source unit 102 in the air conditioning system 101 of this embodiment is a value obtained by dividing the enthalpy difference Δh_3 on the evaporation side in the refrigerating cycle of dot Rc --> dot Ri --> dot Ro3 --> dot Re3 --> dot Rc by the enthalpy difference Δh_c that corresponds to the power consumption of the compressor 121 ($=\Delta h_3/\Delta h_c$). Accordingly, the COP is improved compared to the conventional air conditioning system 901 that does not comprise the outdoor air heating device 144. In particular, the air conditioning system 101 of this embodiment includes the floor heating device 143 in addition to the outdoor air heating device 144, so that the temperature difference between the inlet and the outlet of the heating medium - refrigerant heat exchanger 122 and the COP are further increased, compared to the conventional air conditioning system 901.

(C)

[0086] In the air conditioning system 101 of this embodiment, when water is used as a heating medium that flows through the heating medium circuit 104, it is possible to configure the heating medium circuit 104 at low cost. In addition, when brine that does not freeze below 0 degrees C is used as a heating medium that flows through the heating medium circuit 104, the heating medium is prevented from freezing in the outdoor air heating device 144 even during the low outdoor air temperature period, and the ventilation air that is supplied to the room by the air supply device 103 will be

more reliably heated by using the outdoor air heating device 144.

(D)

[0087] The air conditioning system 101 of this embodiment uses CO₂ as the refrigerant that flows through the vapor compression type refrigerant circuit 120 of the heat source unit 102. Accordingly, the refrigerant temperature on the discharge side of the compressor 121 can be increased, and the temperature level that can be used in the radiator 141, the fan convactor 142, the floor heating device 143, and the outdoor air heating device 144 can be increased. This will achieve comfortable room heating.

(4) Modified Example 1

[0088] In the above described air conditioning system 101, the heating medium circuit 104 may further include a bypass heating medium circuit that bypasses at least one of the radiator 141, the fan convactor 142, the floor heating device 143, and the outdoor air heating device 144. For example, the heating medium circuit 104 that does not include the fan convactor 142 as shown in Figure 7 may be provided with bypass heating medium circuits 151, 153, 154 respectively for the radiator 141, the floor heating device 143, and the outdoor air heating device 144. This will enable to supply the heating medium to only some of the radiator 141, the floor heating device 143, and the outdoor air heating device 144 according to need.

[0089] Also, these bypass heating medium circuits 151, 153, 154 are respectively provided with a solenoid valve 151a, a motor operated valve 153a, and a solenoid valve 154a as a heating medium flow control mechanism. Consequently, the bypass heating medium circuits 151, 154 will be able to block the heating medium that flows through each of the bypass heating medium circuits 151, 154 according to need, and thereby enabling to control the flow of the heating medium that is supplied to the radiator 141 and the outdoor air heating device 144. In addition, the bypass heating medium circuit 153 will be able to control the flow of the heating medium that flows through the bypass heating medium circuit 153, and thereby enabling highly precise control of the flow of the heating medium that is supplied to the floor heating device 143.

[0090] Note that, as described above, the bypass heating medium circuit may be provided to each of the radiator 141, the floor heating device 143, and the outdoor air heating device 144, or to only some of the radiator 141, the floor heating device 143, and the outdoor air heating device 144. Alternatively, some of the radiator 141, the floor heating device 143, and the outdoor air heating device 144 may be collected together such that these devices are bypassed together. In addition, as for the type of a valve to be provided to the bypass heating medium circuit, it is possible to select a valve according to the precision of flow control of the heating medium required in each bypass heating medium circuit.

(5) Modified Example 2

[0091] In the above-described air conditioning system 101, some of the radiator 141, the fan convactor 142, the floor heating device 143, and the outdoor air heating device 144 may use refrigerant that flows through the refrigerant circuit 120 without flowing through the heating medium circuit 104. For example, in the air conditioning system 101 that does not include the fan convactor 142 as shown in Figure 8, the floor heating device 143 and the outdoor air heating device 144 use the heat of the refrigerant that flows through the refrigerant circuit 120 in the heat source unit 102 via the heating medium that circulates in the heating medium circuit 104. However, as for the radiator 141, the high temperature and high pressure refrigerant compressed in and discharged from the compressor 121 may be caused to flow into the radiator heat exchanger 141a of the radiator 141 so as to directly release the heat of the refrigerant into the room. This will enable simplification of the heating medium circuit 104.

[0092] Note that also for the floor heating device 143 and the outdoor air heating device 144 besides the radiator 141, refrigerant that flows through the refrigerant circuit 120 may be caused to flow into the floor heating pipe 143a and the outdoor air heat exchanger 144a so as to use the heat of the refrigerant. In addition, the air conditioning system 101 of this modified example may be provided with the bypass heating medium circuit of the modified example 1.

(6) Modified Example 3

[0093] In the above-described air conditioning system 101, the heating medium circuit 104 may be provided with a heating medium storage tank. For example, in the air conditioning system 101, as shown in Figure 9, which has the bypass heating medium circuits 151, 153, 154 same as those in the modified example 1, the heating medium circulating pump 145 may be provided with a heating medium storage tank 161 on the suction side thereof. This will enable to prevent problems such as breakage of devices constituting the heating medium circuit 104, which may occur when the heating medium circulating in the heating medium circuit 104 expands in volume along with its change in temperature.

In addition, an increase in the amount of heating medium in the heating medium circuit 104 will increase the heat capacity in the entire heating medium circuit 104, and the temperature of the heating medium that is supplied to the radiator 141, the floor heating device 143, and the outdoor air heating device 144, and the temperature of the heating medium that is returned to the heating medium - refrigerant heat exchanger 122 will become stable. As a result, controllability of the heat source unit 102 and the heating medium circuit 104 will improve.

(7) Modified Example 4

[0094] In the above-described air conditioning system 101, the heating medium circuit 104 may be constituted by a plurality of divided heating medium circuits that independently circulate the heating medium between at least one of the radiator 141, the fan convactor 142, the floor heating device 143 and the outdoor air heating device 144, and the heating medium - refrigerant heat exchanger 122.

[0095] For example, in the air conditioning system 101 that does not include the fan convactor 142 as shown in Figure 10, the heating medium circuit 104 may be constituted by a first divided heating medium circuit 104a that independently circulates the heating medium between the radiator 141 and the heating medium - refrigerant heat exchanger 122; by a second divided heating medium circuit 104b that independently circulates the heating medium between the floor heating device 143 and the heating medium - refrigerant heat exchanger 122; and by a third divided heating medium circuit 104c that independently circulates the heating medium between the outdoor air heating device 144 and the heating medium - refrigerant heat exchanger 122. Here, the divided heating medium circuits 104a, 104b, 104c respectively include heating medium circulating pumps 145a, 145b, and 145c. This will enable to supply the heating medium to only some of the radiator 141, the floor heating device 143, and the outdoor air heating device 144 according to need.

[0096] Further, the second divided heating medium circuit 104b is connected to the heating medium - refrigerant heat exchanger 122 such that the temperature of the heating medium that is supplied to the floor heating device 143 is equal to or lower than the temperature of the heating medium used in the radiator 141, and the third divided heating medium circuit 104c is connected to the heating medium - refrigerant heat exchanger 122 such that the temperature of the heating medium that is supplied to the outdoor air heating device 144 is equal to or lower than temperature of the heating medium used by the floor heating device 143. Accordingly, the radiator 141 can use the heat of the heating medium (see dots Wo and Wi1 shown in Figures 2, 3, and 10) that just has been heated by the refrigerant (see dot Ri shown in Figures 2, 3, and 10) compressed in and discharged from the compressor 121 in the heating medium - refrigerant heat exchanger 122; the floor heating device 143 can use the heat of the heating medium whose temperature is lower than the temperature of the heating medium (see dots Wi1 and Wi2 in Figures 2, 3, and 10) used in the radiator 141 heated by the refrigerant (see dot Ro1 shown in Figures 2, 3, and 10) that heat-exchanged with the heating medium that flows through the first divided heating medium circuit 104a in the heating medium - refrigerant heat exchanger 122; and the outdoor air heating device 144 can use the heat of the heating medium (see dots Wi2 and Wi3 shown in Figures 2, 3 and 10) whose temperature is equal to or lower than the temperature of the heating medium used by the floor heating device 143 heated by the refrigerant (see dot Ro2 shown in Figures 2, 3, and 10) that heat-exchanged with the heating medium flowing through the second divided heating medium circuit 104b in the heating medium - refrigerant heat exchanger 122. Along with this, as shown in Figures 2 and 3, the refrigerant will circulate in the refrigerant circuit 120 such that the refrigerant changes in order from a state of dot Rc on the suction side of the compressor 121 to a state of dot Ri that corresponds to dot Wo, to a state of dot Ro3 that corresponds to dot Wi3, and then to a state of Re3, and again is sucked into the compressor 121.

[0097] In this way, in the air conditioning system 101 of this modified example, the heating medium whose temperature is equal to or lower than the temperature of the heating medium cooled by releasing its heat in the radiator 141 and the floor heating device 143 is supplied to the outdoor air heating device 144 and used to heat the ventilation air that is supplied to the room. As a result, as with the air conditioning system of the above described embodiment and the modified example, it will be possible to increase the temperature difference between the inlet and the outlet of the heating medium - refrigerant heat exchanger 122, therefore improving the COP of the heat source unit 102.

(8) Modified Example 5

[0098] In the air conditioning system 101 same as the one in the above described modified example 4, as shown in Figure 11, the heating medium - refrigerant heat exchanger 122 may be constituted by three divided heating medium - refrigerant heat exchangers 122a, 122b, and 122c serving as divided utilization side heat exchangers, which are divided so as to correspond to the divided heating medium circuits 104a, 104b, 104c.

[0099] In this case, the radiator 141 can use the heat of the heating medium (see dots Wo and Wi1 shown in Figures 2, 3, and 11) that just has been heated by the refrigerant (see dot Ri shown in Figures 2, 3, and 11) compressed in and discharged from the compressor 121 in the first divided heating medium - refrigerant heat exchanger 122a; the floor heating device 143 can use the heat of the heating medium (see dots Wi1 and Wi2 in Figures 2, 3, and 11) whose

temperature is lower than the temperature of the heating medium used in the radiator 141 heated by the refrigerant (see dot Ro1 shown in Figures 2, 3, and 11) that heat-exchanged with the heating medium that flows through the first divided heating medium circuit 104a in the first divided heating medium - refrigerant heat exchanger 122a; and the outdoor air heating device 144 can use the heat of the heating medium (see dots Wi2 and Wi3 shown in Figures 2, 3 and 11) whose temperature is equal to or lower than the temperature of the heating medium used by the floor heating device 143 heated by the refrigerant (see dot Ro2 shown in Figures 2, 3, and 11) that heat-exchanged with the heating medium that flows through the second divided heating medium circuit 104b in the second divided heating medium - refrigerant heat exchanger 122b. Along with this, as shown in Figures 2 and 3, the refrigerant will circulate in the refrigerant circuit 120 such that the refrigerant changes in order from a state of dot Rc on the suction side of the compressor 121 to a state of dot Ri that corresponds to dot Wo, to a state of dot Ro1 that corresponds to dot Wi1, to a state of dot Ro2 that corresponds to dot Wi2, to a state of dot Ro3 that corresponds to dot Wi3, and then to a state of dot Re3, and again is sucked into the compressor 121.

(9) Modified Example 6

[0100] In the air conditioning system 101 of the above described modified example 5, the heating medium circuit 104 is divided into the divided heating medium circuits 104a, 104b, 104c which respectively correspond to the radiator 141, the floor heating device 143, and the outdoor air heating device 144; and the heating medium - refrigerant heat exchanger 122 is also divided into the divided heating medium - refrigerant heat exchangers 122a, 122b, 122c which respectively correspond to the divided heating medium circuits 104a, 104b, 104c. However, it is not limited to this configuration. For example, in the air conditioning system 101 that does not include the fan convector 142 as shown in Figure 12, the heating medium circuit 104 may be divided into the first divided heating medium circuit 104a including a first heating medium circulating pump 145a dedicated to the radiator 141, and the second divided heating medium circuit 104d including a second heating medium circulating pump 145d shared by the floor heating device 143 and the outdoor air heating device 144, and also, the heating medium - refrigerant heat exchanger 122 may be divided into the first divided heating medium - refrigerant heat exchanger 122a dedicated to the radiator 141 and a second divided heating medium - refrigerant heat exchanger 122d shared by the floor heating device 143 and the outdoor air heating device 144.

(10) Modified Example 7

[0101] In the air conditioning system 101 of the above described modified examples 5, 6, the refrigerant circuit 120 may further include at least one bypass refrigerant circuit that bypasses the divided heating medium - refrigerant heat exchangers. For example, in the refrigerant circuit 120 including the divided heating medium - refrigerant heat exchangers 122a, 122b, 122c same as those in the modified example 5 as shown in Figure 13, the first divided heating medium - refrigerant heat exchanger 122a may be provided with a bypass refrigerant circuit 171. This will enable to supply the refrigerant to only the divided heating medium - refrigerant heat exchangers 122b, 122c according to need.

[0102] The bypass refrigerant circuit 171 is provided with a solenoid valve 171a as a heating medium flow control mechanism. Consequently, it will be possible to block the heating medium that flows through the bypass heating medium circuit 171 according to need, and thereby enabling to control the flow of refrigerant that is supplied to the divided heating medium - refrigerant heat exchanger 122a.

[0103] Note that, as described above, the bypass refrigerant circuit may be provided to only the first divided heating medium - refrigerant heat exchanger 122a, or to each of the divided heating medium - refrigerant heat exchangers 122a, 122b, 122c. Alternatively, some of the divided heating medium - refrigerant heat exchangers 122a, 122b, 122c may be collected together such that these devices are bypassed together. In addition, as for the type of a valve to be provided to the bypass refrigerant circuit, it is possible to select a valve according to the precision of flow control of the heating medium required in each bypass heating medium circuit. For example, use of a motor operated valve instead of a solenoid valve will enable highly precise control of the flow of refrigerant that is supplied to the bypass refrigerant circuit.

(11) Modified Example 8

[0104] In the above-described air conditioning system 101 of the above described modified examples 5 to 7, some of the radiator 141, the fan convector 142, the floor heating device 143, and the outdoor air heating device 144 may use refrigerant that flows through the refrigerant circuit 120 without flowing through the heating medium circuit 104. For example, in the air conditioning system 101 that does not include the fan convector 142 same as the one in the modified example 5 as shown in Figure 14, the floor heating device 143 and the outdoor air heating device 144 use the heat of the refrigerant that flows through the refrigerant circuit 120 in the heat source unit 102 via the heating medium that circulates in the divided heating medium circuits 104b, 104c. However, as for the radiator 141, the high temperature and high pressure refrigerant compressed in and discharged from the compressor 121 may be caused to flow into the radiator

heat exchanger 141a of the radiator 141 so as to directly release the heat of the refrigerant into the room. This will enable simplification of the heating medium circuit 104.

[0105] Note that also for the floor heating device 143 and the outdoor air heating device 144 besides the radiator 141, refrigerant that flows through the refrigerant circuit 120 may be caused to flow into the floor heating pipe 143a and the outdoor air heat exchanger 144a so as to use the heat of the refrigerant.

(12) Modified Example 9

[0106] In the above-described air conditioning system 101 of the above described modified examples 5 to 7, the heating medium circuit 104 may be provided with a heating medium storage tank. For example, in the air conditioning system 101 having the divided heating medium circuits 104a, 104b, 104c same as those in the modified example 5 as shown in Figure 15, the heating medium circulating pumps 145a, 145b, 145c may be provided with heating medium storage tanks 161 a, 161b, 161c on the suction side each thereof. Consequently, it will be possible to prevent problems such as breakage of devices constituting the divided heating medium circuits 104a, 104b, and 104c, which may occur when the heating medium circulating in the heating medium circuit 104 expands in volume along with its change in temperature. In addition, an increase in the amount of heating medium in the divided heating medium circuits 104a, 104b, 104c will increase the heat capacity of each of the divided heating medium circuits 104a, 104b, 104c, and the temperature of the heating medium that is supplied to the radiator 141, the floor heating device 143, and the outdoor air heating device 144, and the temperature of the heating medium that is returned to the divided heating medium - refrigerant heat exchangers 122a, 122b, 122c will become stable. As a result, controllability of the heat source unit 102 and the divided heating medium circuits 104a, 104b, 104c will improve.

(13) Modified Example 10

[0107] The air conditioning system 101 of the above described embodiments and modified examples comprises the outdoor air heating device 144. Consequently, a cold draft due to the ventilation air that is supplied to the room for ventilation in the room is prevented and the comfort of the room is improved. However, when the absolute humidity of the ventilation air is lower than the absolute humidity of the room air, the supply of ventilation air may dry the room. Therefore, according to this modified example, the air conditioning system 101 of the above described embodiments and modified examples is further provided with a humidifier that humidifies the ventilation air that is heated by the outdoor air heating device 144 and supplied to the room.

[0108] For example, the air conditioning system 101 the same as the one in Figure 1 as shown in Figure 16 can be provided with a humidifier 182 having a spray nozzle 182a that sprays water to the ventilation air that is heated by the outdoor air heating device 144 and supplied to the room, and a water supply pipe 181 that supplies water to a spray nozzle 182a of the humidifier 182.

[0109] In this case, when the ventilation air (shown as SA3 in Figure 16) heated by exchanging heat with the heating medium in the outdoor air heating device 144 is to be supplied to the room, the ventilation air is introduced into the humidifier 182, humidified with water sprayed from the spray nozzle 182a of the humidifier 182, and then supplied to the room (shown as SA3' in Figure 16). Consequently, the air conditioning system 101 of this modified example can humidify the ventilation air, so that even when the absolute humidity of the ventilation air is lower than the absolute humidity of the room air, it is possible to prevent the room from becoming dry due to the supply of ventilation air to the room.

[0110] Incidentally, due to evaporation of water sprayed from the spray nozzle 182a, the temperature of the ventilation air humidified by the humidifier 182 will be lower than the temperature of the ventilation air heated by the outdoor air heating device 144. However, in the air conditioning system 101 of this modified example, the amount of heating the ventilation air in the outdoor air heating device 144 is increased with consideration of evaporation of water in the humidifier 182. For example, as shown in Figure 17, the ventilation air (shown as SA3 in Figure 17) is heated by the outdoor air heating device 144 so as to increase its temperature (to about 30 degrees C in Figure 17) higher than the temperature (about 20 degrees C in Figure 4) of the ventilation air (shown as SA 3 in Figure 4) in the air conditioning system that does not include the humidifier 182 shown in Figure 1. In this way, even when the temperature of the ventilation air decreases due to evaporation of water in the humidifier 182, the temperature of the ventilation air (shown as SA 3' in Figure 17) that is supplied to the room will be close to the temperature (about 20 degrees C in Figure 17) of the room air (shown as RA in Figure 17). Further, the absolute humidity of the ventilation air SA 3' is also almost equal to the absolute humidity of the room air RA (in Figure 17, it is equivalent to relative humidity 50%). Accordingly, in the air conditioning system 101 of this modified example, the ventilation air having a low temperature and a low humidity compared to the room air is heated and humidified respectively by the outdoor air heating device 144 and the humidifier 182 so that the ventilation air and the room air will have the same temperature and humidity conditions, and then is supplied to the room. As a result, it is possible to further enhance the comfort of the room.

[0111] Note that, as a humidifier, an air washer may be used instead of a spray nozzle.

(14) Modified Example 11

[0112] In the air conditioning system 101 of the above described modified example 10, a spray nozzle or an air washer is used as a humidifier for humidifying the ventilation air that is heated by the outdoor air heating device 144 and supplied to the room. However, it is not limited thereto, and a moisture permeable film having a moisture permeability may be used. For example, the air conditioning system 101 that does not include the fan convector 142 as shown in Figure 18 may be provided with a humidifier 183 comprising a moisture permeable film module 183a having a plurality of tube shaped moisture permeable films, and a water supply pipe 181 for supplying water to the moisture permeable film module 183a of the humidifier 183. Here, the moisture permeable film module 183a is provided with a passage such that the ventilation air that is heated by the outdoor air heating device 144 and supplied to the room passes over the outside of the moisture permeable film. In addition, the inside of the moisture permeable film is configured such that water supplied to the moisture permeable film module 183a is introduced therein, and is capable of humidifying the ventilation air by causing water that is supplied to the moisture permeable film to contact with the ventilation air via the moisture permeable film. As the moisture permeable film, polytetrafluoroethylene (PTFE) and the like may be used.

[0113] Also in this case, the ventilation air can be humidified by causing water that is supplied to the moisture permeable film of the moisture permeable film module 183a of the humidifier 183 to contact with the ventilation air via the moisture permeable film. Therefore, as in the modified example 10, even when the absolute humidity of the ventilation air is lower than the absolute humidity of the room air, it is possible to prevent the room from becoming dry due to the supply of ventilation air to the room.

[0114] Further, in the air conditioning system 101 of this modified example, the amount of heating the ventilation air in the outdoor air heating device 144 is increased with consideration of evaporation of water in the humidifier 183. Consequently, as in the modified example 10, the ventilation air having a low temperature and a low humidity compared to the room air is heated and humidified so that the ventilation air and the room air will have the same temperature and humidity conditions, and then supplied to the room. As a result, it is possible to further improve the comfort of the room.

(15) Modified Example 12

[0115] In the air conditioning system 101 of the above described modified examples 10, 11, so-called a water supply type humidifier in which water is supplied to the humidifier via the water supply pipe 181 is used. However, it is not limited thereto, and it is possible to use a humidifier that uses moisture absorbing liquid capable of both absorbing moisture and desorbing the absorbed moisture.

[0116] For example, the air conditioning system 101 that does not include the fan convector 142 as shown in Figure 19 may be provided with a humidifier 184 comprising first and second moisture permeable film modules 184a, 184b having a plurality of tube shaped moisture permeable films, and a moisture absorbing liquid circulating pump 184c that circulates the moisture absorbing liquid between the first and second moisture permeable film modules 184a, 184b.

[0117] More specifically, the first moisture permeable film module 184a is provided with a passage such that the ventilation air that is heated by the outdoor air heating device 144 and supplied to the room passes over the outside of the moisture permeable film. In addition, the inside of the moisture permeable film of the first moisture permeable film module 184a is configured such that moisture absorbing liquid that is circulated by the moisture absorbing liquid circulating pump 184c is introduced therein, and is capable of humidifying the ventilation air, by causing moisture absorbing liquid that is supplied to the moisture permeable film to contact with the ventilation air via the moisture permeable film and by using the ventilation air to heat the moisture absorbing liquid in which moisture is absorbed to desorb moisture back into the ventilation air. The second moisture permeable film module 184b is provided with a passage such that the exhaust air that is exhausted from the room to the outside passes over the outside of the moisture permeable film. In addition, the inside of the moisture permeable film of the second moisture permeable film module 184b is configured such that moisture absorbing liquid that is circulated by the moisture absorbing liquid circulating pump 184c is introduced therein, and the moisture absorbing liquid that is supplied to the moisture permeable film is caused to contact with the exhaust air via the moisture permeable film so that moisture in the exhaust air can be absorbed into the moisture absorbing liquid. As the moisture permeable film, polytetrafluoroethylene (PTFE) and the like may be used. In addition, as a moisture absorbing liquid, lithium chloride aqueous solution and the like may be used.

[0118] This humidifier 184 operates to circulate the moisture absorbing liquid by the moisture absorbing liquid circulating pump 184c in order from the second moisture permeable film module 184b to the first moisture permeable film module 184a. In this condition, when the exhaust air is passed through the second moisture permeable film module 184b, moisture in the exhaust air will be absorbed into the moisture absorbing liquid via the moisture permeable film of the second moisture permeable film module 184b. The moisture absorbing liquid that absorbed this moisture will be sent to the first moisture permeable film module 184a. Next, when the ventilation air heated by the outdoor air heating device 144 is passed through the first moisture permeable film module 184a, the moisture absorbing liquid sent from the second moisture permeable film module 184b to the first moisture permeable film module 184a will be heated via the moisture

permeable film. Then, moisture is desorbed from this heated moisture absorbing liquid back to the ventilation air via the moisture permeable film, and the ventilation air is humidified and supplied to the room.

[0119] In this way, the air conditioning system 101 of this modified example is provided with the humidifier 184 that uses the moisture absorbing liquid, so that it is possible to humidify the ventilation air by using the ventilation air to heat the moisture absorbing liquid in which moisture is absorbed and by desorbing moisture back into the ventilation air. In this air conditioning system 101, moisture included in the exhaust air that is exhausted from the room to the outside is used as moisture to be absorbed into the moisture absorbing liquid, so that it is possible to humidify the ventilation air without the need to supply water to the humidifier 184.

[0120] In addition, as shown in Figure 20, in order to enlarge the range of humidity control by the humidifier 184, the exhaust air that is exhausted from the room to the outside (shown as RA on the left side of the second moisture permeable film module 184b in Figure 20) is mixed with the outdoor air (shown as OA on the left side of the second moisture permeable film module 184b in Figure 20) different from the ventilation air, and this mixed air may be passed through the second moisture permeable film module 184b so that moisture will be absorbed into the moisture absorbing liquid via the moisture permeable film of the second moisture permeable film module 184b, and this absorbed moisture may be caused to be desorbed back to the ventilation air via the moisture permeable film of the first moisture permeable film module 184a.

[0121] Note that in this modified example, the humidifier 184 that uses the moisture absorbing liquid is configured so as to exchange moisture between the moisture absorbing liquid and the air via the moisture permeable film modules 184a, 184b having the moisture permeable film. However, it is not limited thereto and it may be configured such that the moisture absorbing liquid and the air are in direct contact with each other. In addition, with the humidifier 184 shown in Figure 20, both the exhaust air that is exhausted from the room to the outside and the outdoor air different from the ventilation air are caused to pass through the second moisture permeable film module 184b, however, only the outdoor air different from the ventilation air may be caused to pass therethrough.

(16) Modified Example 13

[0122] As a humidifier capable of humidifying the air without the supply of water, the air conditioning system 101 of the above described modified example 12 uses a humidifier that uses the moisture absorbing liquid capable of both absorbing moisture and desorbing the absorbed moisture through heating. However, a humidifier that uses an adsorbent capable of both adsorbing moisture and desorbing the adsorbed moisture through heating may be used.

[0123] For example, the air conditioning system 101 that does not include the fan convector 142 as shown in Figure 21 may be provided with a humidifier 185 having a desiccant rotor 185a in which an adsorbent is carried.

[0124] More specifically, the humidifier 185 is provided with a passage such that the ventilation air that is heated by the outdoor air heating device 144 and supplied to the room passes through a portion of the desiccant rotor 185a. In addition, on a different portion of the desiccant rotor 185a, there is provided a passage in which the exhaust air that is exhausted from the room to the outside passes therethrough. The desiccant rotor 185a is configured to be capable of being rotatably driven by a drive mechanism such as an electric motor, and is capable of flowing the ventilation air and the exhaust air through each portion of the desiccant rotor 185a. As an adsorbent, zeolite, silica gel, activated alumina, and the like may be used.

[0125] With this humidifier 185, when the exhaust air is passed through a portion of the desiccant rotor 185a other than a portion through which the ventilation air is passed, moisture in the exhaust air will be adsorbed onto the adsorbent of the desiccant rotor 185a. Then, the desiccant rotor 185a is rotated, and a portion in which moisture is adsorbed is moved to a portion corresponding to the passage through which the ventilation air is passed. Consequently, the ventilation air will pass through a portion of the desiccant rotor 185a in which moisture in the exhaust air is adsorbed, and the ventilation air heated by the outdoor air heating device 144 will heat the portion of the desiccant rotor 185a in which moisture is adsorbed. Consequently, it will be possible to desorb moisture from this heated adsorbent back to the ventilation air, humidify the ventilation air, and supply the humidified ventilation air to the room. At this time, due to the rotation of the desiccant rotor 185a, a portion of the desiccant rotor 185a, which was located at a position corresponding to a passage of the desiccant rotor 185a through which the ventilation air is passed, is moved to a position corresponding to a passage of the desiccant rotor 185a through which the exhaust air is passed, and therefore moisture in the exhaust air will be adsorbed. Repetition of this action enables continuous humidification of the ventilation air.

[0126] In this way, the air conditioning system 101 of this modified example is provided with the humidifier 185 that uses an adsorbent, so that the adsorbent onto which moisture is adsorbed can be heated by using the ventilation air to desorb the moisture back to the ventilation air, thereby humidifying the ventilation air. In addition, as moisture to be adsorbed onto the adsorbent, the air conditioning system 101 uses moisture in the exhaust air that is exhausted from the room to the outside, so that the ventilation air can be humidified without the need to supply water to the humidifier 185.

[0127] In addition, as shown in Figure 22, in order to enlarge the range of humidity control by the humidifier 185, the exhaust air that is exhausted from the room to the outside (shown as RA on the left side of the desiccant rotor 185a in

Figure 21) is mixed with the outdoor air (shown as OA on the left side of the desiccant rotor 185a in Figure 21) different from the ventilation air, and this mixed air may be passed through the desiccant rotor 185a so as to adsorb moisture onto the adsorbent of the desiccant rotor 185a and desorb the moisture back to the ventilation air.

[0128] Note that with the humidifier 185 shown in Figure 22, both the exhaust air that is exhausted from the room to the outside and the outdoor air different from the ventilation air are caused to pass through the desiccant rotor 185a, however, only the outdoor air different from the ventilation air may be caused to pass therethrough.

(17) Other Embodiments

[0129] While a preferred embodiment of the present invention has been described with reference to the figures, the scope of the present invention is not limited to the above embodiment, and the various changes and modifications may be made without departing from the scope of the present invention.

[0130] For example, the air conditioning system of the above described embodiment uses, as a heat source unit, a heat source unit that has a refrigerant circuit dedicated to heating. However, a heat source unit capable of switchably performing cooling and heating operations may be used.

INDUSTRIAL APPLICABILITY

[0131] Application of the present invention will enable, in the air conditioning system capable of heating the room, the prevention of a cold draft due to the ventilation air that is supplied to the room to ventilate the room.

Claims

1. An air conditioning system (101) capable of heating a room, comprising:

a heat source unit (102) having a vapor compression type refrigerant circuit (120) including a compressor (121), a heat source side heat exchanger (124), an expansion mechanism (123), and a utilization side heat exchanger (122), the heat source unit (102) being capable of heating a heating medium that is used for heating the room in the utilization side heat exchanger;

an air supply device (103) configured to supply an outdoor air to a room as a ventilation air; and

a heating medium circuit (104) having at least one room heating device (141, 142, 143) configured to release the heat of a heating medium heated in the utilization side heat exchanger into the room, and an outdoor air heating device (144) configured to heat the ventilation air with the heat of the heating medium heated in the utilization side heat exchanger, the heating medium circuit (104) being configured to circulate the heating medium between the room heating device and the outdoor air heating device, and the utilization side heat exchanger.

2. The air conditioning system (101) according to claim 1, wherein

the heating medium circuit (104) is connected to the utilization side heat exchanger such that the heating medium heated in the utilization side heat exchanger (122) is sequentially supplied to the room heating device (141, 142, 143) and the outdoor air heating device (144).

3. The air conditioning system (101) according to claim 2, wherein

the heating medium circuit (104) further includes at least one bypass heating medium circuit (151, 153, 154) configured to bypass the room heating device (141, 142, 143) and the outdoor air heating device (144).

4. The air conditioning system (101) according to claim 3, wherein

the bypass heating medium circuit (151, 153, 154) includes a heating medium flow control mechanism (151a, 153a, 154a).

5. The air conditioning system (101) according to claim 1, wherein

the heating medium circuit (104) is constituted by a plurality of divided heating medium circuits (104a, 104b, 104c, 104d) configured to independently circulate the heating medium between at least one of the room heating device (141, 142, 143) and the outdoor air heating device (144), and the utilization side heat exchanger (122).

6. The air conditioning system (101) according to claim 5, wherein

the utilization side heat exchanger (122) is constituted by a plurality of divided utilization side heat exchangers (122a,

122b, 122c, 122d) divided so as to correspond to the plurality of divided heating medium circuits (104a, 104b, 104c, 104d).

7. The air conditioning system (101) according to claim 6, wherein
the heat source unit (102) further includes at least one bypass refrigerant circuit (171) configured to bypass the plurality of divided utilization side heat exchangers (122a, 122b, 122c, 122d).
8. The air conditioning system (101) according to claim 7, wherein
the bypass refrigerant circuit (171) includes a refrigerant flow control mechanism (171a).
9. The air conditioning system (101) according to any one of claims 5 to 8, wherein
the plurality of divided heating medium circuits (104a, 104b, 104c, 104d) are connected to the utilization side heat exchanger (122) such that the temperature of a heating medium that is supplied to the outdoor air heating device (144) is equal to or lower than the temperature of the heating medium used in the room heating device (141, 142, 143).
10. The air conditioning system (101) according to any one of claims 1 to 9, wherein
some of the room heating device (141, 142, 143) and the outdoor air heating device (144) use the refrigerant that flows through the refrigerant circuit (120) without flowing through the heating medium circuit (104).
11. The air conditioning system (101) according to any one of claims 1 to 10, wherein
the heating medium circuit (104) includes a heating medium storage container (161, 161a, 161b, 161c).
12. The air conditioning system (101) according to any one of claims 1 to 11, further comprising a humidifier (182, 183, 184, 185) configured to humidify the ventilation air that is heated by the outdoor air heating device (144) and supplied to the room.
13. The air conditioning system (101) according to claim 12, wherein
the humidifier (183, 184) includes a moisture permeable film (183a, 184a) that allows moisture to permeate there-through, and is capable of humidifying the ventilation air by causing water that is supplied to the moisture permeable film to contact with the ventilation air via the moisture permeable film.
14. The air conditioning system (101) according to claim 12, wherein
the humidifier (184) includes a moisture absorbing liquid capable of both absorbing moisture and desorbing the absorbed moisture through heating, and is capable of humidifying the ventilation air by heating the moisture absorbing liquid in which moisture is absorbed, by using the ventilation air so as to desorb moisture back into the ventilation air.
15. The air conditioning system (101) according to claim 14, wherein
the humidifier (184) causes moisture in exhaust air that is exhausted from the room to the outside to be absorbed into the moisture absorbing liquid in order to humidify the ventilation air.
16. The air conditioning system (101) according to claim 14, wherein
the humidifier (184) causes moisture in an outdoor air different from the ventilation air to be absorbed into the moisture absorbing liquid in order to humidify the ventilation air.
17. The air conditioning system (101) according to claim 14, wherein
the humidifier (184) causes moisture in mixed air between exhaust air that is exhausted from the room to the outside and an outdoor air different from the ventilation air to be absorbed into the moisture absorbing liquid in order to humidify the ventilation air.
18. The air conditioning system (101) according to claim 12, wherein
the humidifier (185) includes an adsorbent (185a) capable of both adsorbing moisture and desorbing the adsorbed moisture through heating, and is capable of humidifying the ventilation air by heating the adsorbent in which moisture is adsorbed, by using the ventilation air so as to desorb moisture back to the ventilation air.
19. The air conditioning system (101) according to claim 18, wherein
the humidifier (185) causes moisture in exhaust air that is exhausted from the room to the outside to be adsorbed onto the adsorbent (185a) in order to humidify the ventilation air.

20. The air conditioning system (101) according to claim 18, wherein the humidifier (185) causes moisture in an outdoor air different from the ventilation air to be adsorbed onto the adsorbent (185a) in order to humidify the ventilation air.

5 **21.** The air conditioning system (101) according to claim 18, wherein the humidifier (185) causes moisture in mixed air between exhaust air that is exhausted from the room to the outside and an outdoor air different from the ventilation air to be adsorbed onto the adsorbent (185a) in order to humidify the ventilation air.

10 **22.** The air conditioning system (101) according to any one of claims 1 to 21, wherein the heating medium that flows through the heating medium circuit (104) is water.

23. The air conditioning system (101) according to any one of claims 1 to 21, wherein the heating medium that flows through the heating medium circuit (104) is brine that does not freeze below 0 degrees C.
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24. The air conditioning system (101) according to any one of claims 1 to 23, wherein the refrigerant that flows through the refrigerant circuit (104) is CO₂.

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Fig. 1

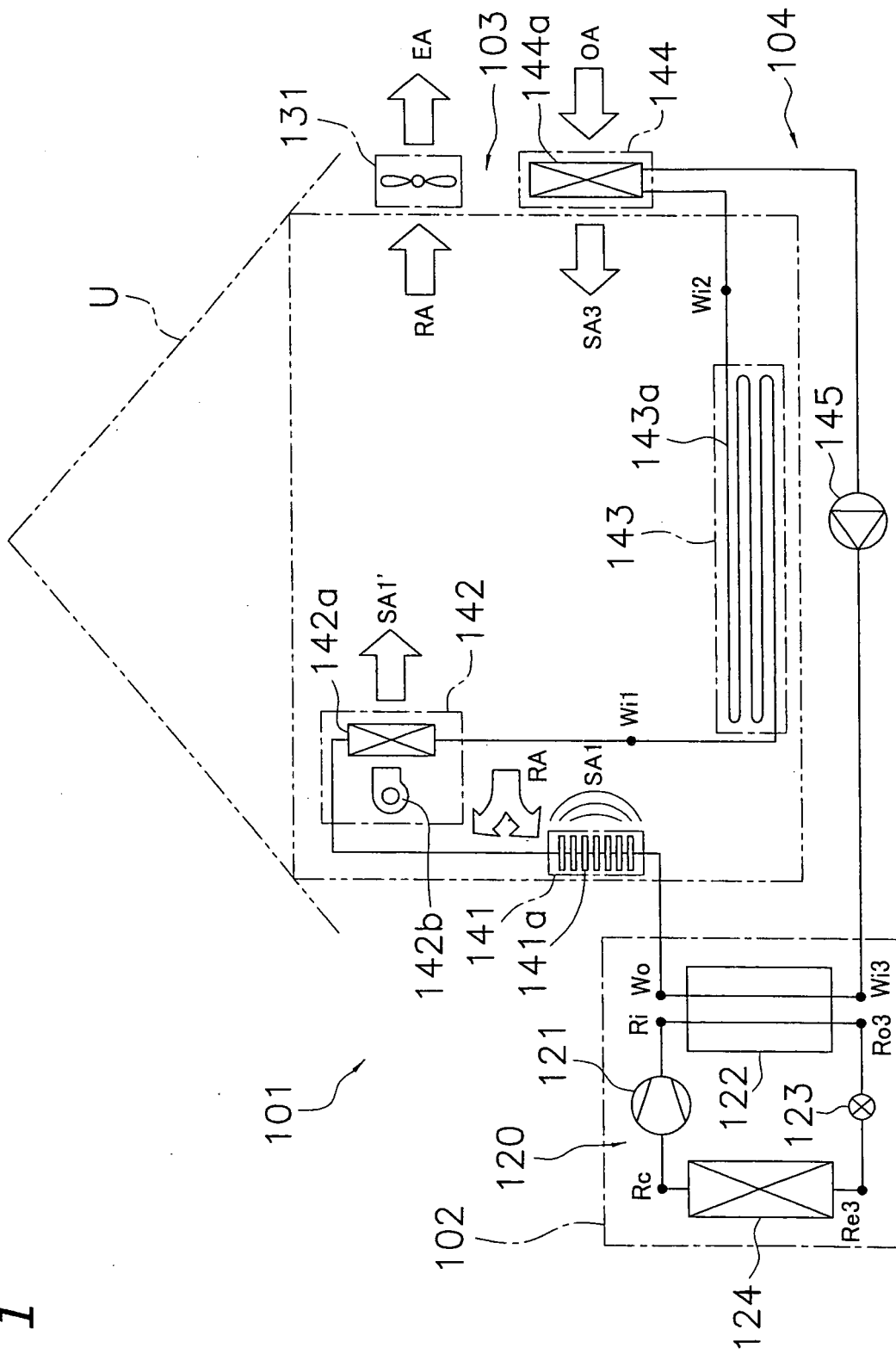


Fig. 2

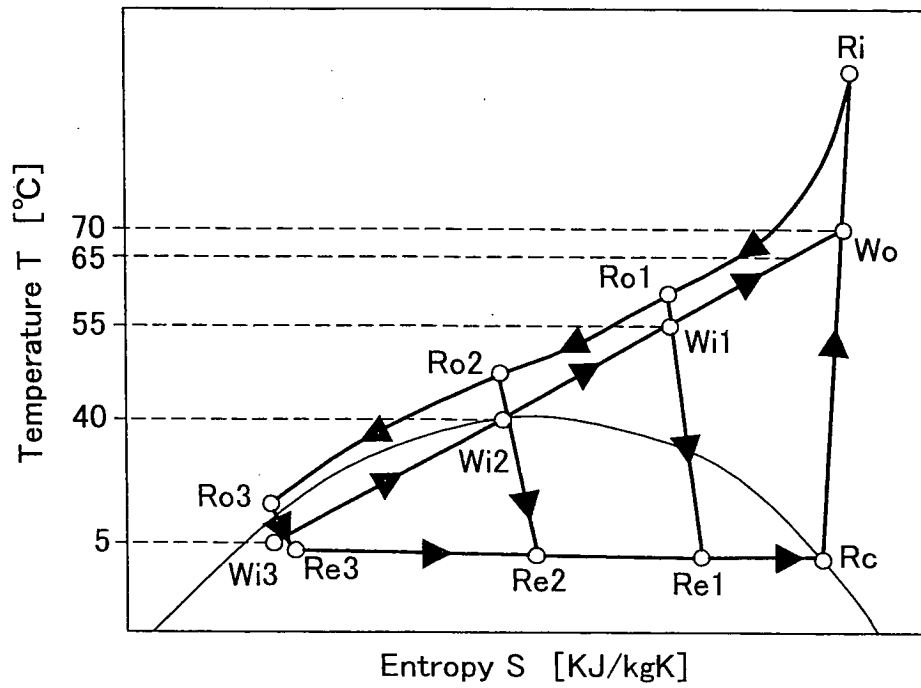


Fig. 3

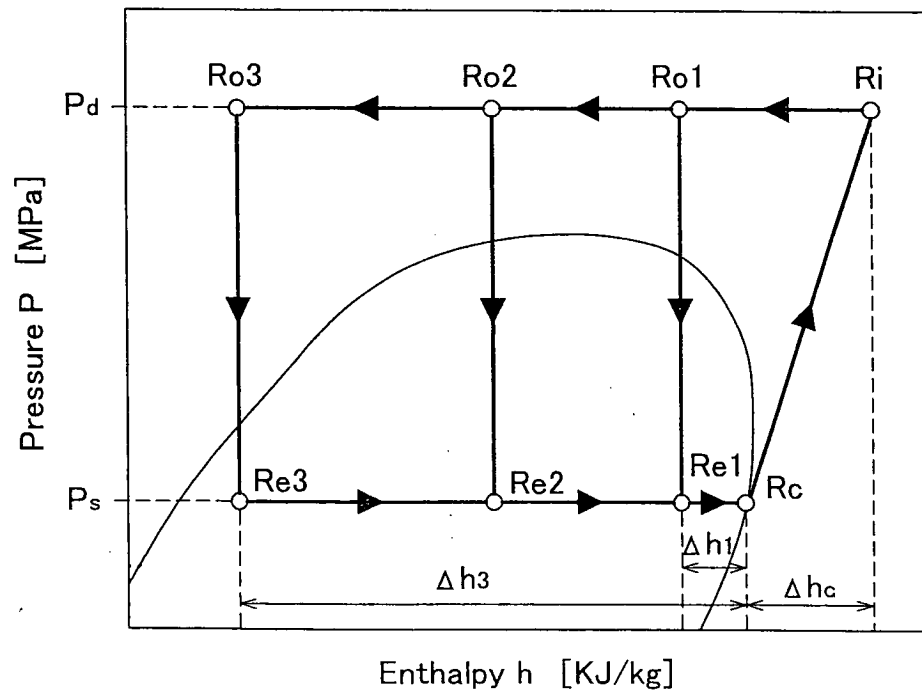


Fig. 4

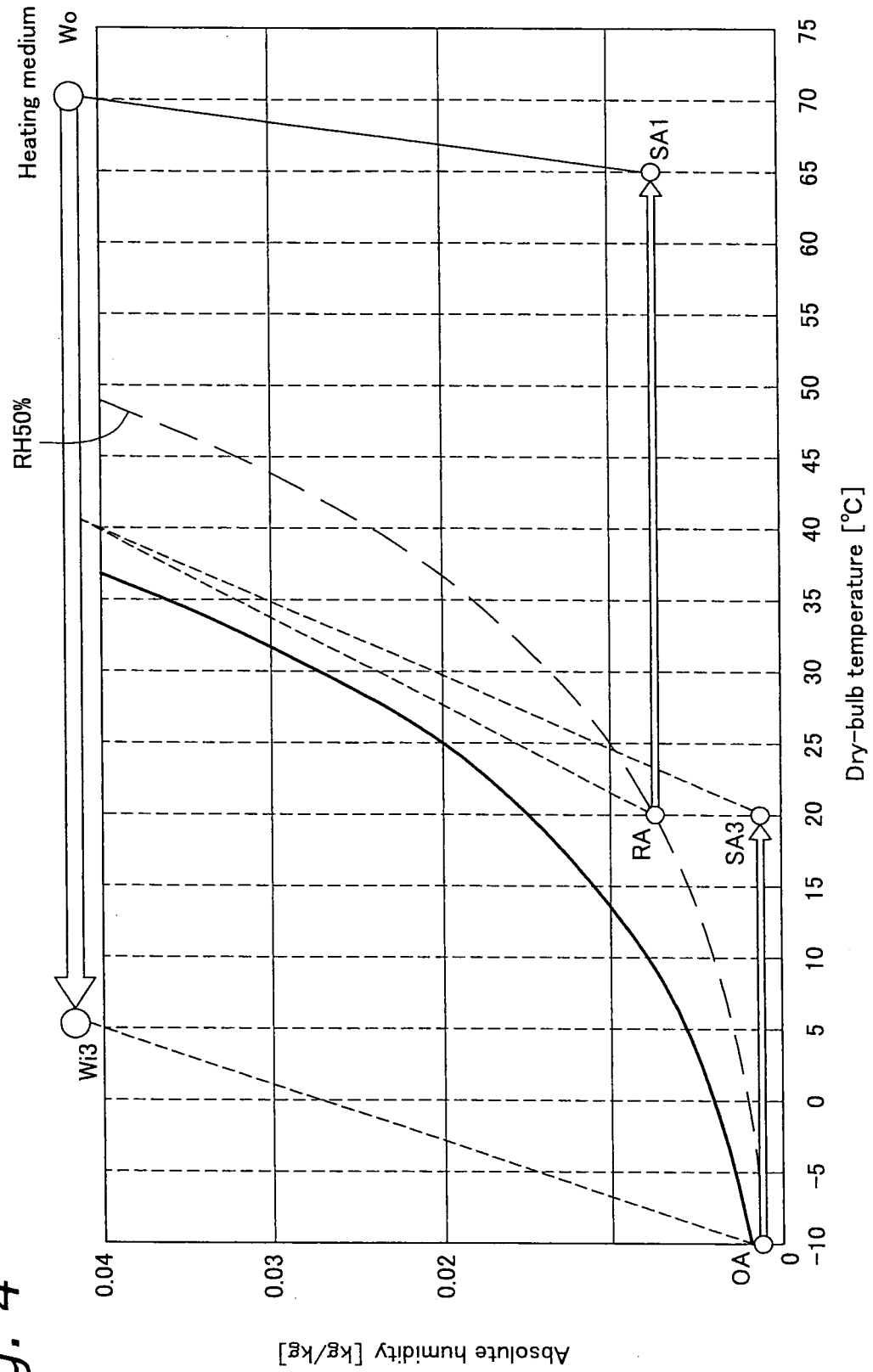


Fig. 5

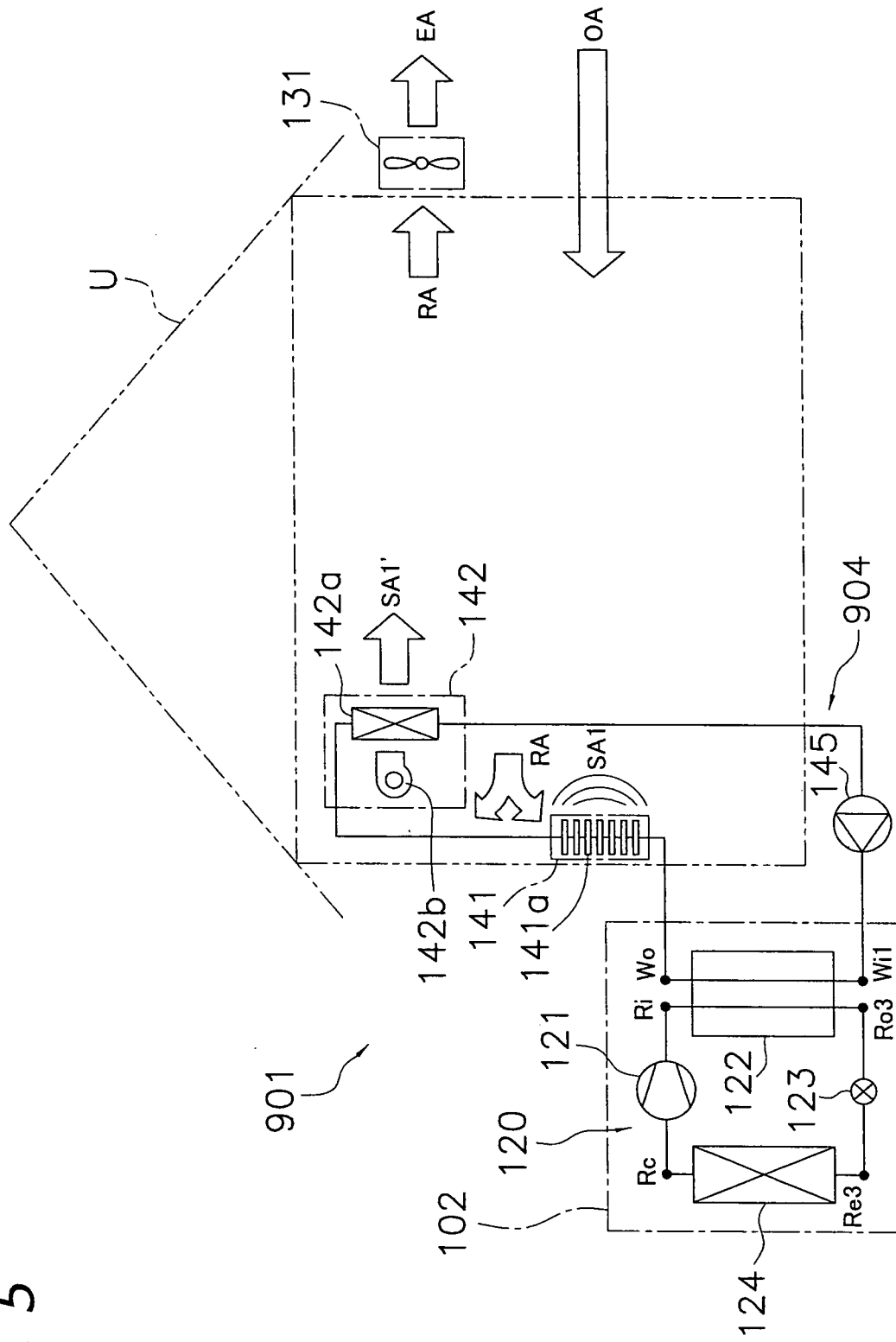


Fig. 6

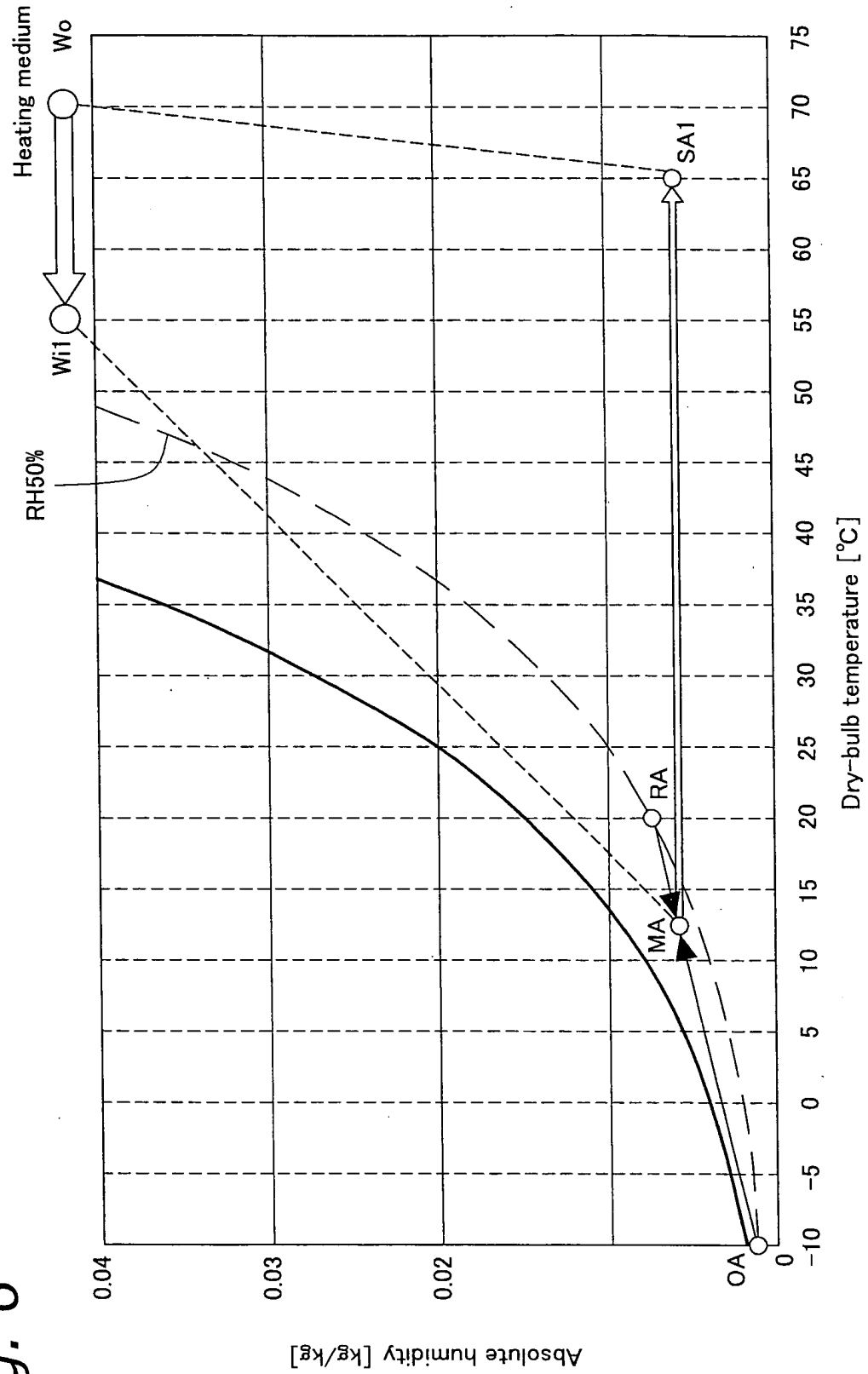
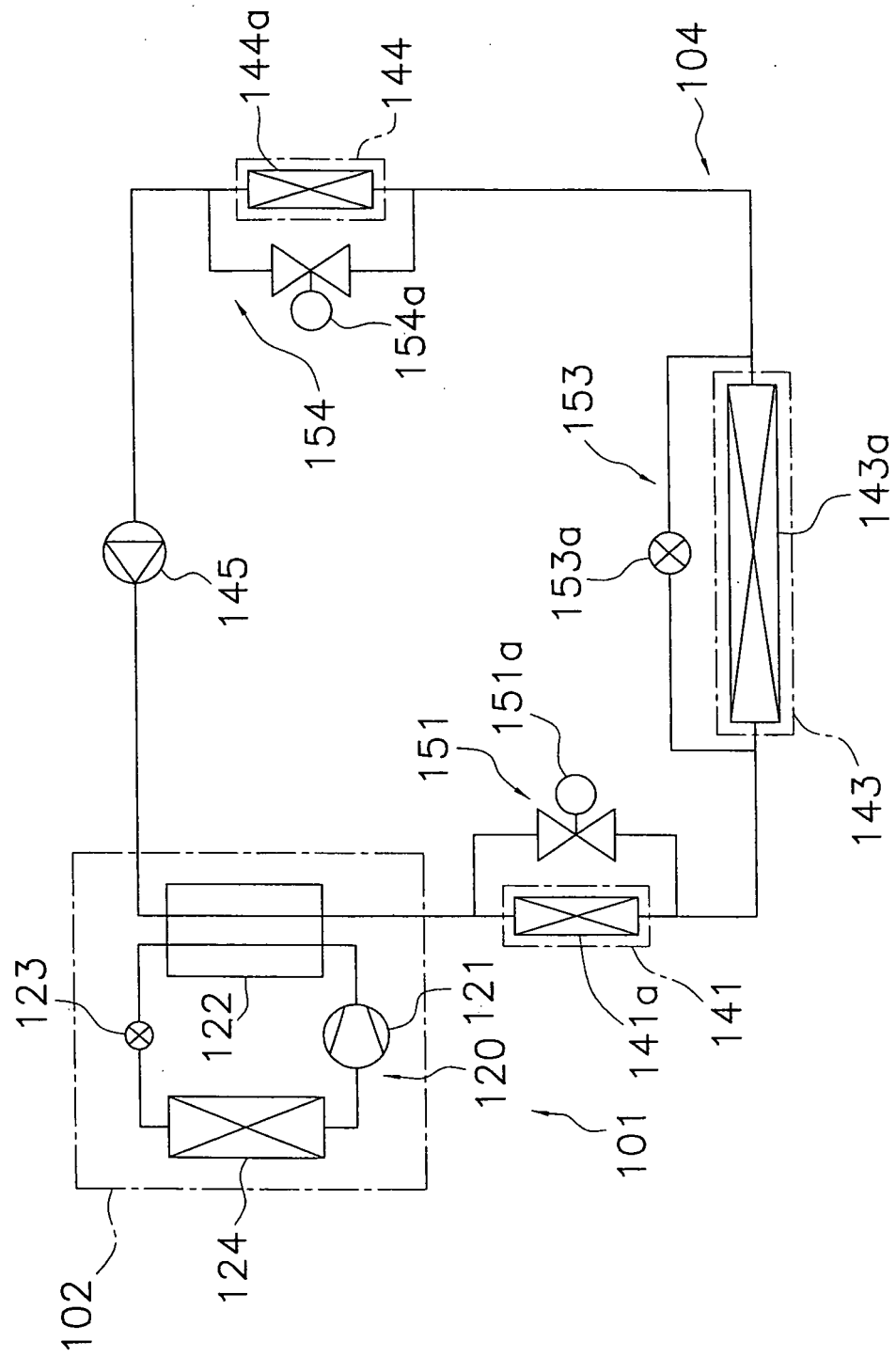


Fig. 7



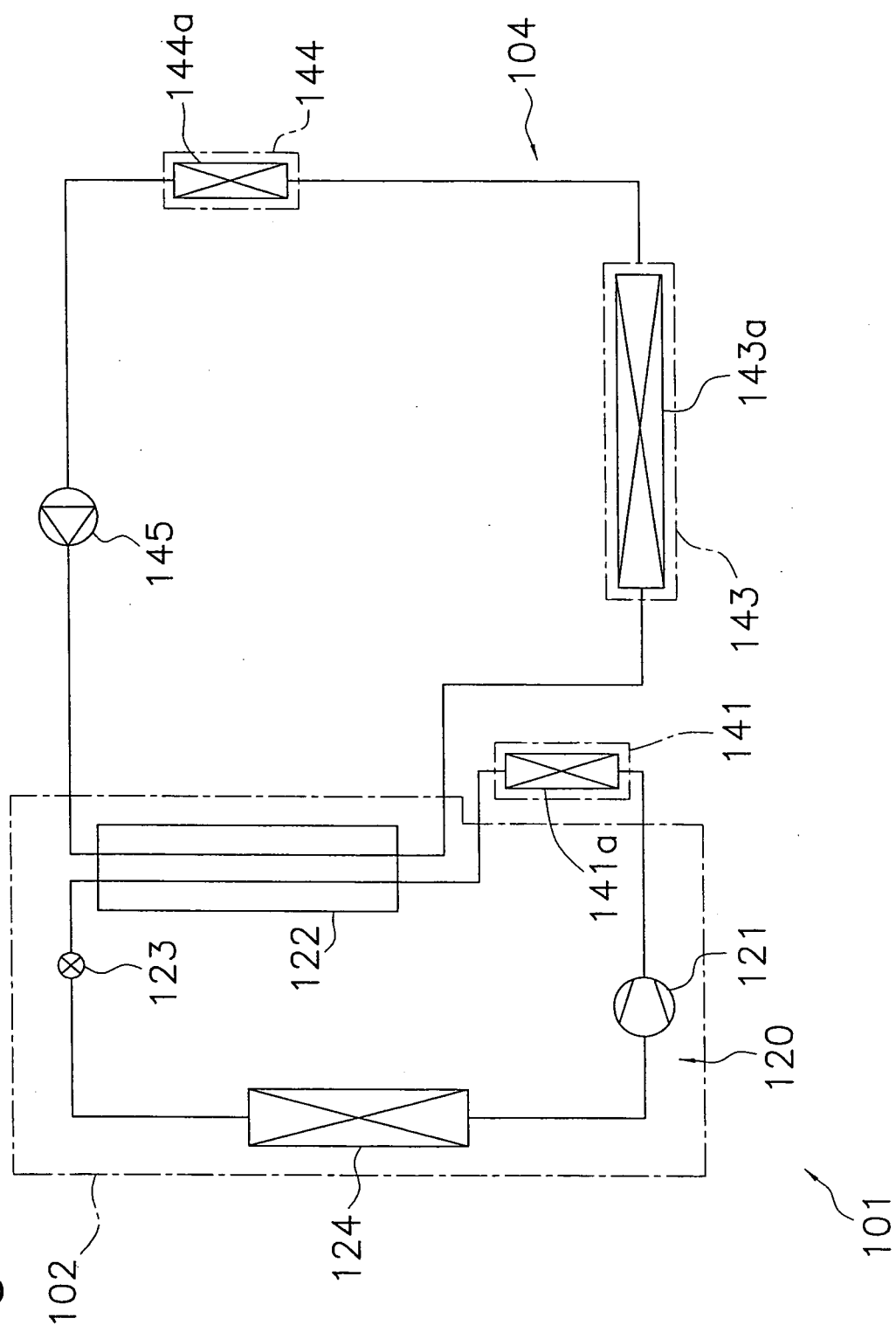
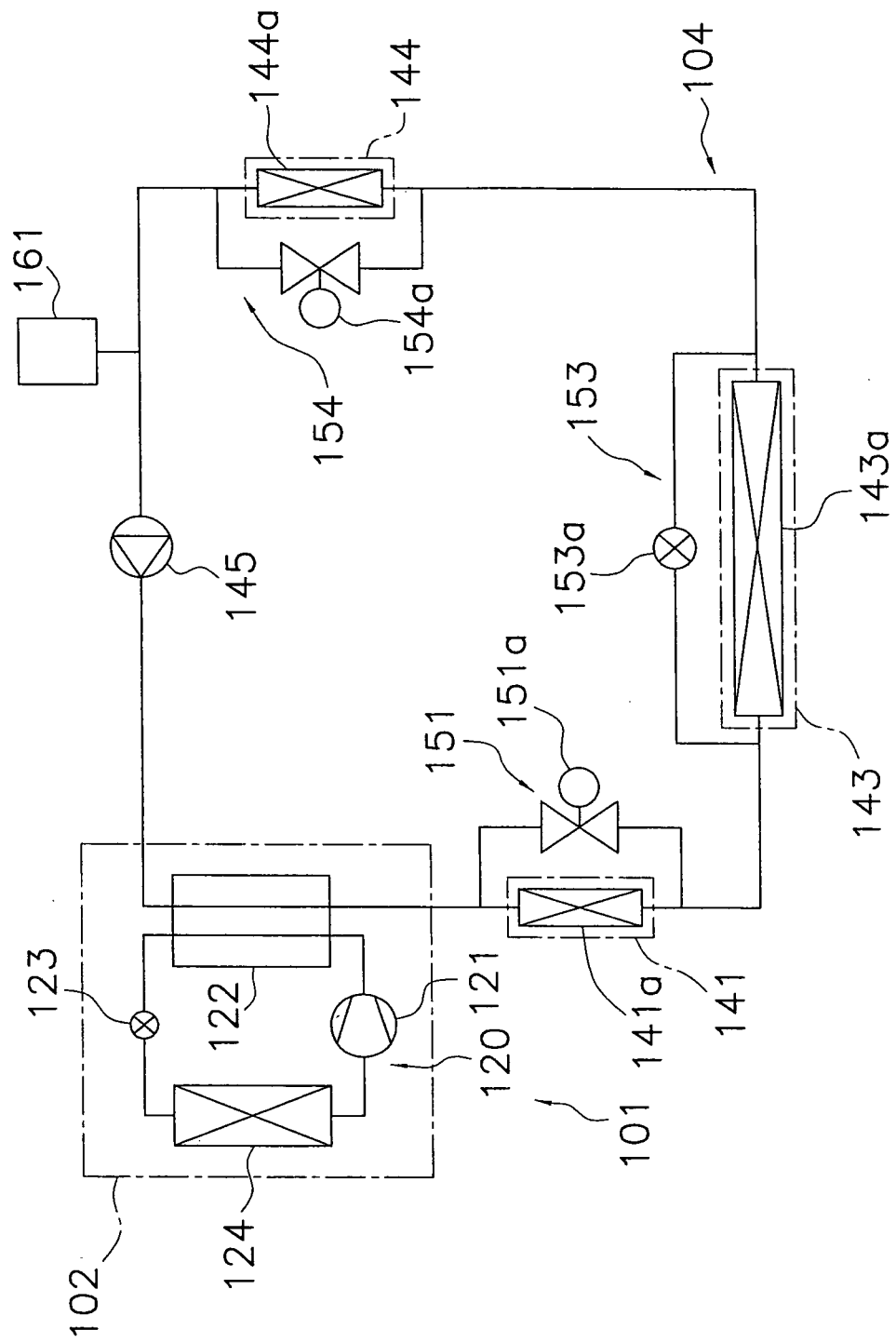
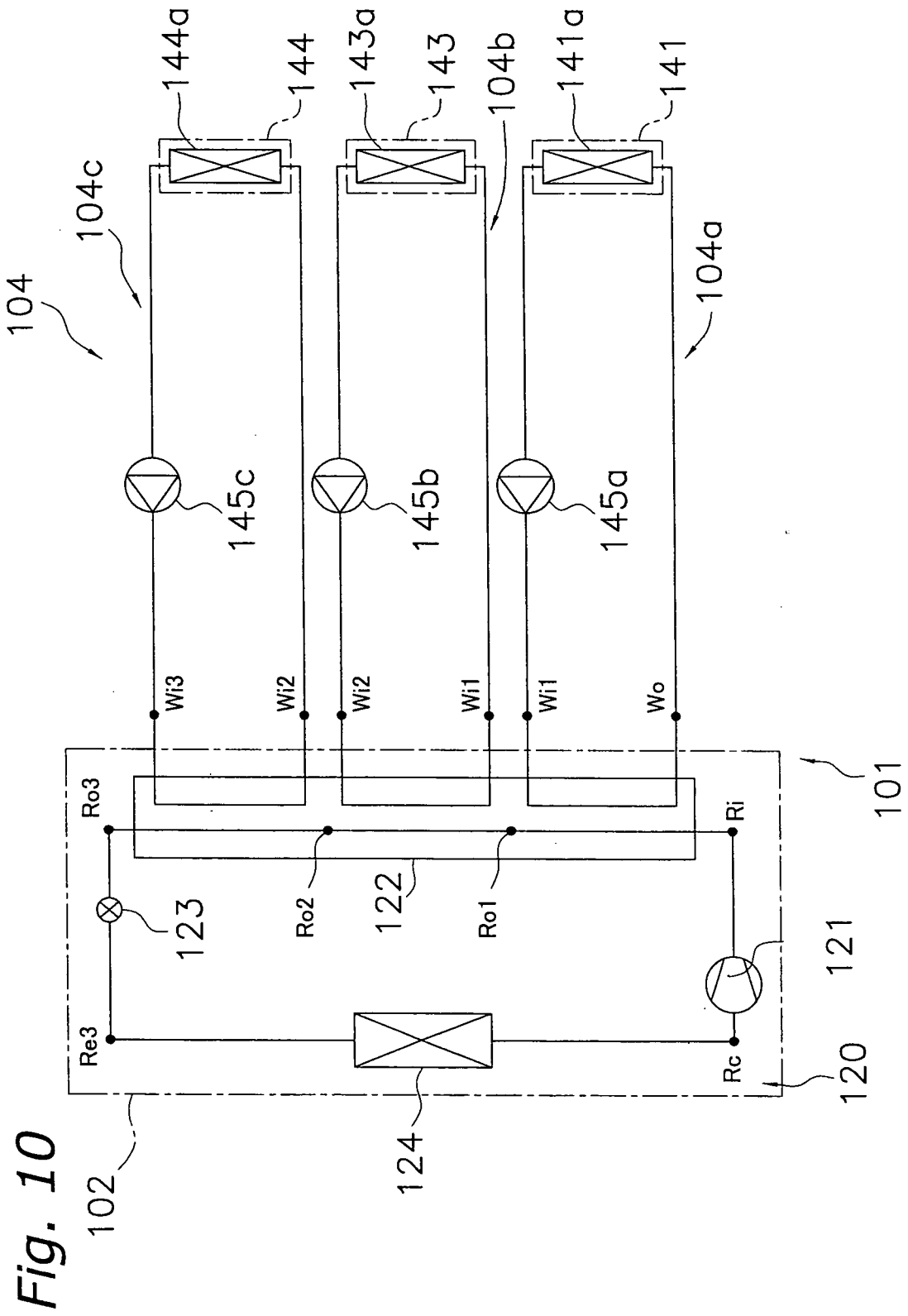
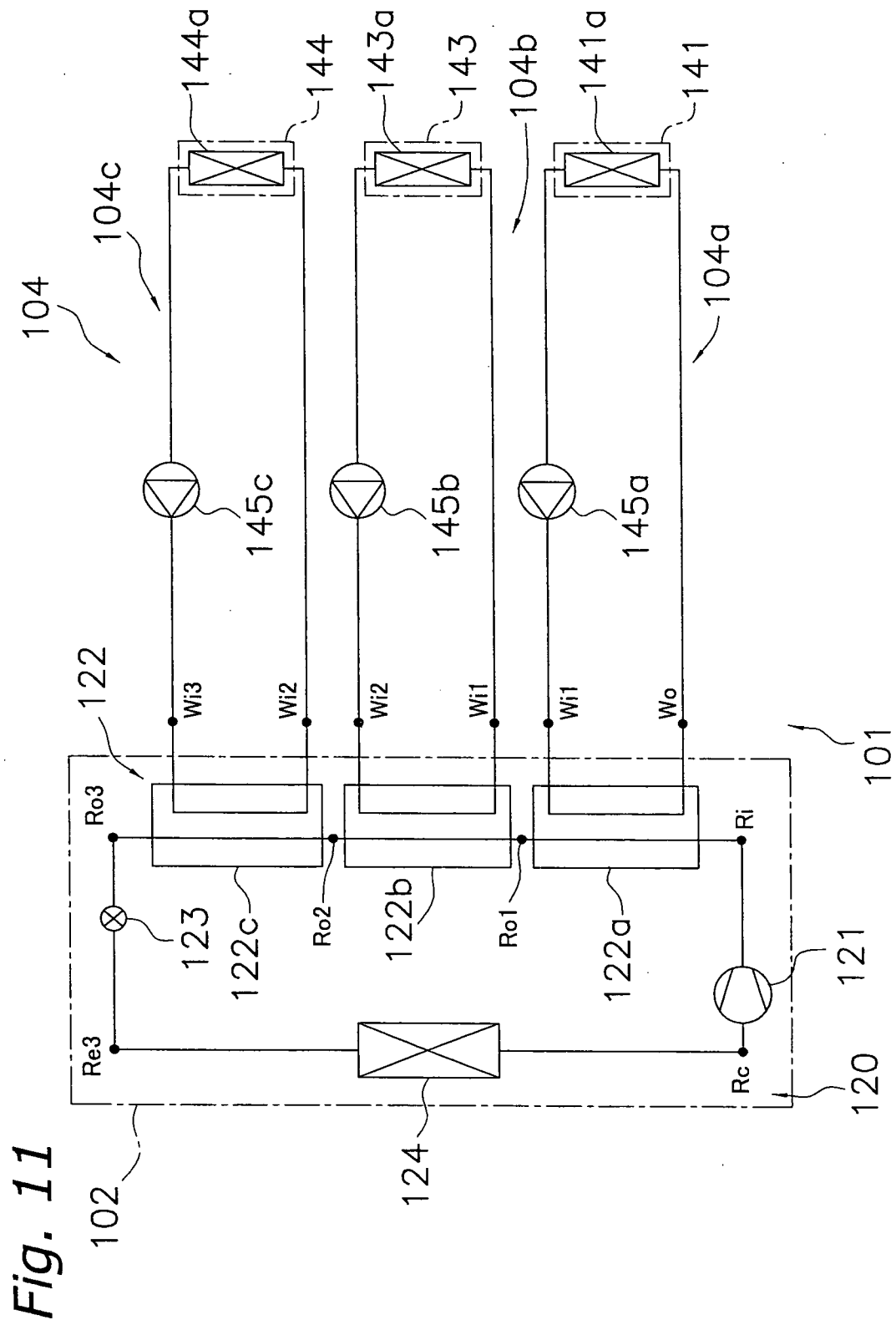


Fig. 8

Fig. 9







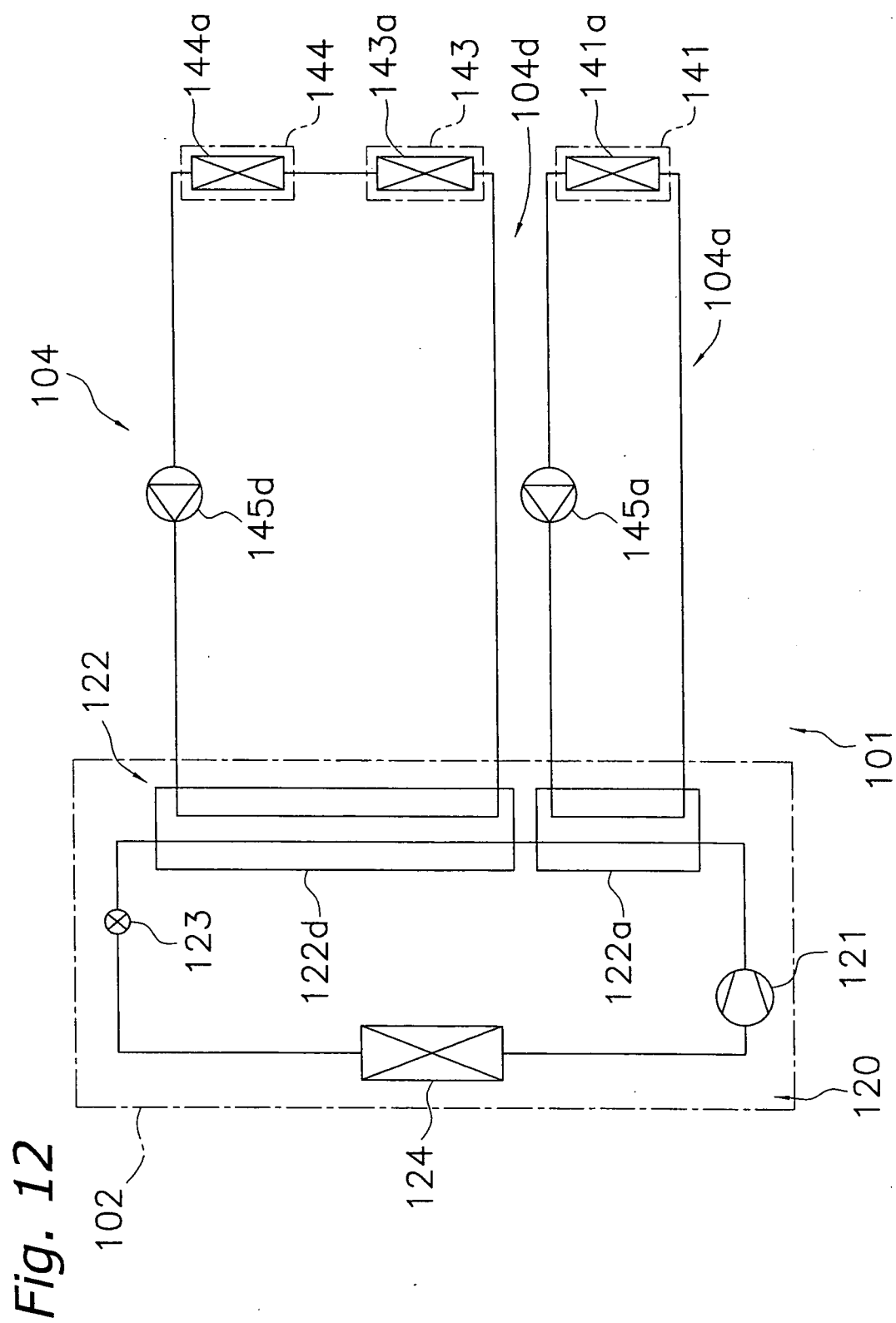
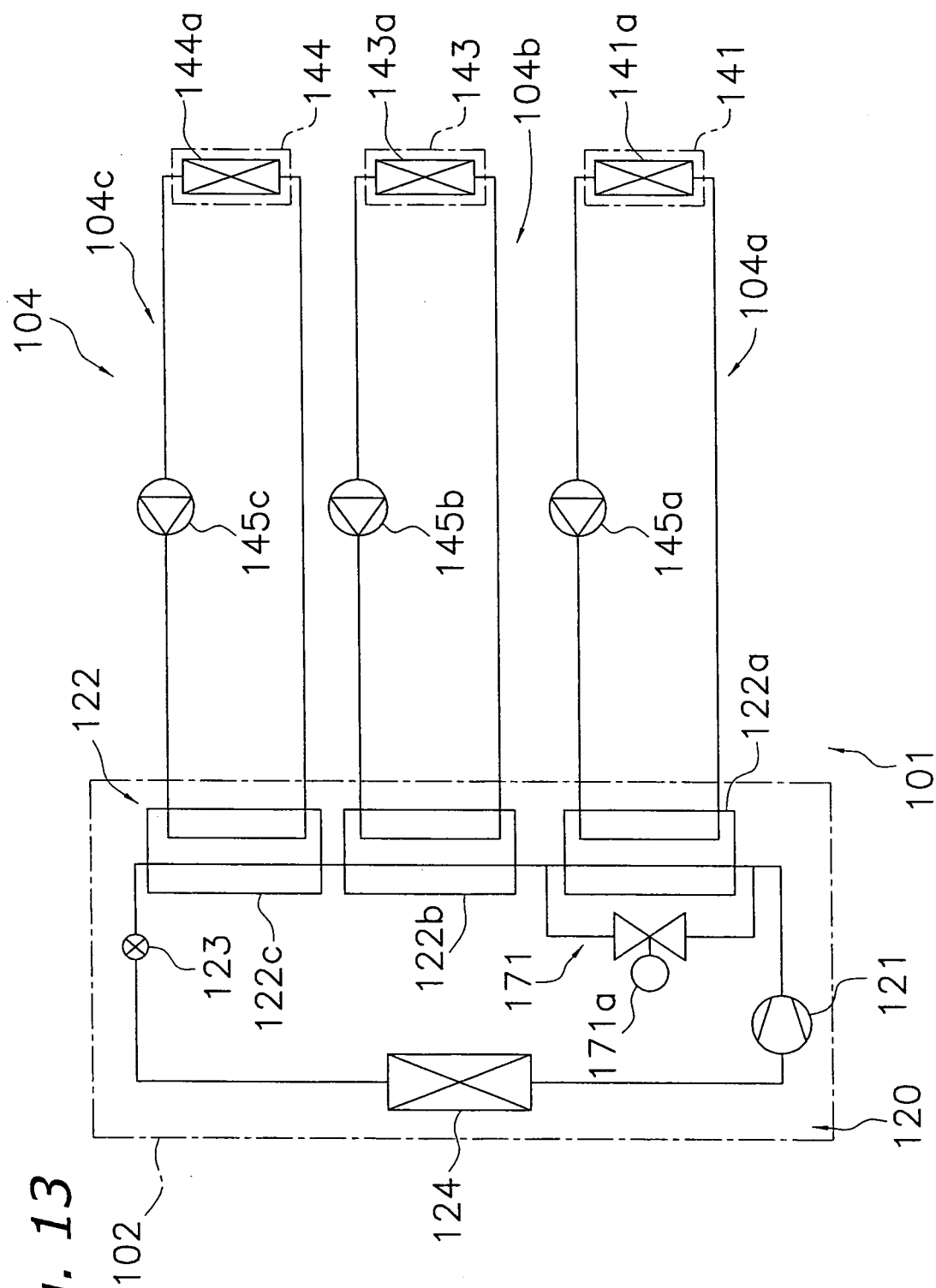


Fig. 13



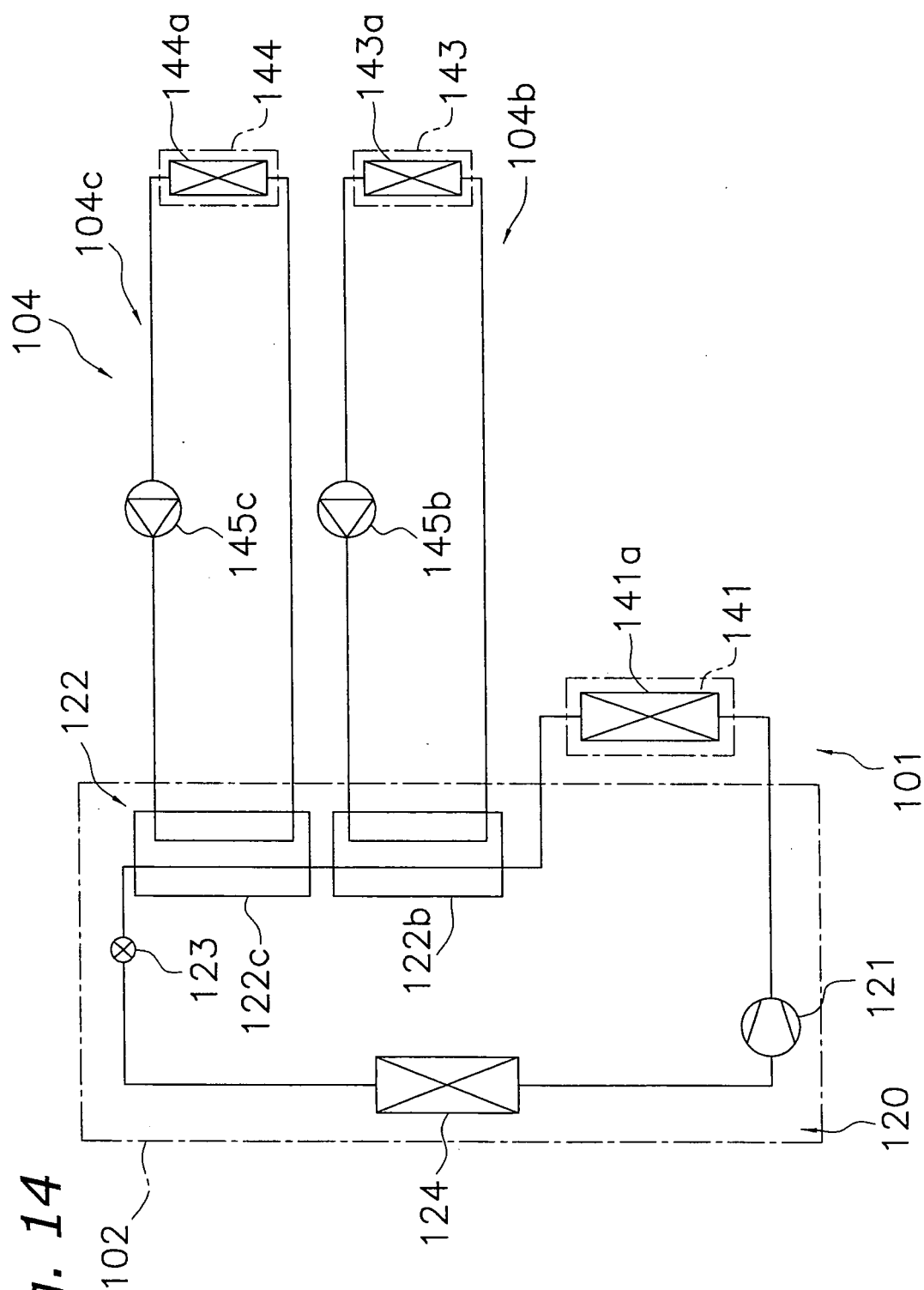


Fig. 14

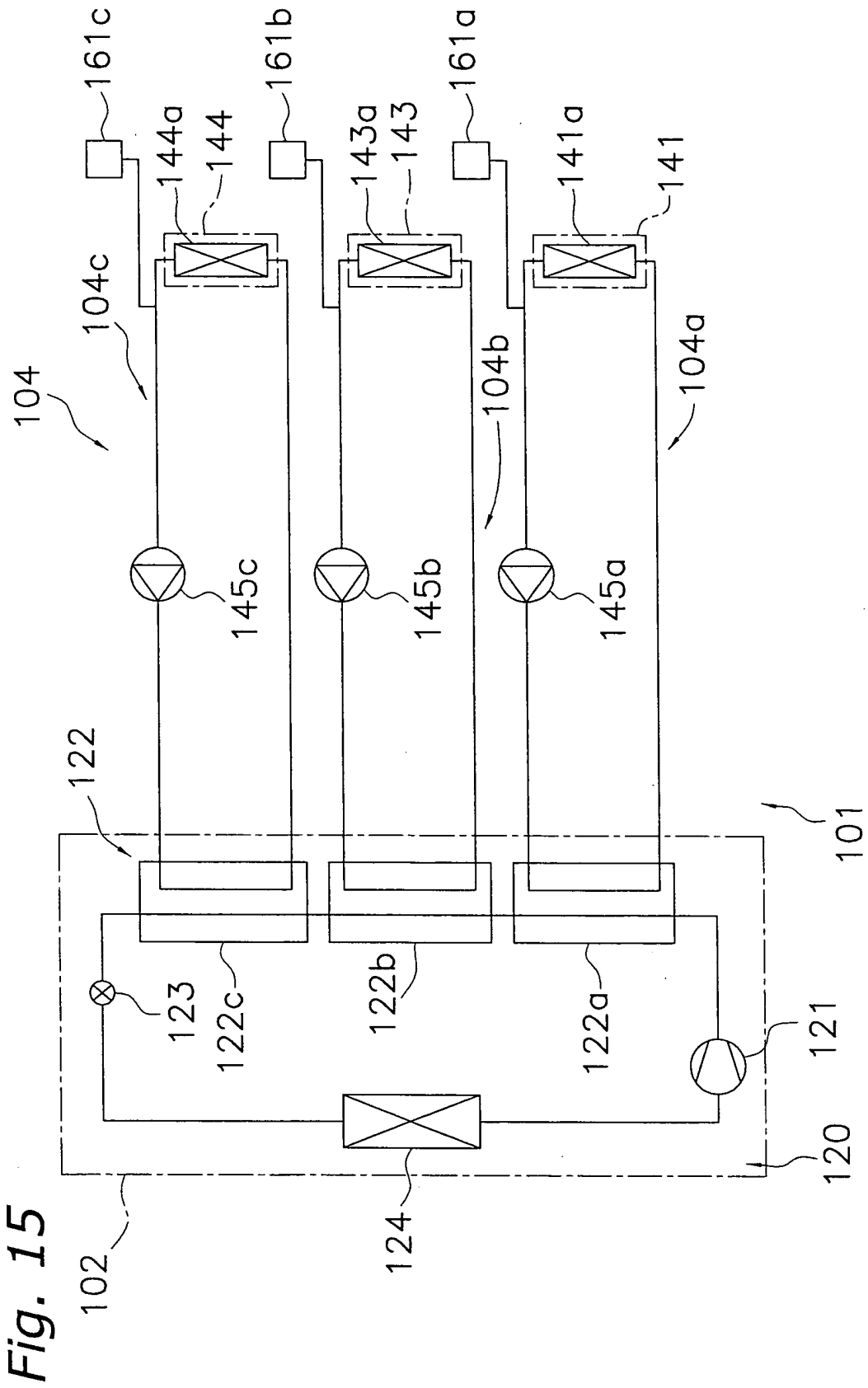


Fig. 16

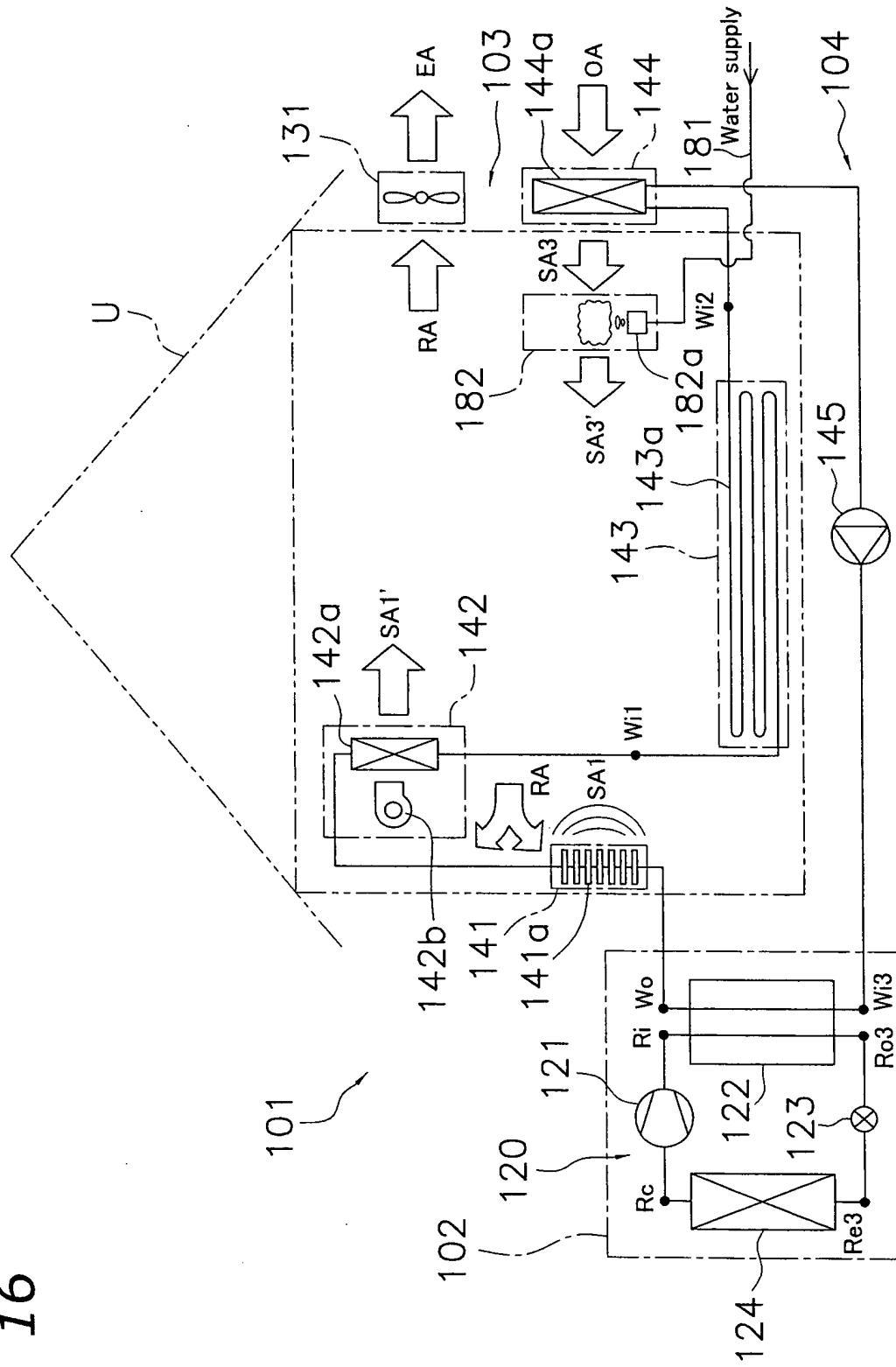


Fig. 17

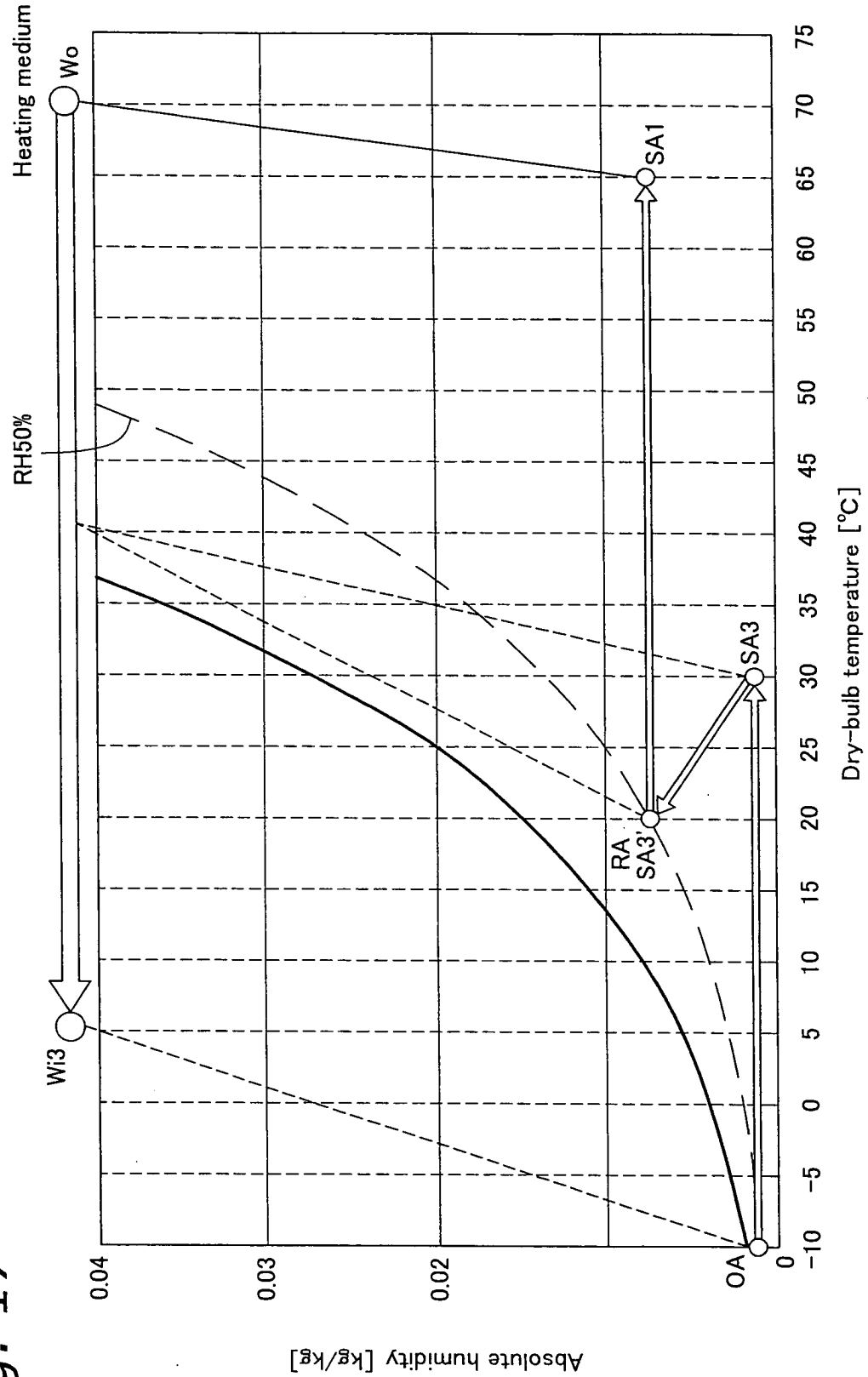


Fig. 18

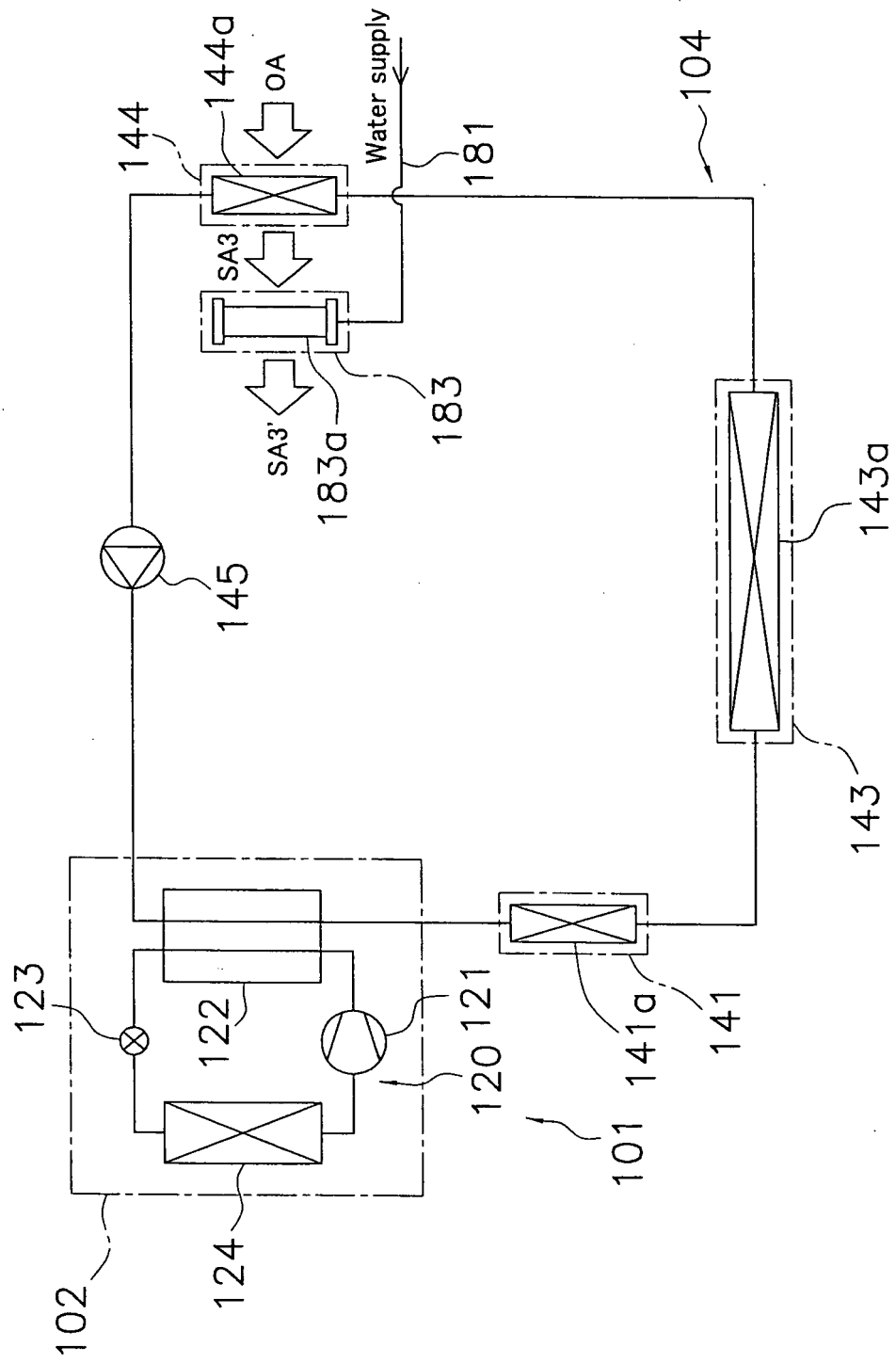


Fig. 19

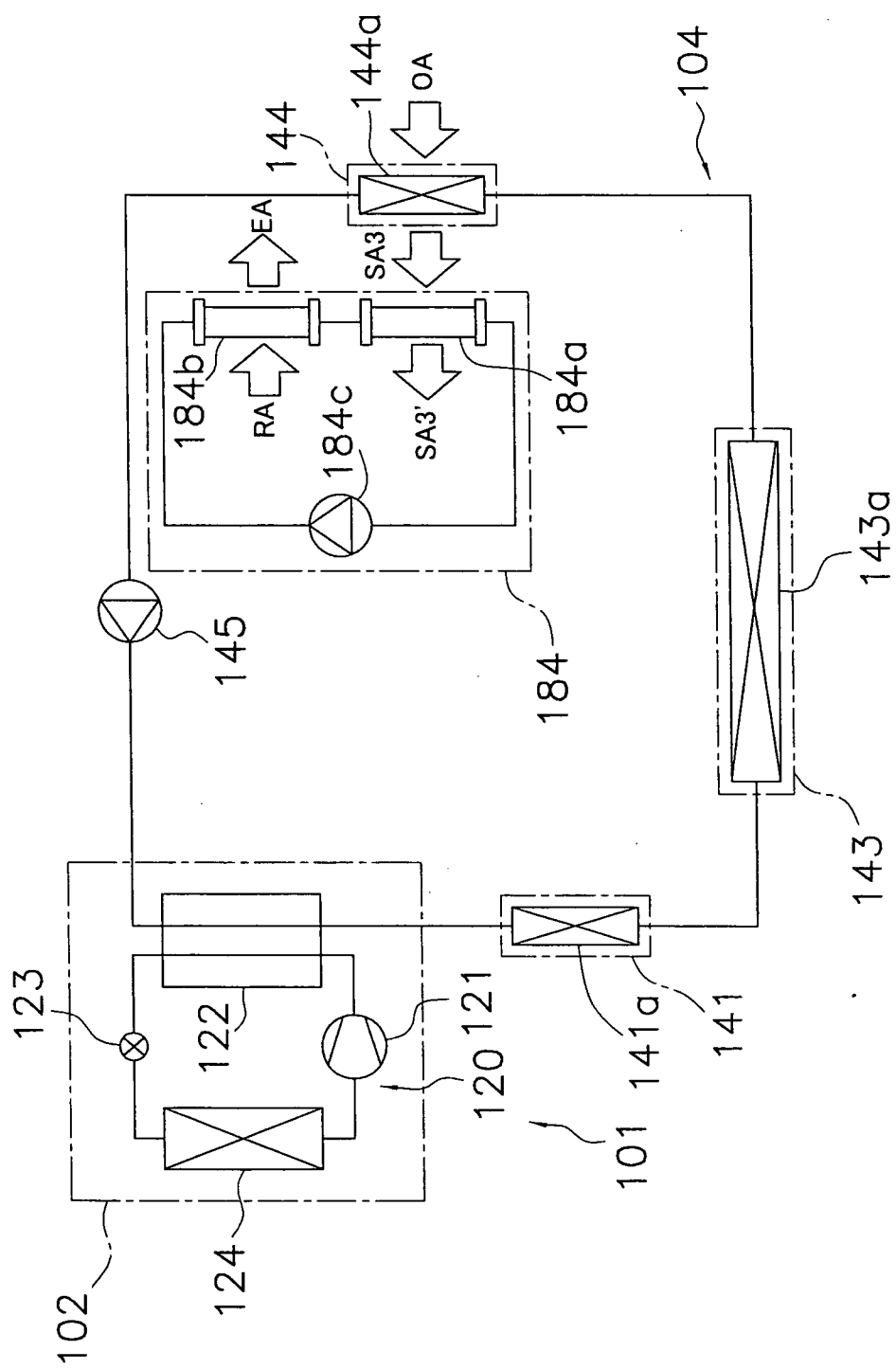


Fig. 20

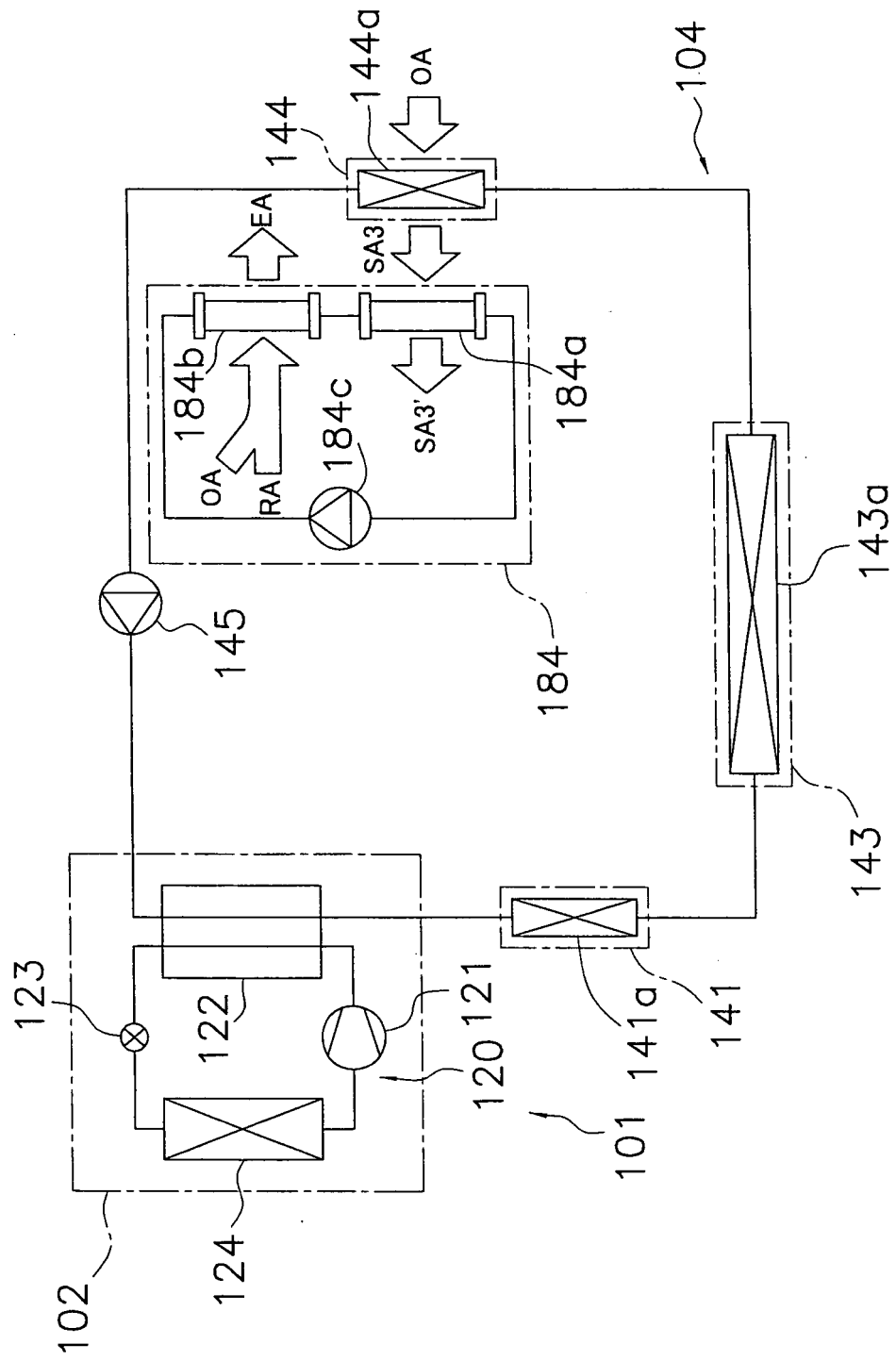


Fig. 21

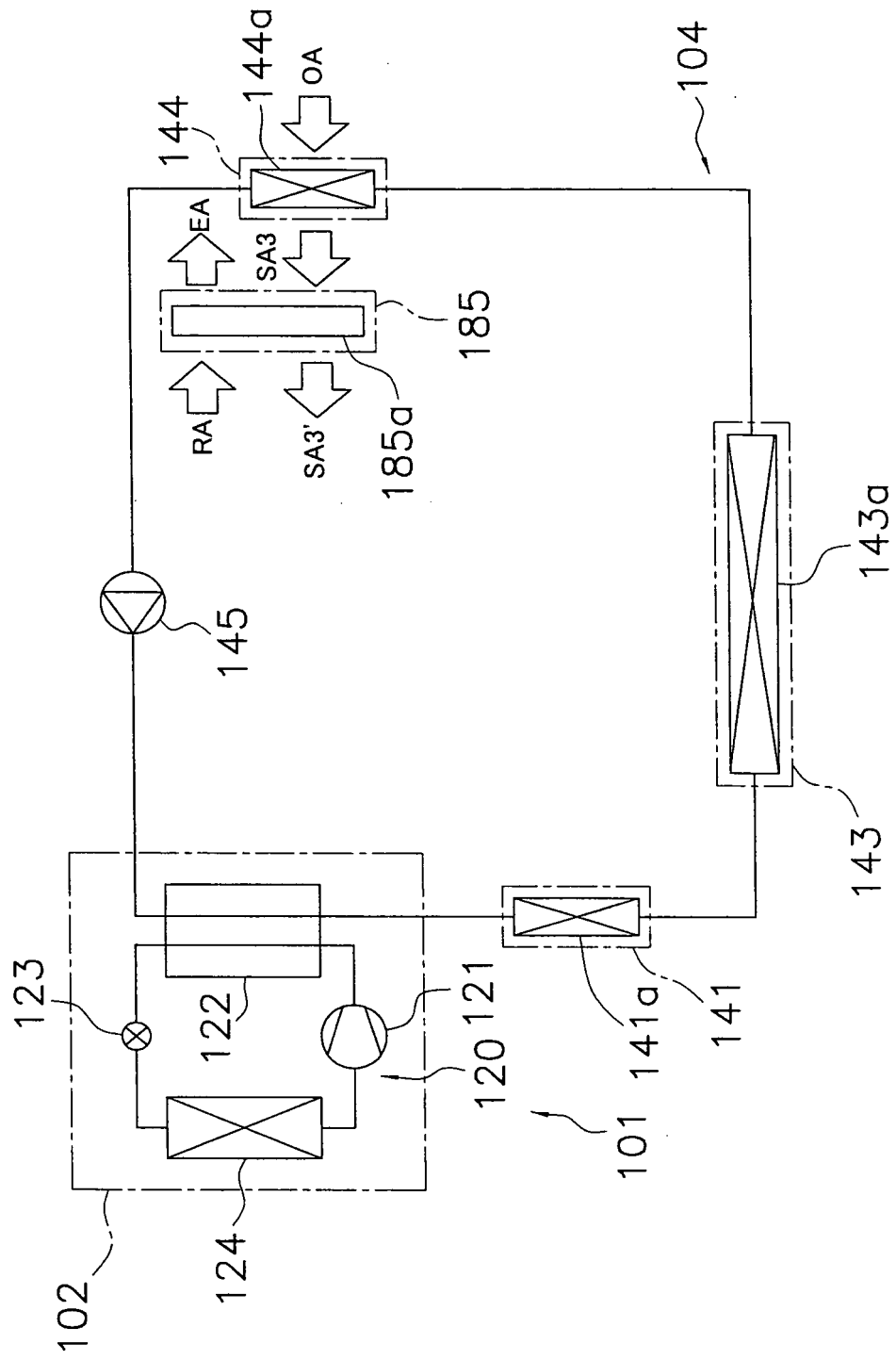
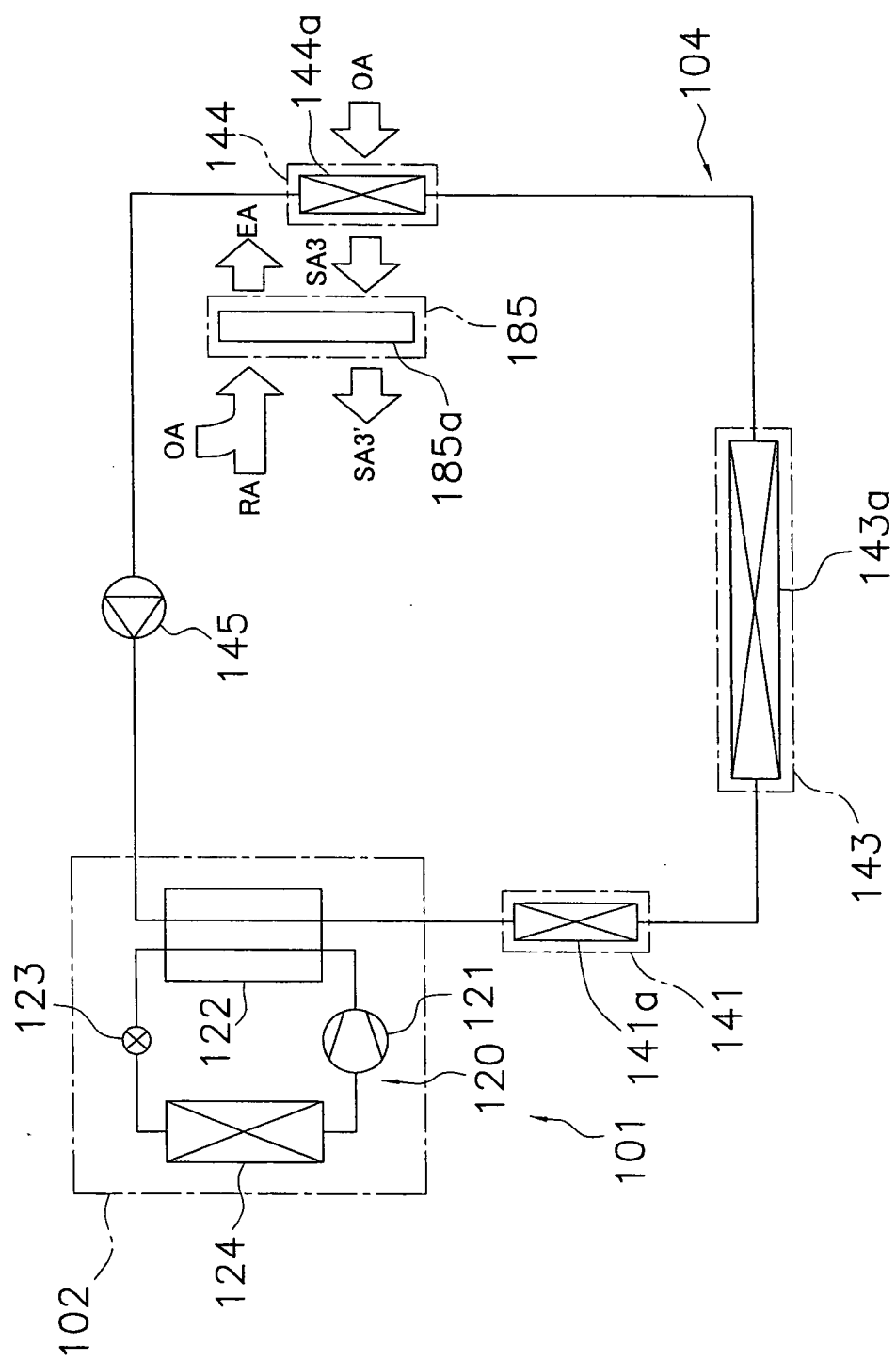


Fig. 22



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/008190

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl. ⁷ F24F5/00, F24D3/00, F24F6/04, F25B1/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) Int.Cl. ⁷ F24F5/00, F24D3/00, F24F6/04, F25B1/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2005 Kokai Jitsuyo Shinan Koho 1971-2005 Toroku Jitsuyo Shinan Koho 1994-2005		
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	JP 2004-3801 A (Matsushita Electric Industrial Co., Ltd.), 08 January, 2004 (08.01.04), Par. Nos. [0008] to [0009]; Fig. 1 (Family: none)	1-24
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 182147/1985 (Laid-open No. 91134/1987) (Sanden Corp.), 11 June, 1987 (11.06.87), Page 6, lines 1 to 18; Figs. 1 to 2 (Family: none)	1-24
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 11 July, 2005 (11.07.05)		Date of mailing of the international search report 26 July, 2005 (26.07.05)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/008190

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2-225924 A (Hitachi Cable, Ltd.), 07 September, 1990 (07.09.90), Page 2, lower right column, line 5 to page 3, upper left column, line 4; Figs. 1 to 2 (Family: none)	2-4, 10-24
Y	JP 55-31459 Y2 (Mitsubishi Electric Corp.), 26 July, 1980 (26.07.80), Column 1, line 34 to column 4, line 6; Fig. 1 (Family: none)	5-24
Y	JP 3-51677 A (Mitsubishi Electric Corp.), 06 March, 1991 (06.03.91), Page 3, upper right column, lines 5 to 13 (Family: none)	7-24
Y	JP 2000-257936 A (Daikin Industries, Ltd.), 22 September, 2000 (22.09.00), Par. Nos. [0025] to [0050]; Figs. 1 to 4 (Family: none)	12-24
Y	JP 3119062 B2 (Daikin Industries, Ltd.), 18 December, 2000 (18.12.00), Par. Nos. [0010] to [0014]; Figs. 1 to 4 (Family: none)	12-24
Y	JP 2000-257912 A (Daikin Industries, Ltd.), 22 September, 2000 (22.09.00), Par. Nos. [0029] to [0053]; Figs. 1 to 5 (Family: none)	12-24
Y	JP 2001-241693 A (Daikin Industries, Ltd.), 07 September, 2001 (07.09.01), Par. Nos. [0056] to [0131]; Figs. 1 to 7 (Family: none)	12-24

Form PCT/ISA/210 (continuation of second sheet) (January 2004)

REFERENCES CITED IN THE DESCRIPTION

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- JP 2003172523 A [0003]
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