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(54) **AIR CONDITIONER SYSTEM**

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Description

TECHNICAL FIELD

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

BACKGROUND ART

[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 Japanese Patent Application Publication No. 2003-50050, Japanese Patent Application Publication No. 2003-172523, and Japanese Patent Application Publication No. 2003-50035. Such an air conditioning system heats the room by heating a floor and indoor air.

[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.

[0004] JP 62-91134 U discloses a heating system capable of heating a room, comprising a heat source unit and a utilisation side radiator, the heat source unit being capable of heating water that is used for heating the room in the radiator, and a water circuit having at least one under floor heating device configured to release the heat of water heated in the utilisation side heat exchanger in to the room, and an outdoor air heating device configured to heat the ventilation air with the heat of the water heated in the heat exchanger, the water circuit being configured to circulate the water between the room heating device, the outdoor air heating device, and the utilisation side heat exchanger.

DISCLOSURE OF THE INVENTION

[0005] An air conditioning system according to the present invention is an air conditioning system capable of heating a room, comprising: a heat source unit having a vapor compression type refrigerant circuit including a compressor, a heat source side heat exchanger, an expansion mechanism, and a utilization side heat exchanger, the heat source unit being capable of heating a heating medium that is used for heating the room in the utilization side heat exchanger; an air supply device configured to supply an outdoor air to a room as a ventilation air; and a heating medium circuit having at least one room heating device 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, configured to heat the ventilation air with the heat of the heating medium heated in the utilization side heat exchanger, the heating medium circuit being configured to circulate the heating medium between the room heating device and each of the outdoor air heating device and the utilization side heat exchanger, wherein the air conditioning system further comprises a room heating device and/or an outdoor air heating device arranged for refrigerant that is arranged to flow through the refrigerant circuit to flow therethrough without flowing through the heating medium circuit so that heat of the refrigerant that flows through the refrigerant circuit can be directly released into the room and/or ventilation air that is arranged to be supplied to the room by the air supply device can be directly heated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] In the following, reference will now be made to the accompanying drawings, which illustrate, by way of example only, ways in which the invention may be carried, out, in which:

Figure 1 is a schematic block diagram of an air conditioning system not 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 or Figure 1,
Figure 8 is a schematic block diagram of an air conditioning system according to the present invention,
Figure 9 is a schematic block diagram of an air conditioning system not according to the present invention,
Figure 10 is a schematic block diagram of an air conditioning system not according to the present invention,
Figure 11 is a schematic block diagram of an air conditioning system not according to the present invention,
Figure 12 is a schematic block diagram of an air con-

ditioning system not according to the present invention, Figure 13 is a schematic block diagram of an air conditioning system not according to the present invention,

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

Figure 15 is a schematic block diagram of an air conditioning system not according to the present invention,

Figure 16 is a schematic block diagram of an air conditioning system not according to the present invention,

Figure 17 is a psychrometric chart of the operation of the air conditioning system according to Figure 16,

Figure 18 is a schematic block diagram of an air conditioning system not according to the present invention,

Figure 19 is a schematic block diagram of an air conditioning system not according to the present invention,

Figure 20 is a schematic block diagram of an air conditioning system not according to the present invention,

Figure 21 is a schematic block diagram of an air conditioning system not according to the present invention, and

Figure 22 is a schematic block diagram of an air conditioning system not according to the present invention.

DESCRIPTION OF THE REFERENCE SYMBOLS

[0007]

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
151 a, 153a, 154a: solenoid valve, motor operated valve (heating medium flow control mechanism)
161, 161a, 161 b, 161 c : 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

[0008] When an air conditioning system according to the state of the art 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.

[0009] 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.

[0010] Therefore, an advantage achieved by embodiments 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.

[0011] In embodiments of the invention, 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 convector, 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.

[0012] An air conditioning system according to a first preferred embodiment of the present invention is the air conditioning system according to 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.

[0013] In such air conditioning systems, 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 such air conditioning systems, 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.

[0014] An air conditioning system according to a second preferred embodiment is the air conditioning system according to the first preferred embodiment, 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.

[0015] In such air conditioning systems, 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.

[0016] An air conditioning system according to a third preferred embodiment is the air conditioning system according to the second preferred embodiment, in which the bypass heating medium circuit includes a heating medium flow control mechanism.

[0017] In such air conditioning systems, 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.

[0018] An air conditioning system according to a fourth preferred embodiment is the air conditioning system according to the 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.

[0019] In such air conditioning systems, 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.

[0020] An air conditioning system according to a fifth preferred embodiment is the air conditioning system according to the fourth preferred embodiment, 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.

[0021] An air conditioning system according to a sixth preferred embodiment is the air conditioning system of the fifth preferred embodiment, in which the heat source unit further includes at least one bypass refrigerant circuit that bypasses the plurality of divided utilization side heat exchangers.

[0022] In such air conditioning systems, 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.

[0023] An air conditioning system according to a seventh preferred embodiment is the air conditioning system according to the sixth preferred embodiment, in which the bypass refrigerant circuit includes a refrigerant flow control mechanism.

[0024] In such air conditioning systems, 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.

[0025] An air conditioning system according to an eighth preferred embodiment is the air conditioning system according to any one of the fourth to seventh preferred embodiments, 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. ’

[0026] In such air conditioning systems, 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.

[0027] An air conditioning system according to a ninth preferred embodiment is the air conditioning system according to the invention or any one of the first to eighth preferred embodiments, 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.

[0028] In such air conditioning systems, not only 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.

[0029] An air conditioning system according to a tenth preferred embodiment is the air conditioning system according to the invention or any one of the first to ninth preferred embodiments, in which the heating medium circuit includes a heating medium storage container.

[0030] In such air conditioning systems, 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.

[0031] An air conditioning system according to an eleventh preferred embodiment is the air conditioning system according to the invention or any one of the first to tenth preferred embodiments, further comprising a humidifier that humidifies the ventilation air that is heated by the outdoor air heating device and supplied to the room.

[0032] In such air conditioning systems, 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.

[0033] An air conditioning system according to a twelfth preferred embodiment is the air conditioning system according to the eleventh preferred embodiment, 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.

[0034] Since such air conditioning systems are 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.

[0035] An air conditioning system according to a thirteenth preferred embodiment is the air conditioning system according to the eleventh preferred embodiment, 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.

[0036] Since such air conditioning systems are 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.

[0037] An air conditioning system according to a fourteenth preferred embodiment is the air conditioning system according to the thirteenth preferred embodiment, 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.

[0038] In such air conditioning systems, 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.

[0039] An air conditioning system according to a fifteenth preferred embodiment is the air conditioning system according to the thirteenth preferred embodiment, 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.

[0040] In such air conditioning systems, 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.

[0041] An air conditioning system according to a sixteenth preferred embodiment is the air conditioning system according to the thirteenth preferred embodiment, 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.

[0042] In such air conditioning systems, 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.

[0043] An air conditioning system according to a seventeenth preferred embodiment is the air conditioning system according to the eleventh preferred embodiment, 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.

[0044] Since such air conditioning systems are 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.

[0045] An air conditioning system according to an eighteenth preferred embodiment is the air conditioning system according to the seventeenth preferred embodiment, 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.

[0046] 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.

[0047] An air conditioning system according to a nineteenth preferred embodiment is the air conditioning system according to the seventeenth preferred embodiment, 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.

[0048] In such 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.

[0049] An air conditioning system according to a twentieth preferred embodiment is the air conditioning system according to the seventeenth preferred embodiment, 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.

[0050] 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.

[0051] An air conditioning system according to a twenty-first preferred embodiment is the air conditioning system according to the invention or any one of the first to twentieth preferred embodiments, in which the heating medium that flows through the heating medium circuit is water.

[0052] 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.

[0053] An air conditioning system according to a twenty-second preferred embodiment is the air conditioning system according to the invention or any one of the first to twentieth preferred embodiments, in which the heating medium flowing through the heating medium circuit is brine that does not freeze below 0 degrees C.

[0054] 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.

[0055] An air conditioning system according to a twenty-third preferred embodiment is the air conditioning system according to the invention or any one of the first to twenty-second preferred embodiments, in which the refrigerant that flows through the refrigerant circuit is CO_2.

[0056] In this air conditioning system, CO_2 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.

[0057] 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

[0058] Figure 1 is a schematic block diagram of an air conditioning system 101 according to the present invention. The air conditioning system 101 is a system capable of heating the room by operating a vapor compression type refrigerating cycle.

[0059] 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>

[0060] 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.

[0061] 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.

[0062] The expansion mechanism 123 is an electric expansion valve that decompresses the refrigerant that flows out from the heating medium - refrigerant heat exchanger 122.

[0063] 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.

[0064] 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.

[0065] 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 CO_2. However, in the present embodiment, CO_2 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 CO_2 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>

[0066] 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>

[0067] The heating medium circuit 104 includes a radiator 141, a fan convector 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 convector 142, the floor heating device 143 and the outdoor air heating device 144, and the heating medium - refrigerant heat exchanger 122.

[0068] 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 SA l' shown in Figure 1).

[0069] 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).

[0070] 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.

[0071] 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).

[0072] 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 141 a, 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.

[0073] 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 141 a, 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.

[0074] 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

[0075] 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.

[0076] 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.

[0077] 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 14 a of the radiator 141, release the heat of the heating medium into the room (specifically, the room air surrounding the radiator heat exchanger 141 a 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 141 a to a state of dot SA1 shown in Figure 4.

[0078] Next, the heating medium that flowed out from the radiator heat exchanger 141 a 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.

[0079] 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) .

[0080] 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.

[0081] 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

[0082] The air conditioning system 101 of this embodiment has the following characteristics.

(A)

[0083] 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.

[0084] 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)

[0085] 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 $\Delta h1$ on the evaporation side in the refrigerating cycle of dot Rc --> dot Ri --> dot Ro1 --> dot Re1 --> dot Rc by the enthalpy difference Δhc that corresponds to the power consumption of the compressor 121 (=$\Delta hl/\Delta hc$).

[0086] 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 $\Delta h3$ on the evaporation side in the refrigerating cycle of dot Rc --> dot Ri --> dot Ro3 --> dot Re3 --> dot Rc by the enthalpy difference Δhc that corresponds to the power consumption of the compressor 121 ($=\Delta h3/\Delta hc$). 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)

[0087] 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)

[0088] The air conditioning system 101 of this embodiment uses CO_2 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 convector 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

[0089] 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 convector 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 convector 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.

[0090] 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.

[0091] 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

[0092] In the above-described air conditioning system 101, 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 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 141 a 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.

[0093] 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

[0094] 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

[0095] 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 convector 142, the floor heating device 143 and the outdoor air heating device 144, and the heating medium - refrigerant heat exchanger 122.

[0096] For example, in the air conditioning system 101 that does not include the fan convector 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.

[0097] 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.

[0098] 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

[0099] 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.

[0100] 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 Ro3 that corresponds to dot Wi3, and then to a state of Re3, and again is sucked into the compressor 121.

(9) Modified Example 6

[0101] 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

[0102] 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.

[0103] The bypass refrigerant circuit 171 is provided with a solenoid valve 171 a 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.

[0104] 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

[0105] 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.

[0106] 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

[0107] 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

[0108] 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.

[0109] 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.

[0110] 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.

[0111] 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.

[0112] Note that, as a humidifier, an air washer may be used instead of a spray nozzle.

(14) Modified Example 11

[0113] 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.

[0114] 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.

[0115] 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

[0116] 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.

[0117] 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.

[0118] 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.

[0119] 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.

[0120] 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.

[0121] 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.

[0122] 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

[0123] 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.

[0124] 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.

[0125] 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.

[0126] 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.

[0127] 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.

[0128] 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.

[0129] 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

[0130] 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 as defined by the appended claims.

[0131] 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

[0132] 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 each of the outdoor air heating device and the utilization side heat exchanger,
wherein the air conditioning system further comprises a room heating device (141, 142, 143) and/or an outdoor air heating device (144) arranged for refrigerant that is arranged to flow through the refrigerant circuit (120) to flow therethrough without flowing through the heating me-

dium circuit (104) so that heat of the refrigerant that flows through the refrigerant circuit can be directly released into the room and/or ventilation air that is arranged to be supplied to the room by the air supply device (103) can be directly heated.

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 (151 a, 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 (171 a).

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 the heating medium circuit (104) includes a heating medium storage container (161, 161a, 161b, 161c).

11. The air conditioning system (101) according to any one of claims 1 to 10, 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.

12. The air conditioning system (101) according to claim 11, wherein
the humidifier (183, 184) includes a moisture permeable film (183a, 184a) that allows moisture to permeate therethrough, 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.

13. The air conditioning system (101) according to claim 11, 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.

14. The air conditioning system (101) according to claim 13, 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.

15. The air conditioning system (101) according to claim 13, 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.

16. The air conditioning system (101) according to claim 13, 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.

17. The air conditioning system (101) according to claim 11, 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.

18. The air conditioning system (101) according to claim 17, 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.

19. The air conditioning system (101) according to claim 17, 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.

20. The air conditioning system (101) according to claim 17, 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.

21. The air conditioning system (101) according to any one of claims 1 to 20, wherein
the heating medium that flows through the heating medium circuit (104) is water or brine that does not freeze below 0 degrees C.

22. The air conditioning system (101) according to any one of claims 1 to 21, wherein
the refrigerant that flows through the refrigerant circuit (104) is CO_2.

Patentansprüche

1. Klimaanlagensystem (101) zum Wärmen eines Raumes mit:

einer Wärmequelleneinheit (102), die einen Dampfverdichtungstyp-Kühlmittelkreislauf (120) mit einem Verdichter (121), einen wärmequellseitigen Wärmetauscher (124), einen Expansionsmechanismus (123), und einen nutzseitigen Wärmetauscher (122) aufweist, wobei die Wärmequelleneinheit (102) geeignet ist, ein Wärmemedium zu erwärmen, welches zum Wärmen des Raumes in dem nutzseitigen Wärmetauscher verwendet wird;
einer Luftzuführeinrichtung (103), die ausgestaltet ist, eine Außenluft einem Raum als Zuluft zuzuführen; und
einem Wärmemediumkreislauf (104) mit mindestens einer Raumwärmeeinrichtung (141, 142, 143), die eingerichtet ist, die Wärme eines Wärmemediums, das in dem nutzseitigen Wärmetauscher erwärmt wurde, in den Raum abzugeben,
und einer Außenluftwärmeeinrichtung (144), die eingerichtet ist, die Zuluft mit der Wärme des Wärmemediums, welches in dem nutzseitigen Wärmetauscher erwärmt wurde, zu erwärmen,
wobei der Wärmemediumkreislauf (104) eingerichtet ist, das Wärmemedium zwischen der Raumwärmeeinrichtung und der Außenluftwärmeeinrichtung sowie dem nutzseitigen Wärmetauscher zu zirkulieren,
wobei das Klimaanlagensystem ferner eine Raumwärmeeinrichtung (141, 142, 143) und/oder eine Außenluftwärmeeinrichtung (144) aufweist, die für Kühlmittel ausgestaltet sind, welches eingerichtet ist, durch den Kühlmittelkreislauf (120) so hindurchzufließen, dass dieses nicht durch den Wärmemediumkreislauf (104) fließt, sodass Wärme des Kühlmittels, welches durch den Kühlmittelkreislauf fließt, direkt in den Raum abgegeben werden kann, und/oder Zuluft, die eingerichtet ist, dem Raum durch die Luftzuführeinrichtung (103) zugeführt zu werden, direkt erwärmt werden kann.

2. Klimaanlagensystem (101) nach Anspruch 1, bei dem
der Wärmemediumkreislauf (104) mit dem nutzseitigen Wärmetauscher so verbunden ist, dass das Wärmemedium, welches in dem nutzseitigen Wärmetauscher (122) erwärmt wurde, sequenziell der Raumwärmeeinrichtung (141, 142, 143) und der Außenluftwärmeeinrichtung (144) zugeführt wird.

3. Klimaanlagensystem (101) nach Anspruch 2, bei dem
der Wärmemediumkreislauf (104) ferner mindestens einen Umgehungs-Wärmemediumkreislauf (151, 153, 154) aufweist, der ausgestaltet ist, die Raumwärmeeinrichtung (141, 142, 143) und die Außenluftwärmeeinrichtung (144) zu umgehen.

4. Klimaanlagensystem (101) nach Anspruch 3, bei dem der Umgehungs-Wärmemediumkreislauf (151, 153, 154) einen Wärmemediumsflusskontrollmechanismus (151a, 153a, 154a) aufweist.

5. Klimaanlagensystem (101) nach Anspruch 1, bei dem
der Wärmemediumkreislauf (104) durch eine Vielzahl von unterteilten Wärmemediumkreisläufen (104a, 104b, 104c, 104d) ausgestaltet ist, die eingerichtet sind, unabhängig das Wärmemedium zwischen der Raumwärmeeinrichtung (141, 142, 143) und/oder der Außenluftwärmeeinrichtung (144), und dem nutzseitigen Wärmetauscher (122) zu zirkulieren.

6. Klimaanlagensystem (101) nach Anspruch 5, bei dem
der nutzseitige Wärmetauscher (122) durch eine Vielzahl von unterteilten nutzseitigen Wärmetauschern (122a, 122b, 122c, 122d) ausgestaltet ist, die so unterteilt sind, dass diese mit der Vielzahl von unterteilten Wärmemediumkreisläufen (104a, 104b, 104c, 104d) korrespondieren.

7. Klimaanlagensystem (101) nach Anspruch 6, bei dem
die Wärmequelleneinheit (102) ferner mindestens einen Umgehungs-Kühlmittelkreislauf (171) aufweist, der eingerichtet ist, die Vielzahl von unterteilten nutzseitigen Wärmetauschern (122a, 122b, 122c, 122d) zu umgehen.

8. Klimaanlagensystem (101) nach Anspruch 7, bei dem
der Umgehungs-Kühlmittelkreislauf (171) einen Kühlmittelflusskontrollmechanismus (171a) aufweist.

9. Klimaanlagensystem (101) nach einem der Ansprüche 5 bis 8, bei dem
die Vielzahl von unterteilten Wärmemediumkreisläufen (104a, 104b, 104c, 104d) mit dem nutzseitigen Wärmetauscher (122) so verbunden sind, dass die Temperatur eines Wärmemediums, welches der Außenluftwärmeeinrichtung (144) zugeführt wird, identisch oder geringer als die Temperatur des Wärmemediums ist, welches in der Raumwärmeeinrichtung (141, 142, 143) verwendet wird.

10. Klimaanlagensystem (101) nach einem der Ansprüche 1 bis 9, bei dem
der Wärmemediumkreislauf (104) ein Wärmemediumspeicherbehältnis (161, 161a, 161b, 161c) aufweist.

11. Klimaanlagensystem (101) nach einem der Ansprüche 1 bis 10, welches ferner einen Befeuchter (182, 183, 184, 185) aufweist, der eingerichtet ist, die Zuluft zu befeuchten, welche durch die Außenluftwärmeeinrichtung (144) erwärmt wird und dem Raum zugeführt wird.

12. Klimaanlagensystem (101) nach Anspruch 11, bei dem
der Befeuchter (183, 184) einen feuchtigkeitsdurchlässigen Film (183a, 184a) aufweist, durch welchen Feuchtigkeit hindurchdringen kann, und der geeignet ist, die Zuluft zu befeuchten, indem Wasser, welches dem feuchtigkeitsdurchlässigen Film zugeführt wird, in Kontakt mit der Zuluft über den feuchtigkeitsdurchlässigen Film gebracht wird.

13. Klimaanlagensystem (101) nach Anspruch 11, bei dem
der Befeuchter (184) eine feuchtigkeitsabsorbierende Flüssigkeit aufweist, die sowohl Feuchtigkeit absorbieren, als auch die absorbierte Feuchtigkeit durch Erwärmung desorbieren kann, und ausgestaltet ist, die Zuluft zu befeuchten, indem die feuchtigkeitsabsorbierende Flüssigkeit, in der Feuchtigkeit absorbiert ist, unter Verwendung der Zuluft erwärmt wird, sodass Feuchtigkeit zurück zu der Zuluft desorbiert wird.

14. Klimaanlagensystem (101) nach Anspruch 13, bei dem
der Befeuchter (184) Feuchtigkeit in der Abluft, welche aus dem Raum nach Außeren ausgestoßen wird, dazu bringt, in der feuchtigkeitsabsorbierenden Flüssigkeit absorbiert zu werden, um die Zuluft zu befeuchten.

15. Klimaanlagensystem (101) nach Anspruch 13, bei dem
der Befeuchter (184) Feuchtigkeit in einer Außenluft, die verschieden von der Zuluft ist, dazu bringt, in der feuchtigkeitsabsorbierenden Flüssigkeit absorbiert zu werden, um die Zuluft zu befeuchten.

16. Klimaanlagensystem (101) nach Anspruch 13, bei dem
der Befeuchter (184) Feuchtigkeit in Mischluft zwischen der Abluft, die aus dem Raum nach Außeren ausgestoßen wird, und einer Außenluft, welche verschieden von der Zuluft ist, dazu bringt, in der feuchtigkeitsabsorbierenden Flüssigkeit absorbiert zu werden, um die Zuluft zu befeuchten.

17. Klimaanlagensystem (101) nach Anspruch 11, bei dem
der Befeuchter (185) ein Adsorptionsmittel (185a) aufweist, das geeignet ist, Feuchtigkeit zu adsorbieren und die adsorbierte Feuchtigkeit durch Erwärmen zu desorbieren, und geeignet ist, die Zuluft durch Erwärmen des Adsorptionsmittels, in welchem Feuchtigkeit adsorbiert ist, unter Verwendung der

Zuluft zu befeuchten, sodass Feuchtigkeit zurück zu der Zuluft desorbiert wird.

18. Klimaanlagensystem (101) nach Anspruch 17, bei dem der Befeuchter (185) Feuchtigkeit in Abluft, welche aus dem Raum nach Außen ausgestoßen wird, dazu bringt, auf dem Adsorptionsmittel (185a) adsorbiert zu werden, um die Zuluft zu befeuchten.

19. Klimaanlagensystem (101) nach Anspruch 17, bei dem der Befeuchter (185) Feuchtigkeit in einer Außenluft, welche verschieden von der Zuluft ist, dazu bringt, auf dem Adsorptionsmittel (185a) adsorbiert zu werden, um die Zuluft zu befeuchten.

20. Klimaanlagensystem (101) nach Anspruch 17, bei dem der Befeuchter (185) Feuchtigkeit in Mischluft zwischen Abluft, die aus dem Raum nach Außen ausgestoßen wird, und einer Außenluft, welche verschieden von der Zuluft ist, dazu bringt, auf dem Adsorptionsmittel (185a) adsorbiert zu werden, um die Zuluft zu befeuchten.

21. Klimaanlagensystem (101) nach einem der Ansprüche 1 bis 20, bei dem das Wärmemedium, welches durch den Wärmemediumkreislauf (104) fließt, Wasser oder Salzlauge ist, welches nicht unterhalb 0°C friert.

22. Klimaanlagensystem (101) nach einem der Ansprüche 1 bis 21, bei dem das Kühlmittel, welches durch den Kühlmittelkreislauf (104) fließt, CO_2 ist.

Revendications

1. Système de conditionnement d'air (101) capable de chauffer une pièce, comprenant :

une unité de source de chaleur (102) ayant un circuit de fluide frigorigène du type à compression de vapeur (120) comportant un compresseur (121), un échangeur de chaleur côté source de chaleur (124), un mécanisme de détente (123), et un échangeur de chaleur côté utilisation (122), l'unité de source de chaleur (102) étant capable de chauffer un milieu chauffant qui est utilisé pour chauffer la pièce dans l'échangeur de chaleur côté utilisation ;
un dispositif d'alimentation en air (103) configuré pour alimenter un air extérieur à une pièce comme air de ventilation ; et
un circuit de milieu chauffant (104), ayant au moins un dispositif de chauffage de pièce (141, 142, 143) configuré pour libérer la chaleur d'un milieu chauffant chauffé dans l'échangeur de chaleur côté utilisation dans la pièce,
et un dispositif de chauffage d'air extérieur (144), configuré pour chauffer l'air de ventilation avec la chaleur du milieu chauffant chauffé dans l'échangeur de chaleur côté utilisation, le circuit de milieu chauffant (104) étant configuré pour faire circuler le milieu chauffant entre le dispositif de chauffage de pièce et chacun du dispositif de chauffage d'air extérieur et de l'échangeur de chaleur côté utilisation,
où le système de conditionnement d'air comprend en outre un dispositif de chauffage de pièce (141, 142, 143) et/ou un dispositif de chauffage d'air extérieur (144) agencé(s) pour permettre à un fluide frigorigène, qui est agencé pour s'écouler à travers le circuit de fluide frigorigène (120), de s'écouler à travers celui-ci/ceux-ci sans s'écouler à travers le circuit de milieu chauffant (104) de sorte que la chaleur du fluide frigorigène qui s'écoule à travers le circuit de fluide frigorigène puisse être directement libérée dans la pièce et/ou l'air de ventilation qui est agencé pour être alimenté à la pièce par le dispositif d'alimentation en air (103) peut être directement chauffé.

2. Système de conditionnement d'air (101) selon la revendication 1, dans lequel le circuit de milieu chauffant (104) est relié à l'échangeur de chaleur côté utilisation de sorte que le milieu chauffant chauffé dans l'échangeur de chaleur côté utilisation (122) soit séquentiellement alimenté au dispositif de chauffage de pièce (141, 142, 143) et au dispositif de chauffage d'air extérieur (144).

3. Système de conditionnement d'air (101) selon la revendication 2, dans lequel le circuit de milieu chauffant (104) comporte en outre au moins un circuit de milieu chauffant de contournement (151, 153, 154) configuré pour contourner le dispositif de chauffage de pièce (141, 142, 143) et le dispositif de chauffage d'air extérieur (144).

4. Système de conditionnement d'air (101) selon la revendication 3, dans lequel le circuit de milieu chauffant de contournement (151, 153, 154) comporte un mécanisme de commande d'écoulement de milieu chauffant (151a, 153a, 154a).

5. Système de conditionnement d'air (101) selon la revendication 1, dans lequel le circuit de milieu chauffant (104) est constitué d'une pluralité de circuits de milieu chauffant divisés (104a, 104b, 104c, 104d) configurés pour faire circuler de façon indépendante le milieu chauffant entre au moins l'un du dispositif de chauffage de pièce (141, 142, 143) et le dispositif de chauffage d'air extérieur (144), et l'échangeur de chaleur côté utilisation (122).

6. Système de conditionnement d'air (101) selon la revendication 5, dans lequel
l'échangeur de chaleur côté utilisation (122) est constitué d'une pluralité d'échangeurs de chaleur côté utilisation divisés (122a, 122b, 122c, 122d), divisés de manière à correspondre à la pluralité de circuits de milieu chauffant divisés (104a, 104b, 104c, 104d).

7. Système de conditionnement d'air (101) selon la revendication 6, dans lequel
l'unité de source de chaleur (102) comporte en outre au moins un circuit de fluide frigorigène de contournement (171) configuré pour contourner la pluralité d'échangeurs de chaleur côté utilisation divisés (122a, 122b, 122c, 122d).

8. Système de conditionnement d'air (101) selon la revendication 7, dans lequel
le circuit de fluide frigorigène de contournement (171) comporte un mécanisme de commande d'écoulement de fluide frigorigène (171a).

9. Système de conditionnement d'air (101) selon l'une quelconque des revendications 5 à 8, dans lequel
la pluralité de circuits de milieu chauffant divisés (104a, 104b, 104c, 104d) sont reliés à l'échangeur de chaleur côté utilisation (122) de sorte que la température d'un milieu chauffant qui est alimenté au dispositif de chauffage d'air extérieur (144) soit inférieure ou égale à la température du milieu chauffant utilisé dans le dispositif de chauffage de pièce (141, 142, 143).

10. Système de conditionnement d'air (101) selon l'une quelconque des revendications 1 à 9, dans lequel le circuit de milieu chauffant (104) comporte un récipient de stockage de milieu chauffant (161, 161a, 161b, 161c).

11. Système de conditionnement d'air (101) selon l'une quelconque des revendications 1 à 10, comprenant en outre un humidificateur (182, 183, 184, 185) configuré pour humidifier l'air de ventilation qui est chauffé par le dispositif de chauffage d'air extérieur (144) et alimenté à la pièce.

12. Système de conditionnement d'air (101) selon la revendication 11, dans lequel
l'humidificateur (183, 184) comporte un film perméable à l'humidité (183a, 184a) qui permet à l'humidité de pénétrer à travers celui-ci, et est capable d'humidifier l'air de ventilation en amenant l'eau qui est alimentée au film perméable à l'humidité à entrer en contact avec l'air de ventilation par l'intermédiaire du film perméable à l'humidité.

13. Système de conditionnement d'air (101) selon la revendication 11, dans lequel
l'humidificateur (184) comporte un liquide d'absorption d'humidité capable à la fois d'absorber l'humidité et de désorber l'humidité absorbée par chauffage, et est capable d'humidifier l'air de ventilation en chauffant le liquide d'absorption d'humidité dans lequel l'humidité est absorbée, en utilisant l'air de ventilation de manière à désorber l'humidité pour retourner dans l'air de ventilation.

14. Système de conditionnement d'air (101) selon la revendication 13, dans lequel
l'humidificateur (184) amène l'humidité dans l'air d'échappement qui est évacué de la pièce vers l'extérieur à être absorbée dans le liquide d'absorption d'humidité afin d'humidifier l'air de ventilation.

15. Système de conditionnement d'air (101) selon la revendication 13, dans lequel
l'humidificateur (184) amène l'humidité dans un air extérieur différent de l'air de ventilation à être absorbée dans le liquide d'absorption d'humidité afin d'humidifier l'air de ventilation.

16. Système de conditionnement d'air (101) selon la revendication 13, dans lequel
l'humidificateur (184) amène l'humidité dans l'air mélangé entre l'air d'échappement qui est évacué de la pièce vers l'extérieur et un air extérieur différent de l'air de ventilation à être absorbée dans le liquide d'absorption d'humidité afin d'humidifier l'air de ventilation.

17. Système de conditionnement d'air (101) selon la revendication 11, dans lequel
l'humidificateur (185) comporte un adsorbant (185a) capable à la fois d'adsorber l'humidité et de désorber l'humidité adsorbée par chauffage, et est capable d'humidifier l'air de ventilation en chauffant l'adsorbant dans lequel l'humidité est adsorbée, en utilisant l'air de ventilation de manière à désorber l'humidité pour retourner vers l'air de ventilation.

18. Système de conditionnement d'air (101) selon la revendication 17, dans lequel
l'humidificateur (185) amène l'humidité dans l'air d'échappement qui est évacué de la pièce vers l'extérieur à être adsorbée sur l'adsorbant (185a) afin d'humidifier l'air de ventilation.

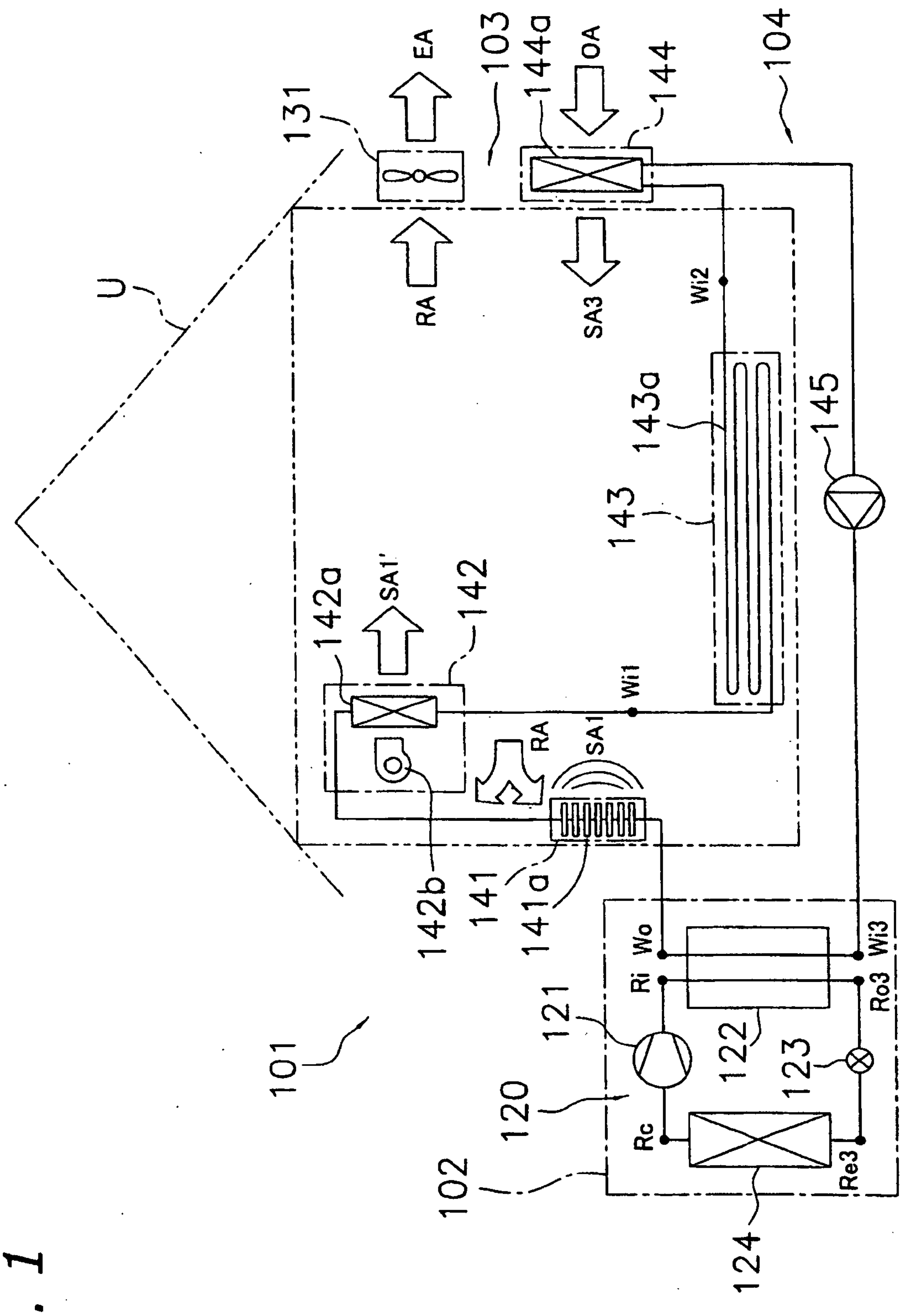
19. Système de conditionnement d'air (101) selon la revendication 17, dans lequel
l'humidificateur (185) amène l'humidité dans un air extérieur différent de l'air de ventilation à être adsor-

bée sur l'adsorbant (185a) afin d'humidifier l'air de ventilation.

20. Système de conditionnement d'air (101) selon la revendication 17, dans lequel l'humidificateur (185) amène l'humidité dans l'air mélangé entre l'air d'échappement qui est évacué de la pièce vers l'extérieur et un air extérieur différent de l'air de ventilation à être adsorbée sur l'adsorbant (185a) afin d'humidifier l'air de ventilation.

21. Système de conditionnement d'air (101) selon l'une quelconque des revendications 1 à 20, dans lequel le milieu chauffant qui s'écoule à travers le circuit de milieu chauffant (104) est de l'eau ou de la saumure qui ne gèle pas en-dessous de 0°C.

22. Système de conditionnement d'air (101) selon l'une quelconque des revendications 1 à 21, dans lequel le fluide frigorigène qui s'écoule à travers le circuit de fluide frigorigène (104) est du $C0_2$.



131
EA
103
144a
OA
144
104
U
RA
SA3
Wi2
143a
145
143
142a
SA1'
142
RA
SA1
Wi1
142b
141
141a
Wo
Wi3
Ri
Ro3
121
122
123
120
Rc
Re3
101
102
124

Fig. 1

Fig. 2

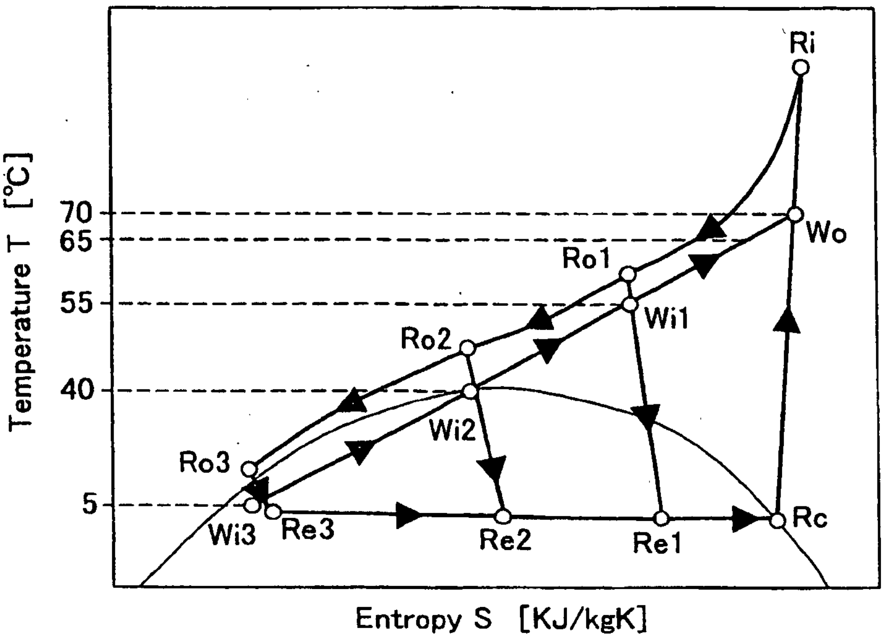

Ri
70
65
55
40
5
Temperature T [°C]
Wo
Ro1
Wi1
Ro2
Wi2
Ro3
Wi3
Re3
Re2
Re1
Rc
Entropy S [KJ/kgK]

Fig. 3

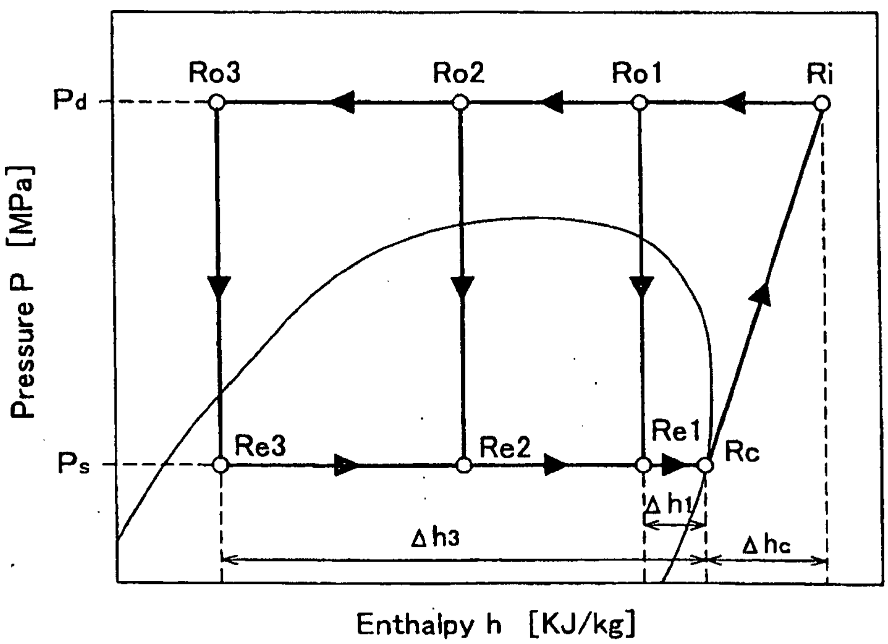

Ro3
Ro2
Ro1
Ri
Pd
Pressure P [MPa]
Ps
Re3
Re2
Re1
Rc
Δh1
Δh3
Δhc
Enthalpy h [KJ/kg]

Fig. 4

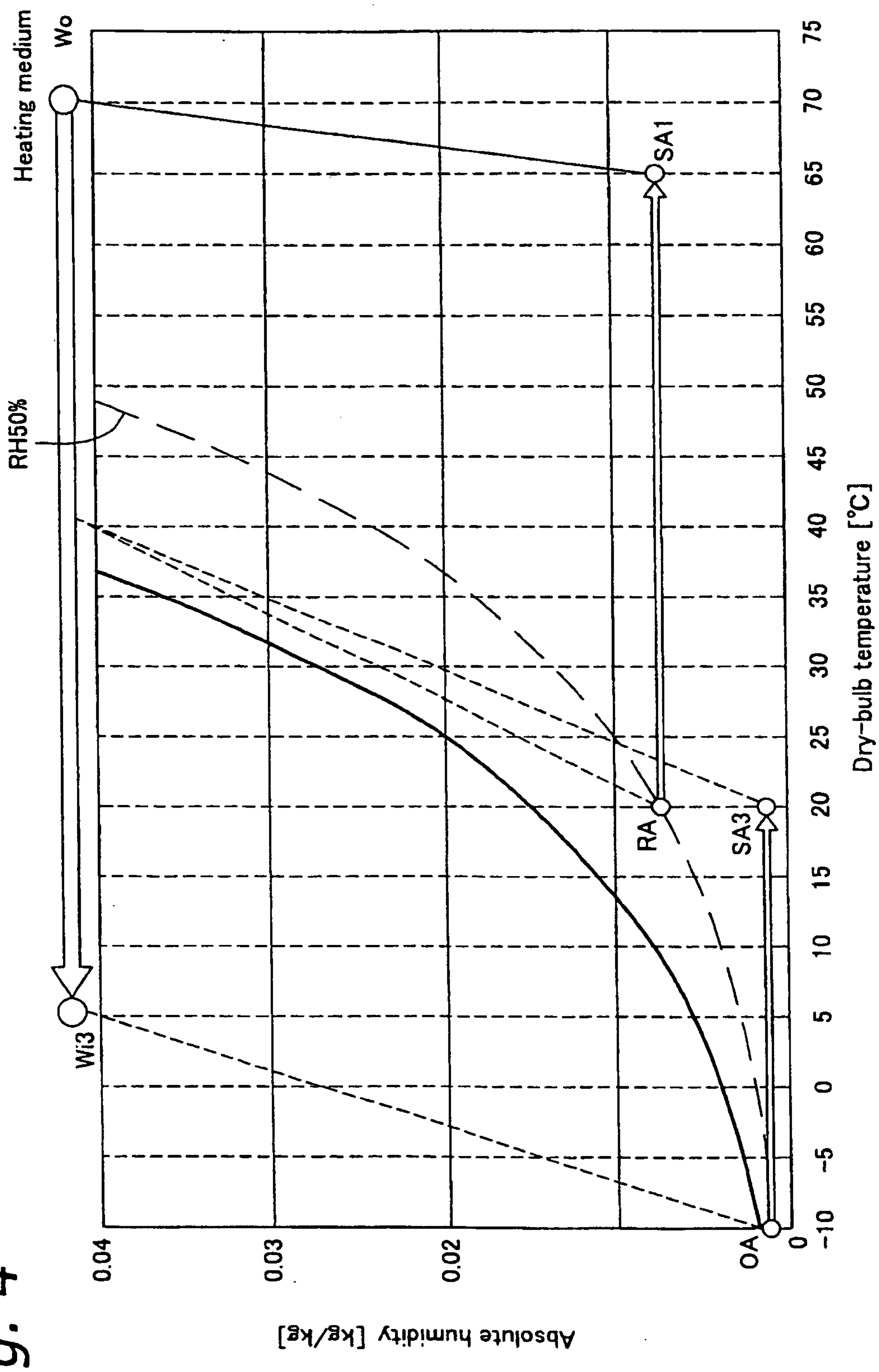
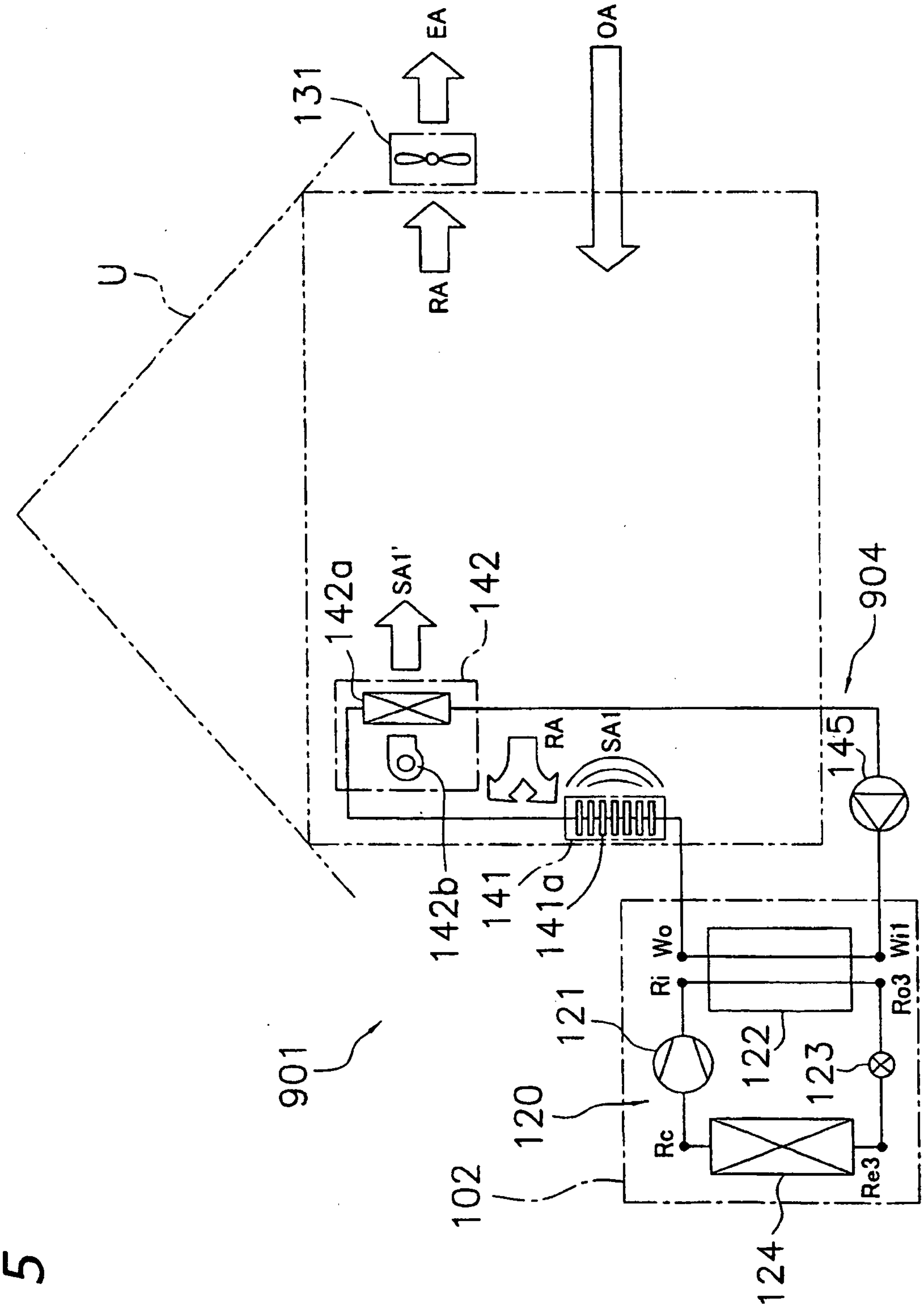
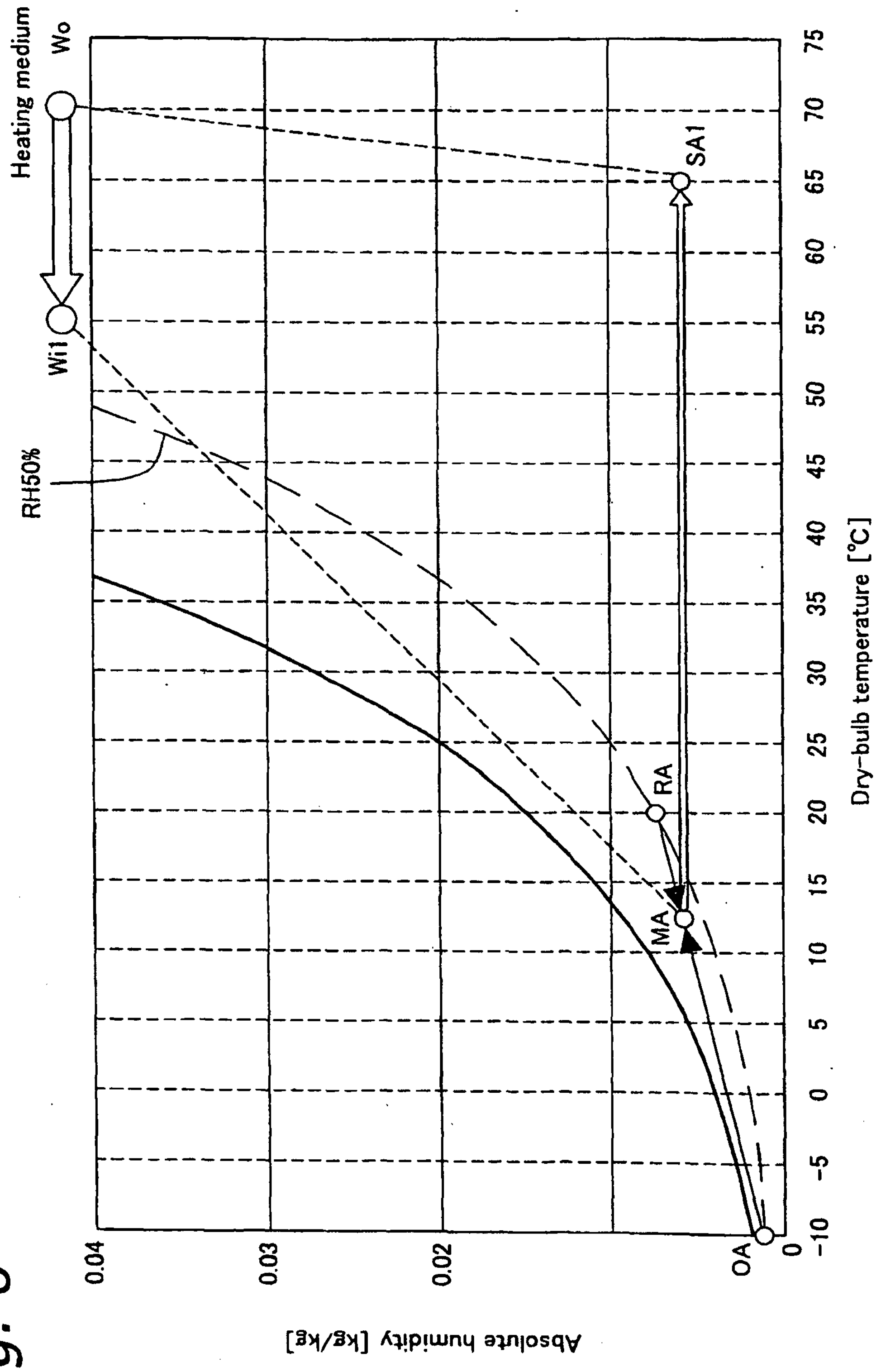

Heating medium
Wo
RH50%
SA1
RA
SA3
Wi3
OA
0.04
0.03
0.02
0
-10
-5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Dry-bulb temperature [°C]
Absolute humidity [kg/kg]

Fig. 5



EA
OA
131
RA
U
142a
SA1'
142
904
RA
SA1
145
142b
141
141a
Wo
Wi1
Ri
Ro3
121
122
123
901
120
Rc
Re3
102
124

Fig. 6


Heating medium
Wo
Wi1
RH50%
SA1
RA
MA
OA
Absolute humidity [kg/kg]
0.04
0.03
0.02
0
Dry-bulb temperature [°C]
-10
-5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75

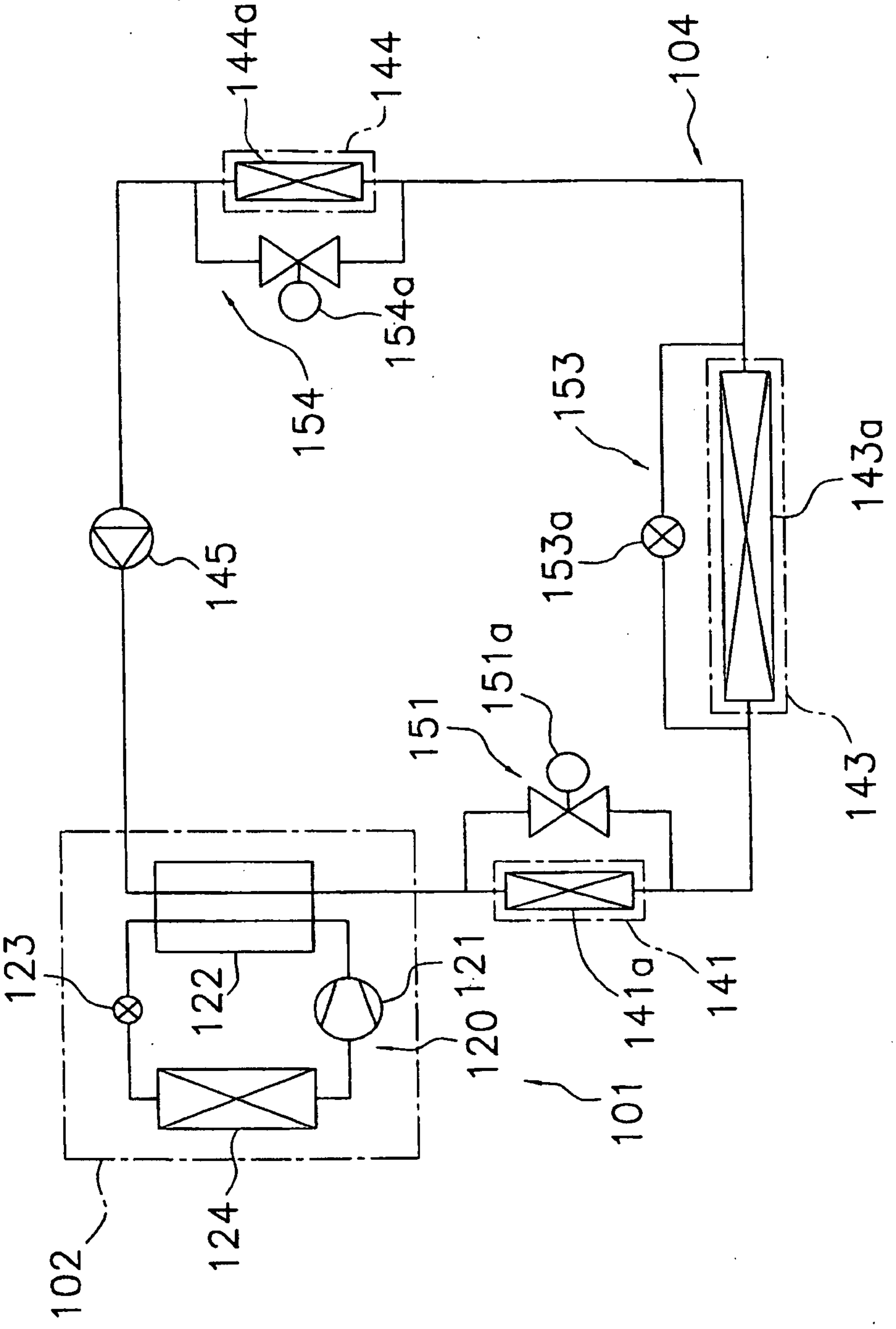

144a
144
104
154a
154
153
143a
153a
145
151a
151
143
123
122
121
120
141a
141
101
124
102

Fig. 7

Fig. 8

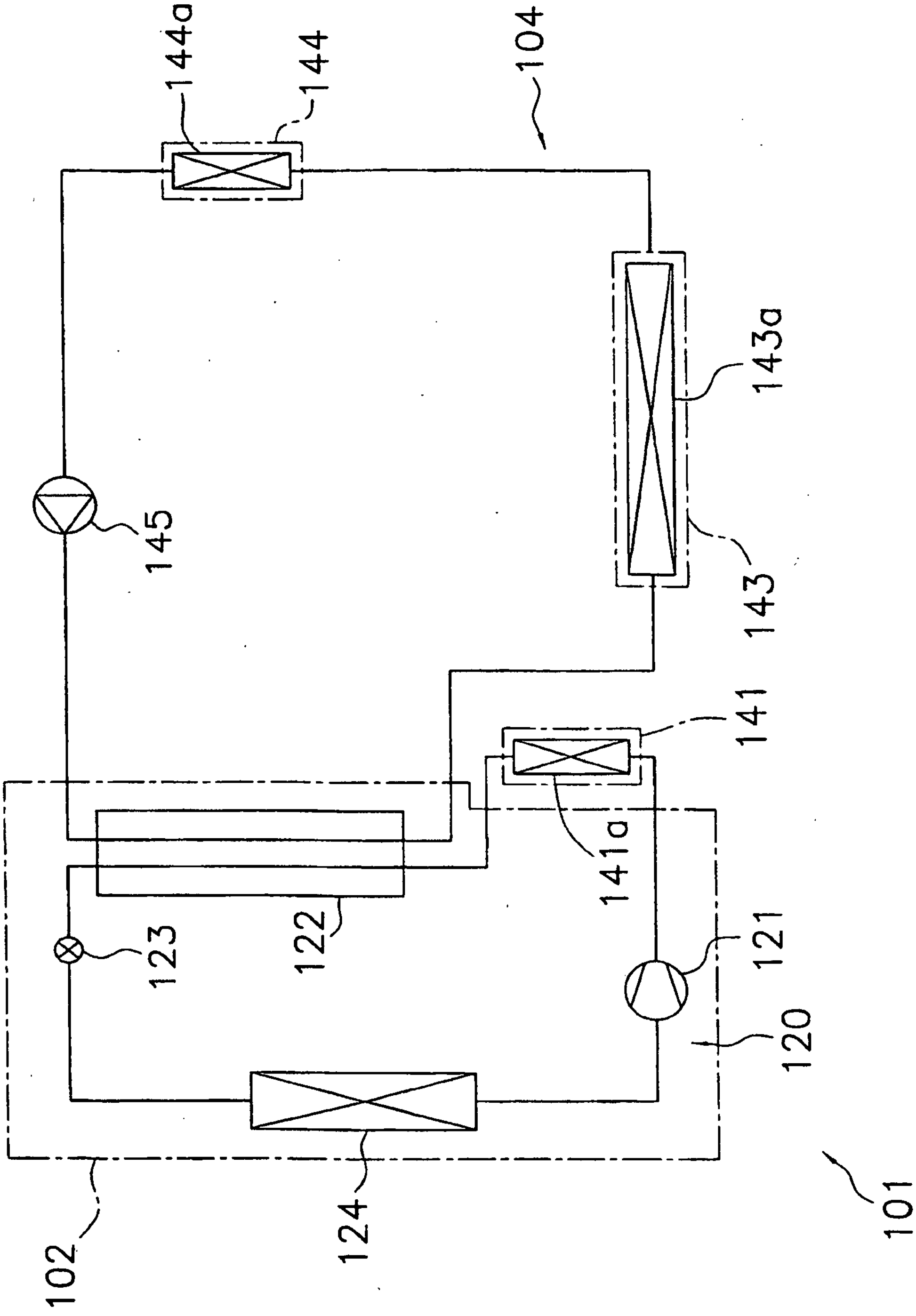
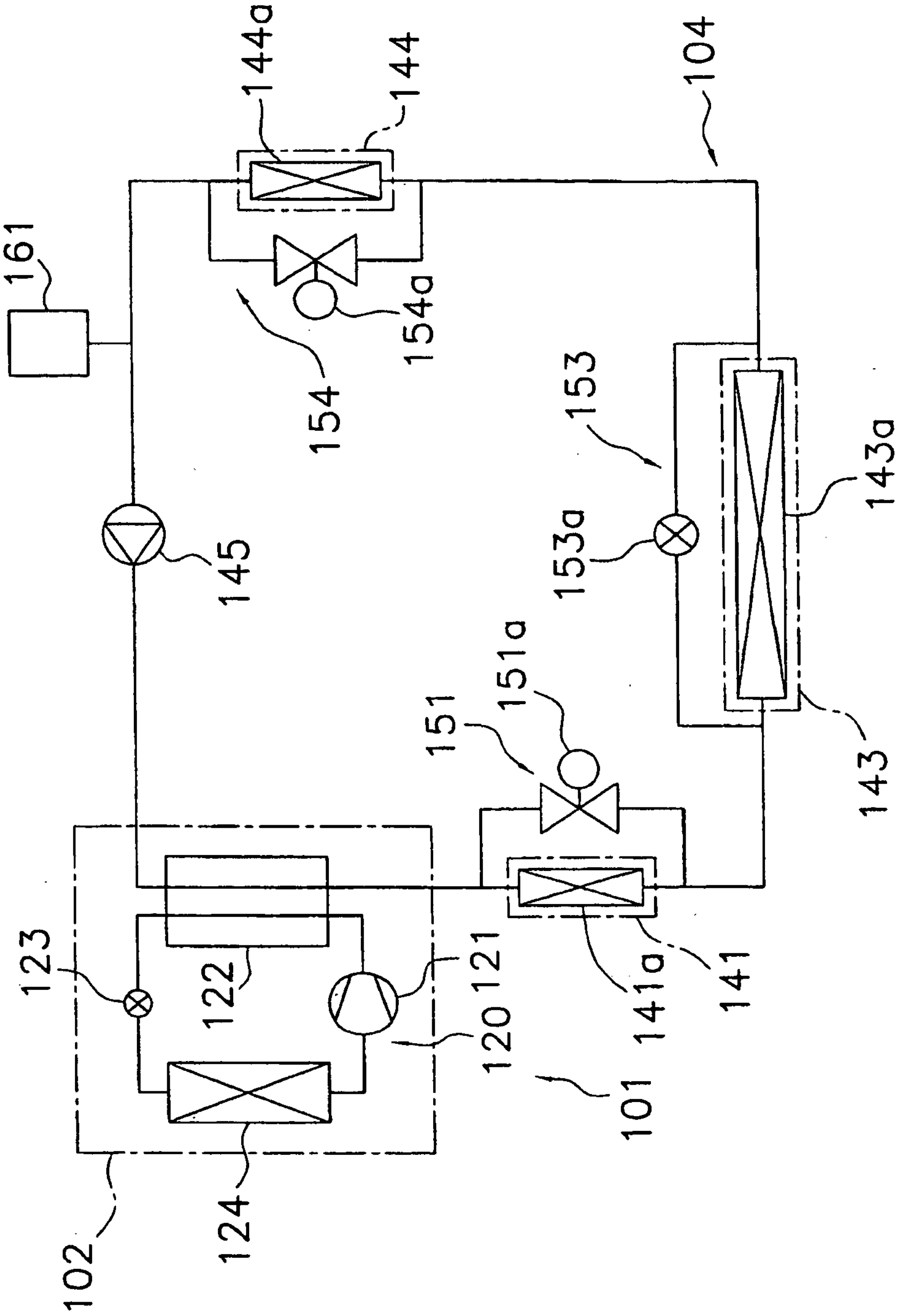


Fig. 9



101
102
104
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121
122
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141a
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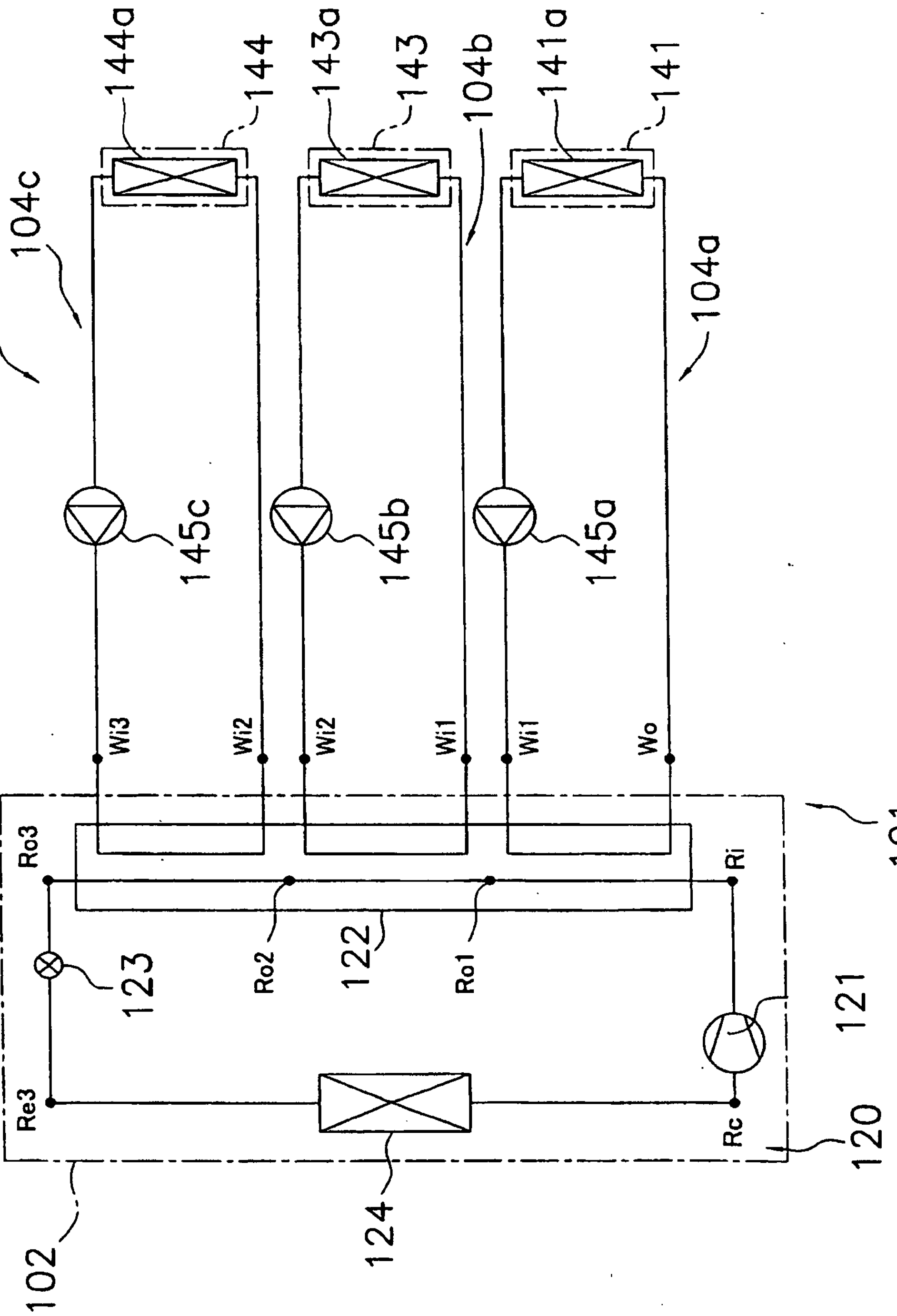
143a
144
144a
145
151
151a
153
153a
154
154a
161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104c
104b
104a
144a
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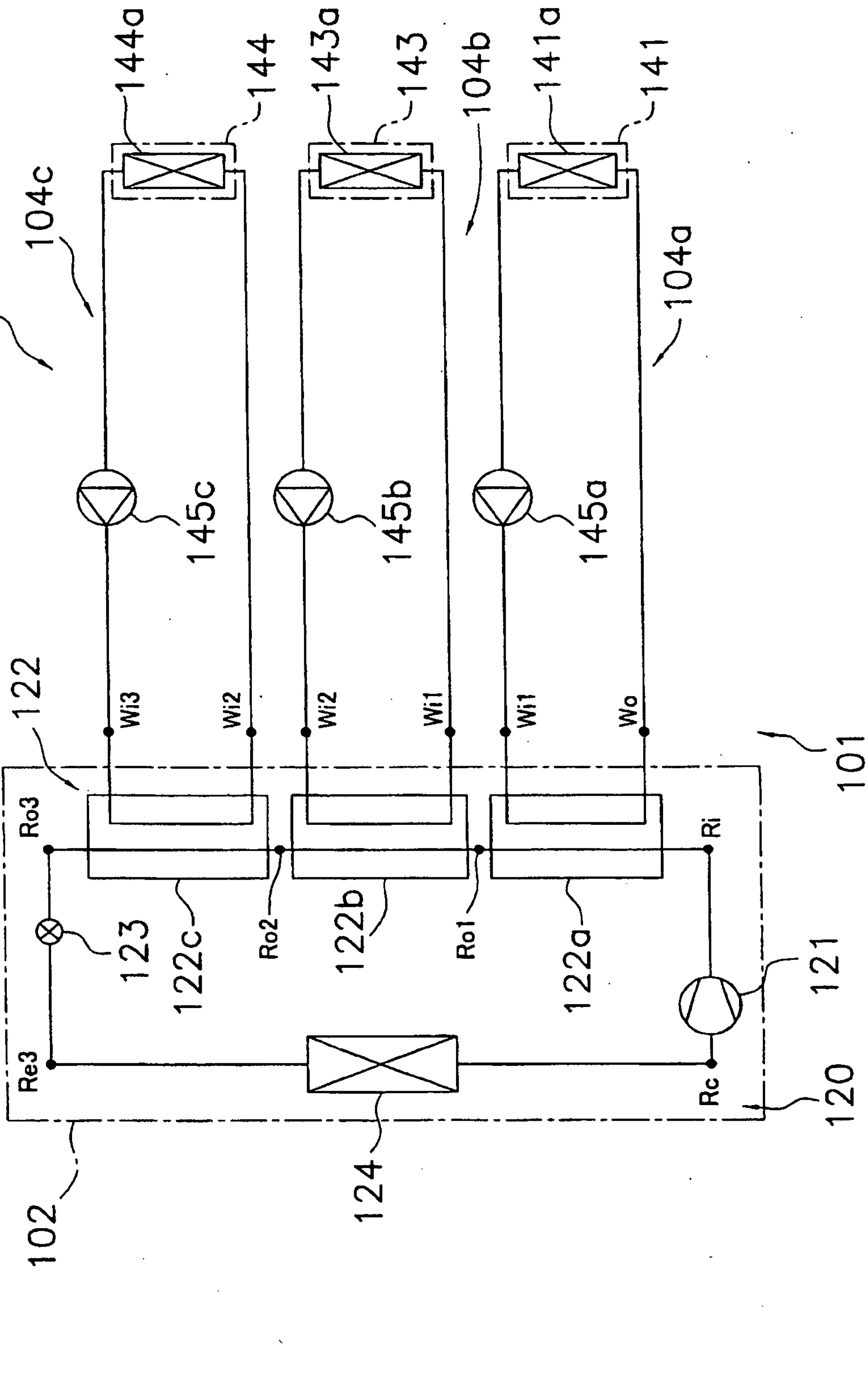
143a
143
141a
141
145c
145b
145a
Wi3
Wi2
Wi2
Wi1
Wi1
Wo
Ro3
Ri
Ro2
Ro1
122
123
121
Re3
Rc
124
101
120
102

Fig. 10

Fig. 11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143a
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141a
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145c
145b
145a
122
Wi3
Wi2
Wi2
Wi1
Wi1
Wo
101
Ro3
Ro2
Ro1
Ri
123
122c
122b
122a
121
Re3
Rc
124
120
102

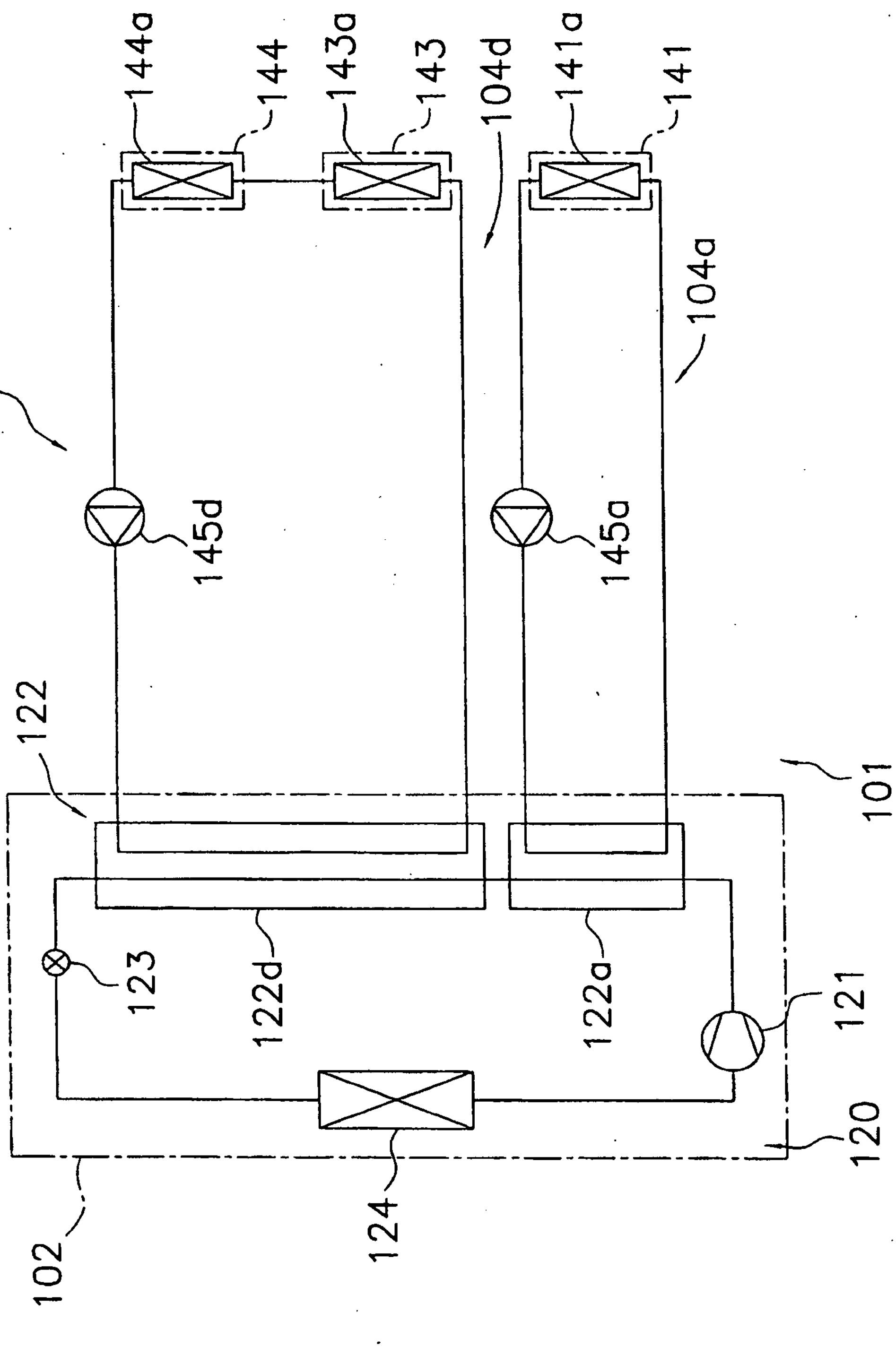

102
124
120
121
122a
122d
123
122
101
145d
145a
104
104a
104d
141
141a
143
143a
144
144a

Fig. 12

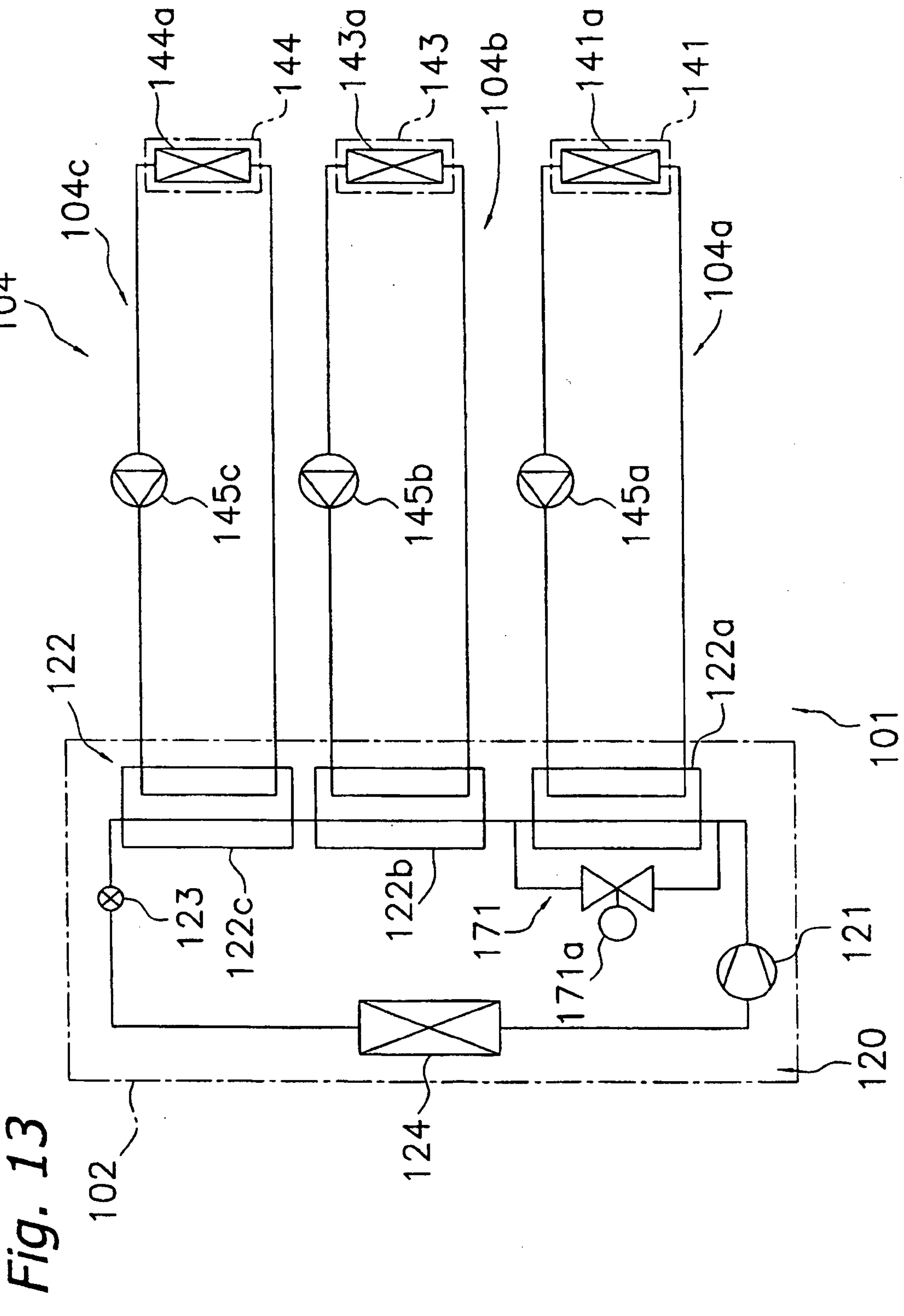
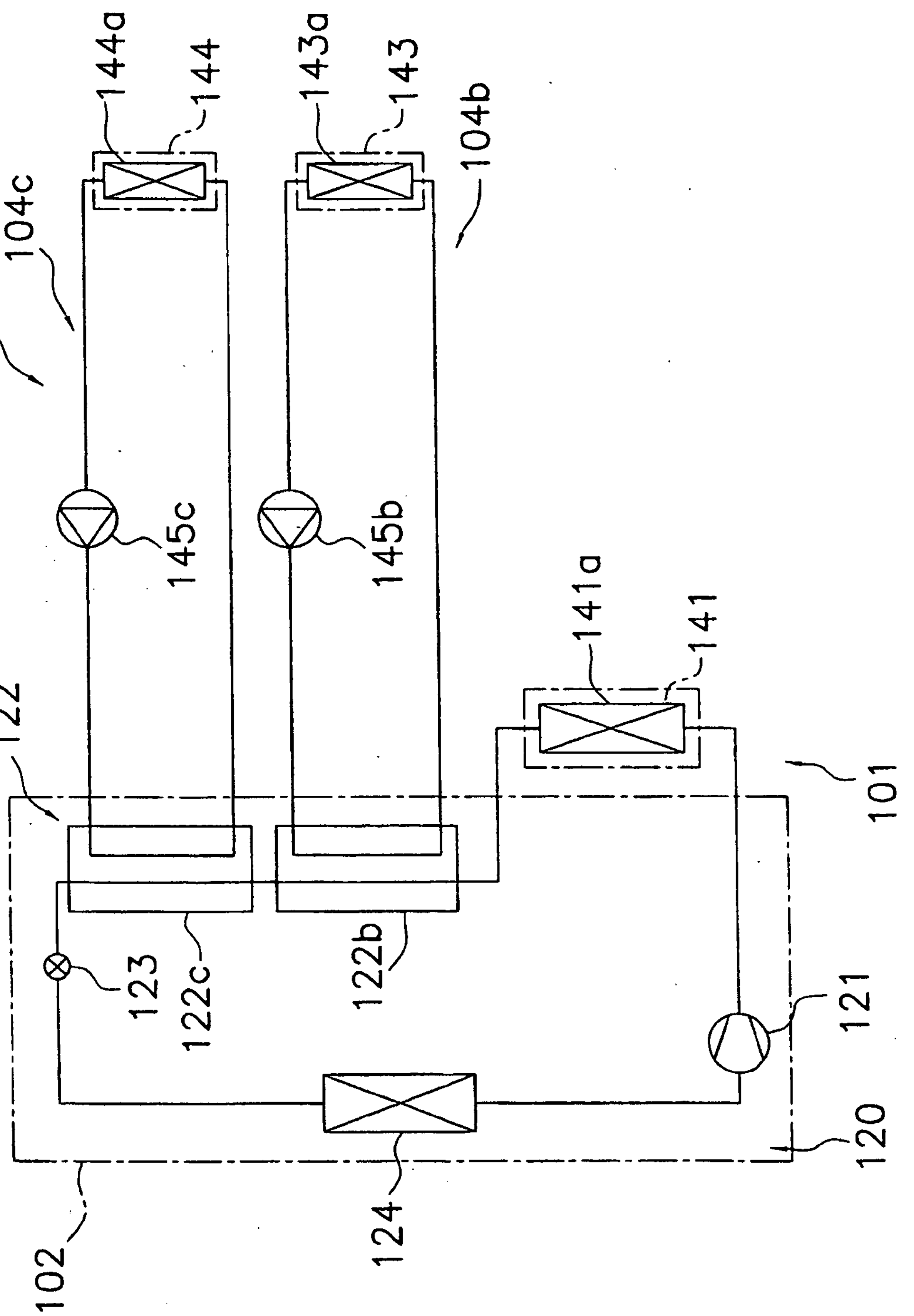


Fig. 13
104
104c
144a
144
143a
143
104b
141a
141
104a
145c
145b
145a
122
122a
101
123
122c
122b
171
171a
121
120
102
124

Fig. 14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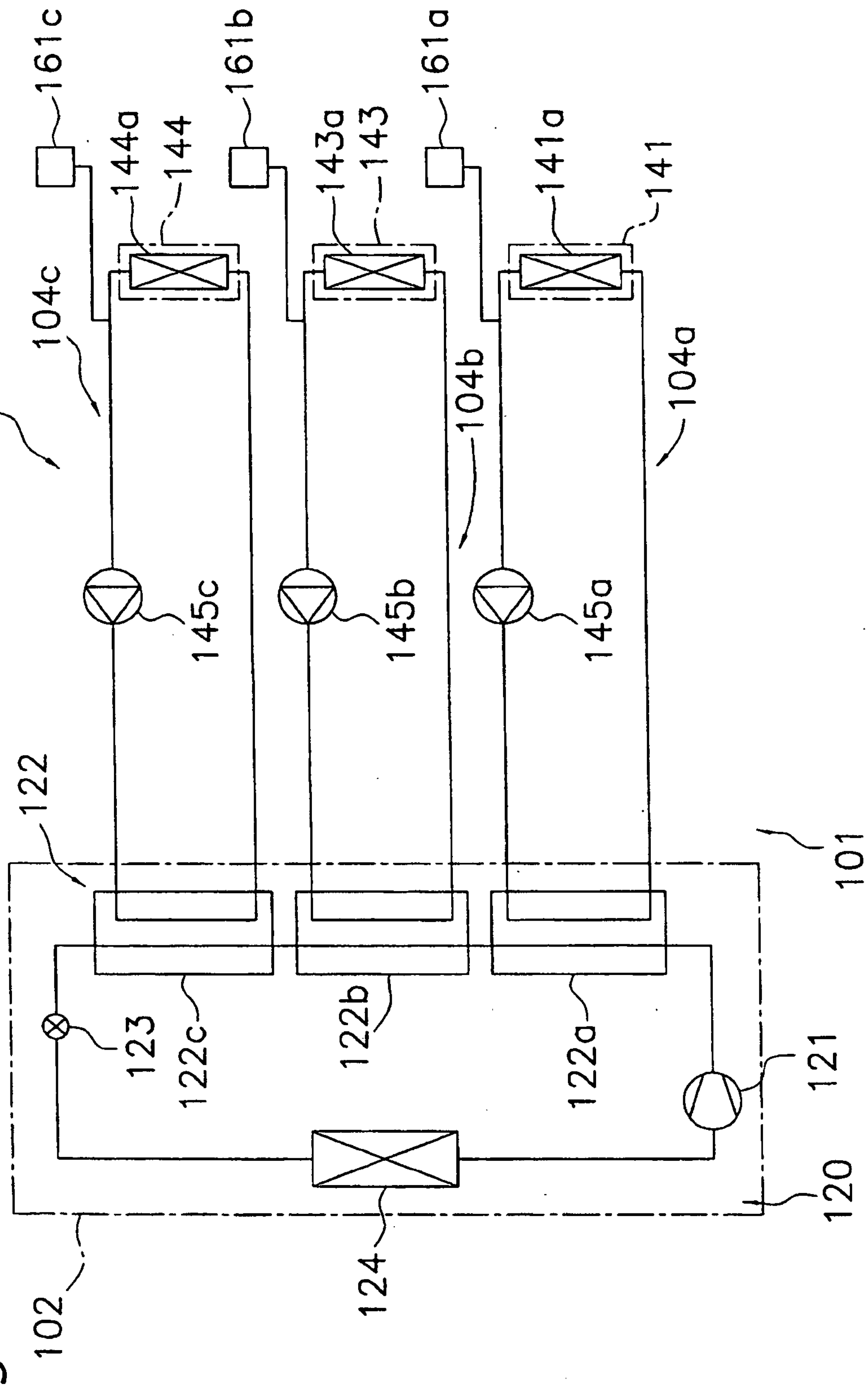
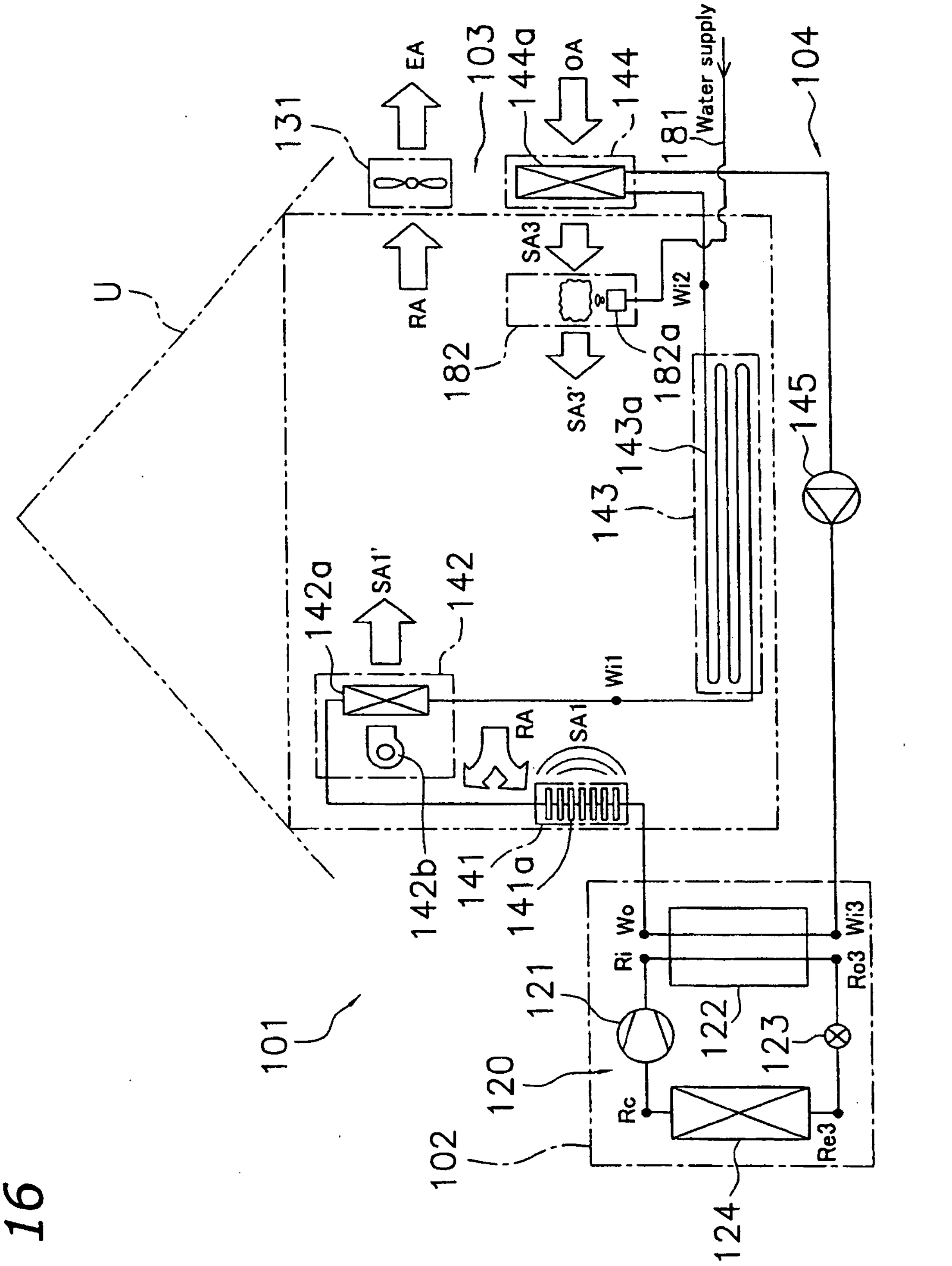
104c
144a
144
143a
143
104b
145c
145b
141a
141
122
101
123
122c
122b
121
120
124
102

Fig. 15


161c
161b
161a
144a
144
143a
143
141a
141
104
104c
104b
104a
145c
145b
145a
122
101
123
122c
122b
122a
121
120
124
102



101
102
103
104
120
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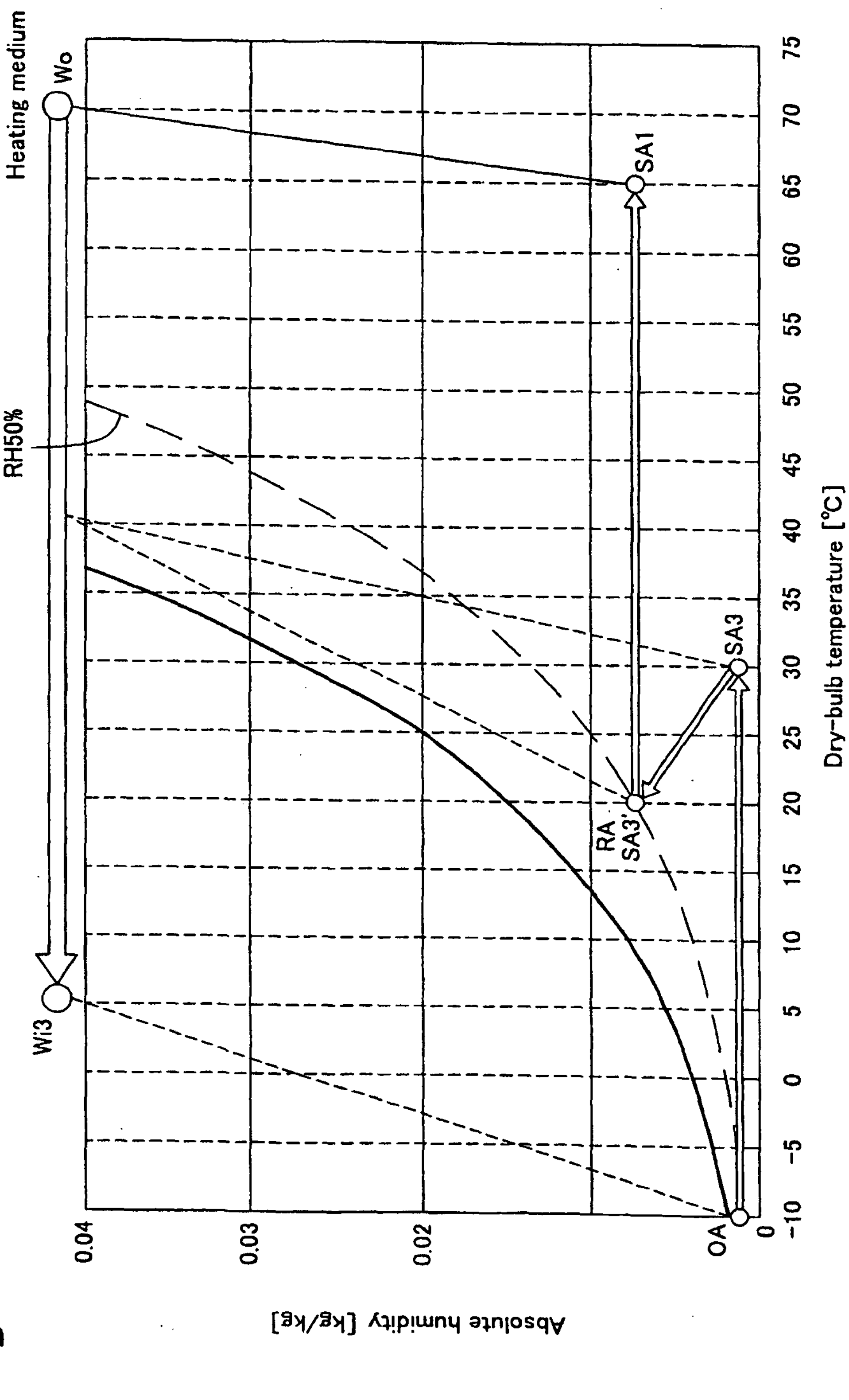
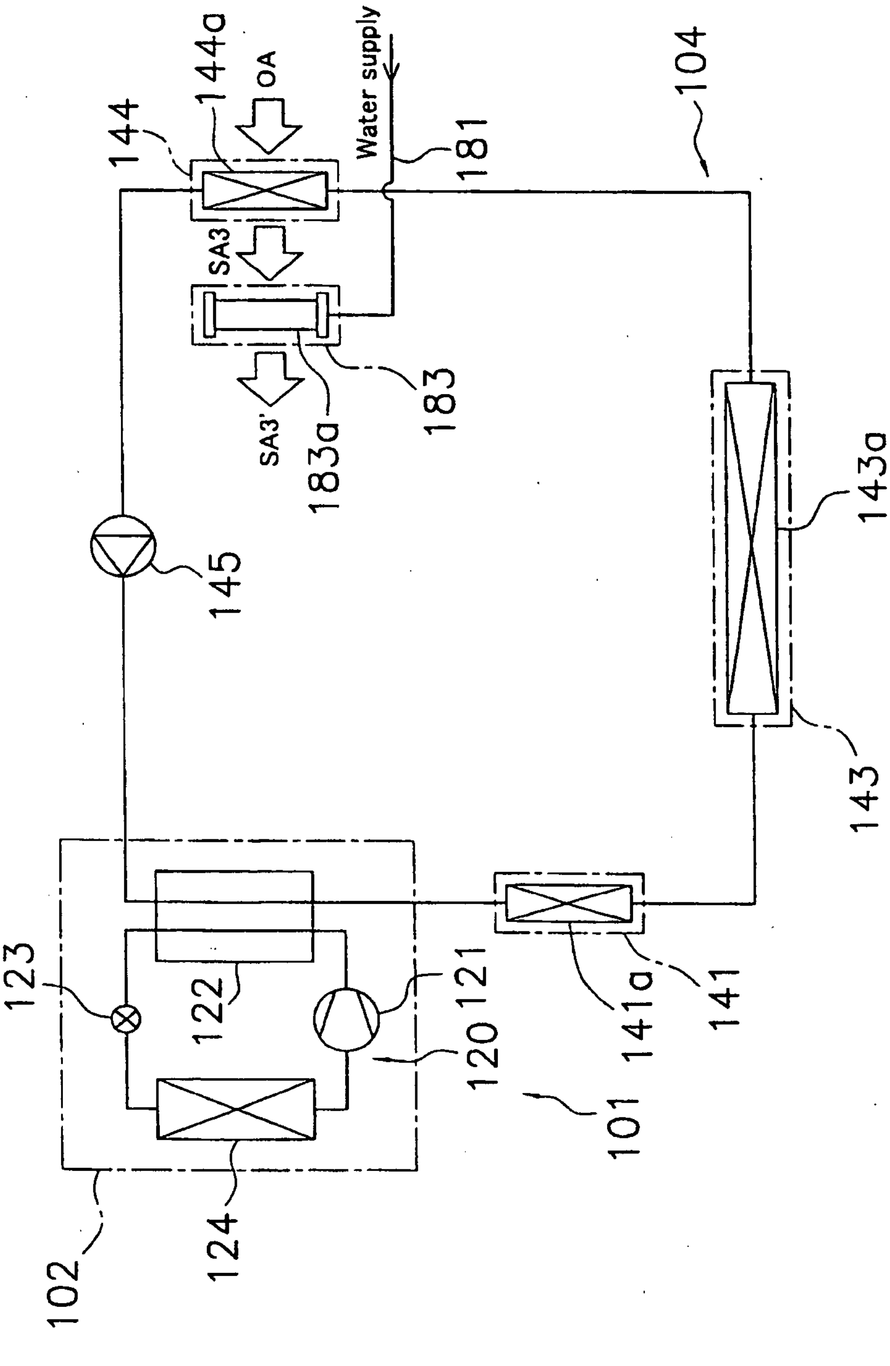
122
123
124
131
141
141a
142
142a
142b
143
143a
144
144a
145
181
182
182a
U
EA
RA
OA
SA1
SA1'
SA3
SA3'
Wi1
Wi2
Wi3
Wo
Ri
Ro3
Rc
Re3
Water supply

Fig. 16

Fig. 17


Heating medium
Wo
RH50%
SA1
SA3
RA
SA3'
Wi3
OA
Absolute humidity [kg/kg]
0.04
0.03
0.02
0
Dry-bulb temperature [°C]
-10
-5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75


144
144a
OA
Water supply
181
104
SA3
183
183a
SA3'
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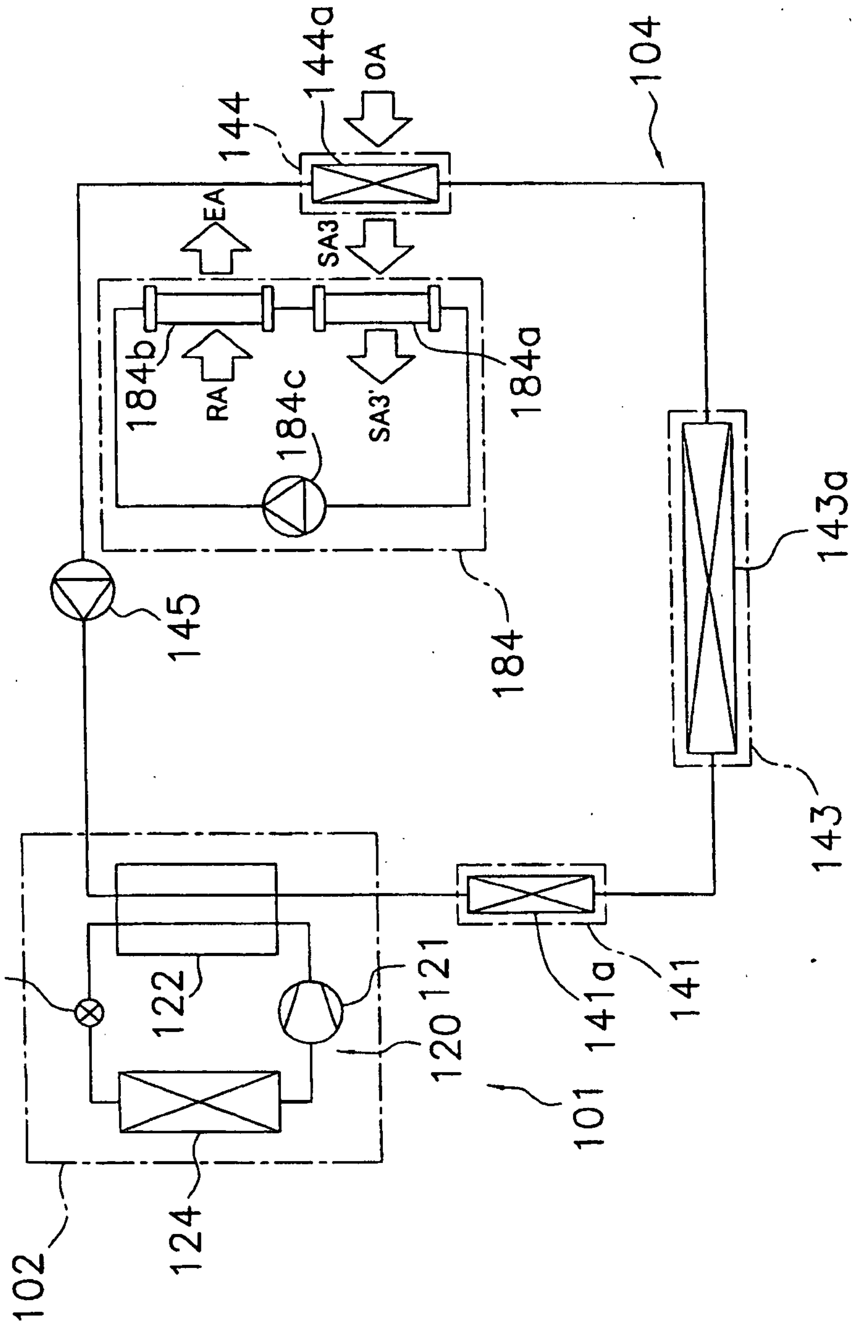
120
124
102
101
141a
141

Fig. 18

Fig. 19


144a
OA
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144
EA
SA3
184b
RA
184c
SA3'
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143a
145
184
143
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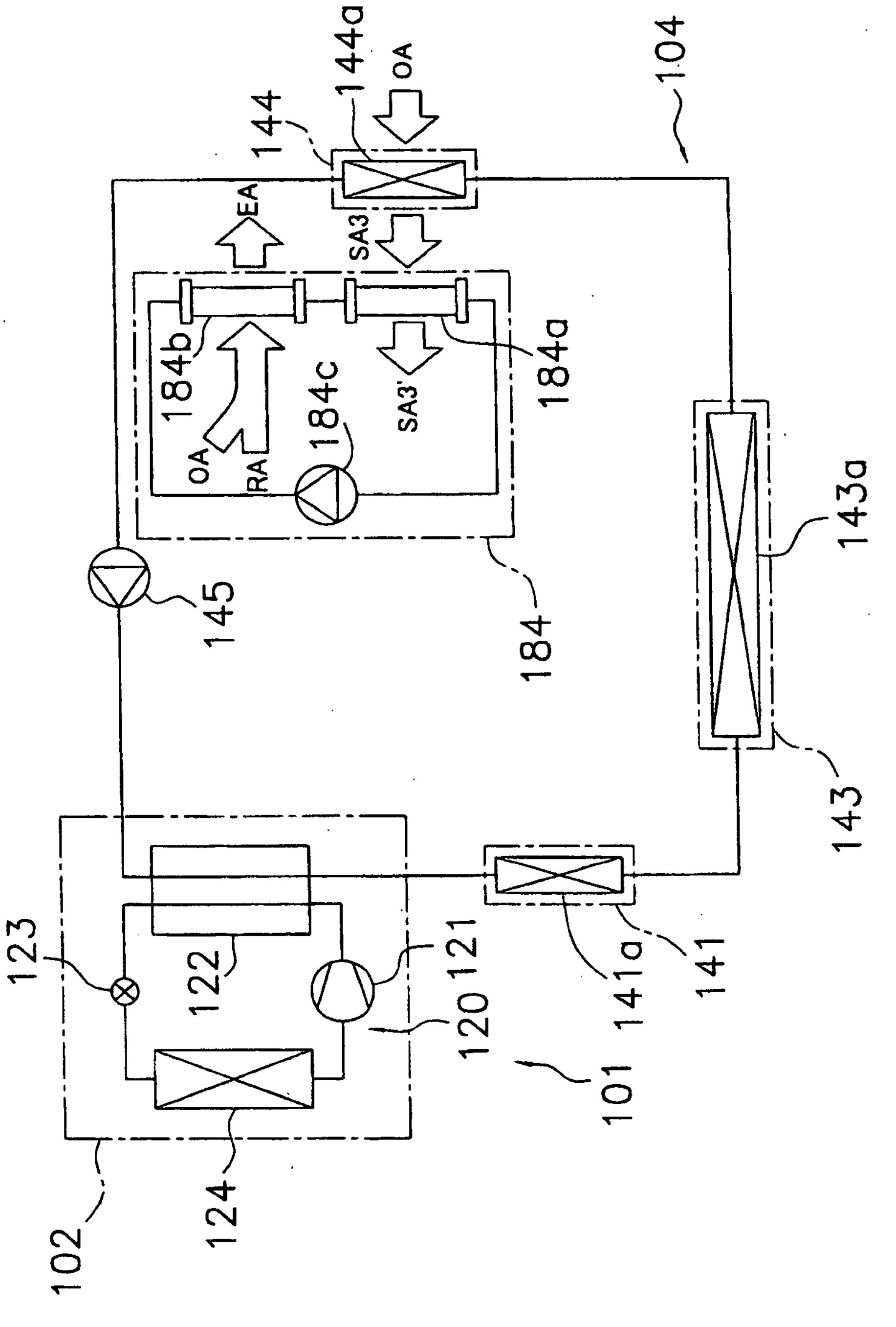
122
121
120
101
141a
141
124
102


104
144a
144
OA
EA
SA3
184b
184a
184c
SA3'
OA
RA
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184
143a
143
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122
121
120
141a
141
101
124
102

Fig. 20

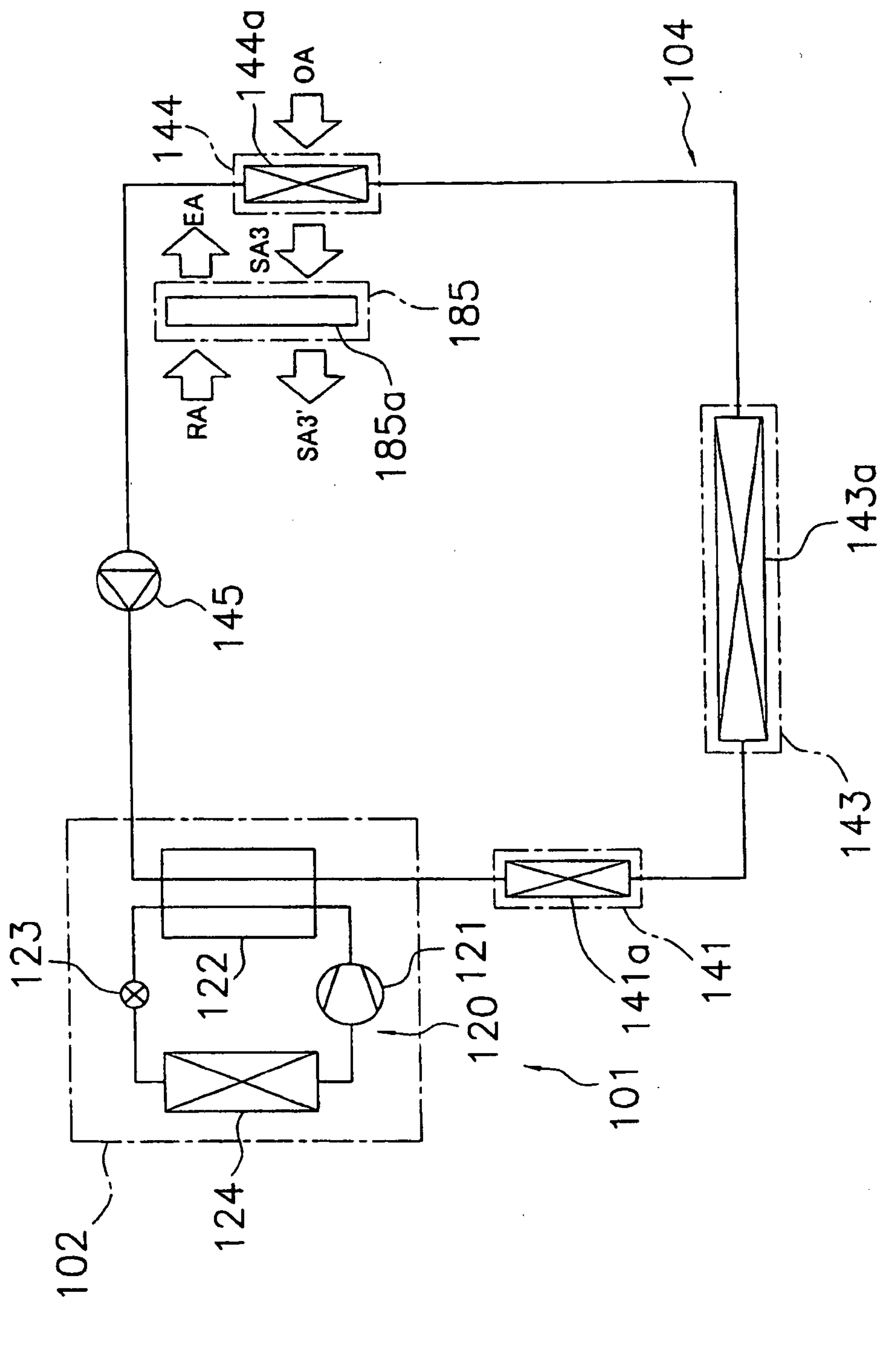
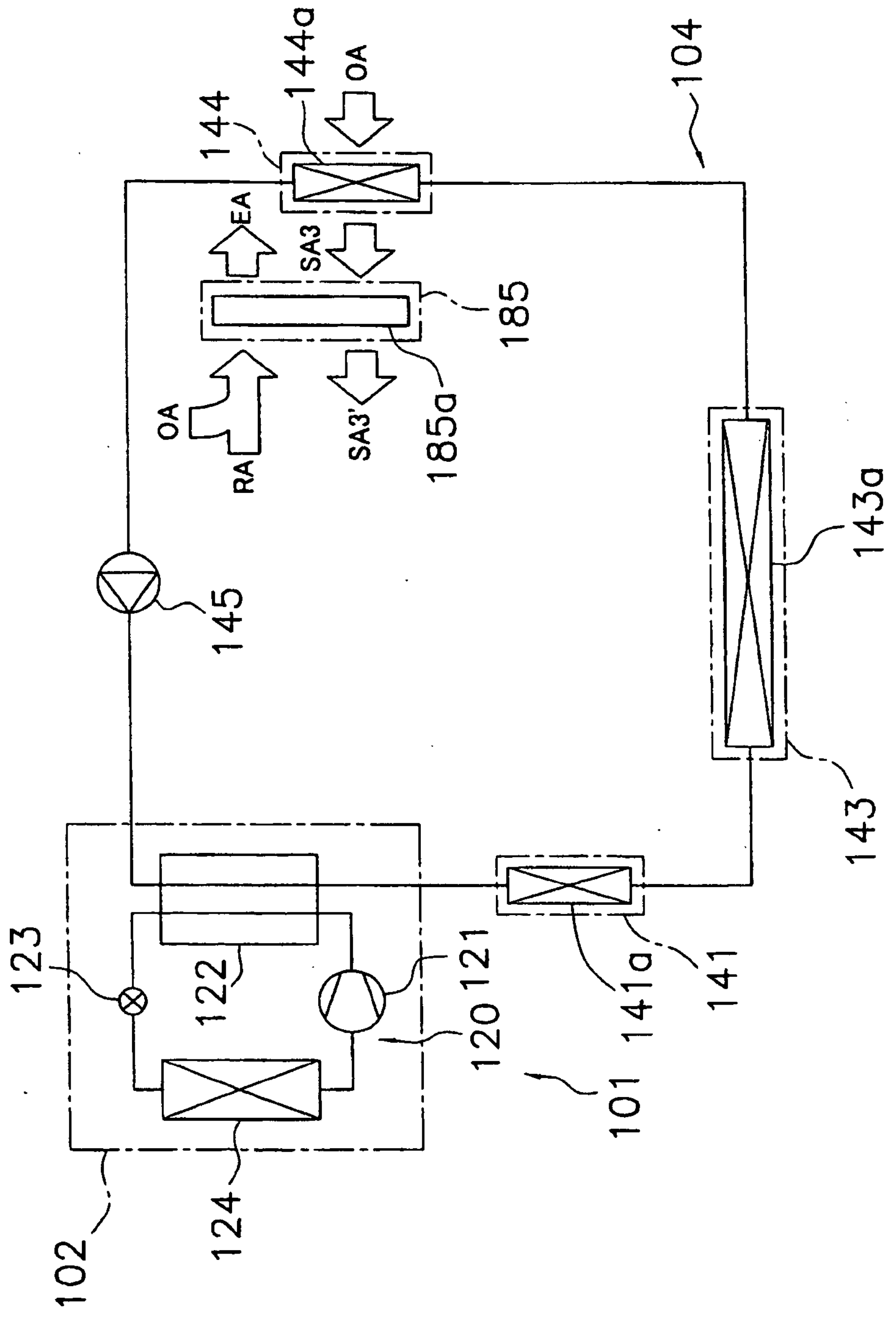

144a
OA
104
144
EA
SA3
185
185a
RA
SA3'
143a
145
143
123
122
121
120
141a
141
101
102
124

Fig. 21

Fig. 22


144a
OA
104
144
EA
SA3
185
185a
OA
RA
SA3'
145
143a
143
123
122
121
120
141a
141
101
124
102

REFERENCES CITED IN THE DESCRIPTION

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