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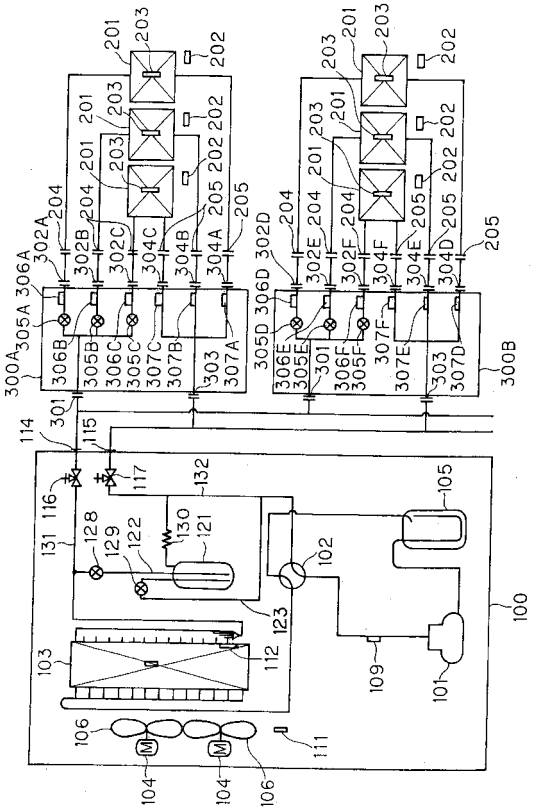
(54) Air conditioner refrigerant circuit

(57) An air conditioner refrigerant circuit, in which the refrigerant circuit includes an outdoor unit refrigerant circuit that includes an accumulator 105, a compressor 101, a four way directional control valve 102 and an outdoor heat exchanger 103 disposed inside an outdoor unit 100, and an indoor heat exchanger 201 disposed inside an indoor heat exchanger 200. A bypass circuit is provided that bypasses liquid line piping 131 and gas line piping 132, a receiver 121 is provided that collects liquid refrigerant in the bypass circuit, and a liquid line electric valve 128 and a gas line electric valve 129 are provide before and after the receiver 121.

Fig. 5



EP 1 933 102 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to an air conditioner refrigerant circuit, and more particularly to an air conditioner refrigerant circuit that connects an outdoor unit refrigerant circuit that includes a compressor, a four way directional control valve, and an outdoor heat exchanger that is disposed inside the outdoor device, with an indoor heat exchanger that is disposed inside an indoor unit, by means of liquid line piping and gas line piping.

BACKGROUND ART

[0002] An air conditioner refrigerant circuit is a system in which a compressor, a four way directional control valve, and a outdoor heat exchanger disposed inside an outdoor unit are connected, by means of refrigerant piping, to an indoor heat exchanger disposed inside an indoor unit, and which forms a circulatory route for refrigerant.

[0003] In this type of air conditioner refrigerant circuit, during cooling, in order for the outdoor heat exchanger to function as a condenser, and the indoor heat exchanger to function as an vaporizer, the direction in which the refrigerant circulates is controlled by the four way directional control valve. At this time, when a high pressure receiver (hereinafter referred to as a "receiver") that temporarily stores liquid refrigerant condensed by the outdoor heat exchanger is provided in the refrigerant circuit, and the amount of refrigerant inside the outdoor heat exchanger that functions as a condenser, and the amount of refrigerant inside the indoor heat exchanger that functions as an vaporizer, changes, there are times when the refrigerant circuit is constructed such that the change in the amount of refrigerant is absorbed by the receiver.

[0004] Normally, in the outdoor unit, a liquid line shut off valve is provided on the liquid line piping that is connected to the outdoor heat exchanger, a gas line shut off valve is provided on the gas line piping that is connected to the four way directional control valve, and the receiver is serially disposed between the liquid line shut off valve and the outdoor heat exchanger.

[0005] With a multi-type of air conditioner, in which one outdoor unit is connected to a plurality of indoor units, in order for sufficient refrigerant to be distributed to each indoor unit, a decompression circuit such as an electric valve or the like is provided for each indoor heat exchanger.

[0006] In an air conditioner refrigerant circuit constructed in this manner, during cooling operations, the amount of refrigerant supplied to each indoor heat exchanger can be controlled at a suitable level by means of the decompression circuit provided for each indoor heat exchanger. In addition, in situations in which the sum of the amount of refrigerant in the outdoor heat exchanger and the amount of refrigerant in each indoor heat exchanger fluctuates, the air conditioner refrigerant circuit is constructed so that an adjustment in the amount of refrigerant takes place by means of the receiver, and is returned to the compressor.

[0007] During heating, in order for the indoor heat exchangers to function as condensers, and the outdoor heat exchanger to function as a vaporizer, the four way directional control valve is operated and the refrigerant cycle takes place. At this time, because the surplus refrigerant used during heating is stored in the receiver, it is necessary to provide decompression circuits, such as electric valves or the like, between the receiver and the indoor heat exchangers. Because of this, there is a danger that the pressure differential before and after the decompression circuits used for distribution that correspond to each indoor heat exchanger will become small, and that the flow of refrigerant inside the indoor heat exchangers will worsen.

[0008] In particular, in situations in which each indoor device is provided on different floors inside a building, there is a danger that vertical drift will develop due to the differences in the elevation of each indoor heat exchanger, and that the flow of refrigerant to the indoor heat exchanger on the lowest floor will cease. In order to eliminate this, it is possible to enhance the capacity of the decompression circuit provided on the outlet of the receiver in the outdoor device, and enlarge the pressure differential before and after the decompression circuits used for distribution. For example, it is possible to enlarge the diameter of an electric valve employed as a decompression circuit on the receiver outlet. However, this is an expensive component, and thus makes it difficult to reduce costs.

[0009] It is an object of the present invention to reduce the occurrence of refrigerant drift in situations in which there are differences in the elevation in which a plurality of indoor devices are disposed, and to provide a refrigerant circuit in which cost reductions can be achieved.

DISCLOSURE OF THE INVENTION

[0010] The air conditioner refrigerant circuit according to the present invention connects a refrigerant circuit for an outdoor unit, which includes a compressor, a four way directional control valve, and an outdoor heat exchanger disposed inside the outdoor unit, and an indoor heat exchanger disposed inside an indoor unit, by means of liquid line piping and gas line piping. The air conditioner refrigerant circuit further provides a bypass circuit that bypasses the liquid line piping

and gas line piping, and a liquid receiving circuit on the bypass circuit that collects the liquid refrigerant.

[0011] Here, the air conditioner refrigerant circuit further comprises a liquid line shut off valve and a gas line shut off valve disposed in the outdoor unit that are provided between the outdoor unit refrigerant circuit and the indoor heat exchanger. The bypass circuit is disposed inside the outdoor unit and provided between the gas line piping between the four way directional control valve and the gas line shutoff valve, and the liquid line piping between the outdoor heat exchanger and the liquid line shut off valve. The liquid receiving circuit is disposed inside the outdoor unit and comprises a receiver that is provided in the bypass circuit and which collects liquid refrigerant, and refrigerant opening and closing means that are provided in a liquid line connector that connects the receiver to the liquid line piping, and in a gas line connector that connects the receiver to the gas line piping.

[0012] Further, the refrigerant opening and closing means can be formed with a functional component that is capable of decompressing refrigerant. Specifically, the refrigerant opening and closing means can be formed with an electric valve or a capillary.

[0013] In addition, the refrigerant opening and closing means can be formed with a functional component that is capable of shutting off the flow of refrigerant. For example, the refrigerant opening and closing means can be selected from the group consisting of an electric valve, a magnetic valve, or a check valve.

[0014] Further, the refrigerant opening and closing valve can be constructed to comprise a function that decompresses the refrigerant and a function that shuts off the flow of refrigerant, and can be constructed to be a combination of an electric valve or a capillary and a magnetic valve.

[0015] In addition, the air conditioning refrigeration circuit can be constructed to further comprise a gas recovery capillary that is interposed between the gas line piping between the four way directional control valve and the gas line, and the receiver.

[0016] Further, the air conditioning refrigeration circuit can be constructed to further comprise the refrigerant opening and closing means provided in the gas line connector of the receiver and an auxiliary heat exchanger that is interposed between the gas line piping between the four way directional control valve and the gas line shut off valve.

[0017] At this time, the refrigerant opening and closing means provided in the gas line connector of the receiver is preferably a decompression circuit that employs an electric valve.

[0018] In addition, the auxiliary heat exchanger is preferably provided on the lower portion of the outdoor heat exchanger. Moreover, the outdoor heat exchanger can be constructed to comprise a subcooling heat exchanger positioned on the liquid line, and disposed adjacent to the auxiliary heat exchanger and the subcooling heat exchanger. In this situation, the auxiliary heat exchanger is preferably disposed upwind of the subcooling heat exchanger.

[0019] Moreover, the air conditioning refrigeration circuit can be constructed to further comprise a decompression circuit in the liquid line piping between the outdoor refrigerant circuit and the indoor heat exchanger. In this situation, the decompression circuit can be constructed to be partial pressure electric valves that correspond to a plurality of connected indoor units.

[0020] In addition, this decompression circuit can be constructed to be provided inside a refrigerant branching unit disposed between the outdoor refrigerant circuit and the indoor heat exchanger.

[0021] Moreover, the present invention can be an air conditioner comprising a refrigeration circuit that includes an outdoor unit refrigerant circuit that includes a compressor, a four way directional control valve and an outdoor heat exchanger disposed inside an outdoor unit, an indoor heat exchanger disposed inside an indoor unit connected to the outdoor refrigerant circuit via liquid line piping and gas line piping, a receiver that is disposed in a bypass circuit that bypasses the liquid line piping and the gas line piping and collects surplus refrigerant in a refrigerant circuit, and refrigerant opening and closing means that are disposed in a liquid line connector that connects the receiver to the liquid line piping, and a gas line connector that connects the receiver to the gas line piping. The air conditioner controls a discharge line temperature of the compressor at a predetermined value by controlling the opening and closing of the refrigerant opening and closing means.

[0022] Here, the refrigerant opening and closing means provided in the gas line connector of the receiver is a decompression circuit that employs an electric valve.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023]

Fig. 1 is a schematic view of a first embodiment of the present invention.
Fig. 2 is a schematic view of a second embodiment of the present invention.
Fig. 3 is a schematic view of a third embodiment of the present invention.
Fig. 4 is a schematic view of a fourth embodiment of the present invention.
Fig. 5 is a schematic view of a fifth embodiment of the present invention.
Fig. 6 is a schematic view of a seventh embodiment of the present invention.

Fig. 7 is a schematic view of a seventh embodiment of the present invention.
Fig. 8 is a schematic view of a eighth embodiment of the present invention.
Fig. 9 is a schematic view of a ninth embodiment of the present invention.
Fig. 10 is a simplified descriptive view of an outdoor heat exchanger.
Fig. 11 is a view of a preferred embodiment.
Fig. 12 is a control flow chart during heating operations.
Fig. 13 is a descriptive view showing a working example during heating operations.
Fig. 14 is a descriptive view showing a working example during heating operations.
Fig. 15 is a descriptive view showing a working example during heating operations.
Fig. 16 is a descriptive view showing a working example during heating operations.
Fig. 17 is a control flow charge during cooling operations.
Fig. 18 is a descriptive view showing a working example during cooling operations.
Fig. 19 is a descriptive view showing a working example during cooling operations.
Fig. 20 is a descriptive view showing a working example during cooling operations.
Fig. 21 is a descriptive view showing a working example during cooling operations.
Fig. 22 is a descriptive view showing a working example during cooling operations.
Fig. 23 is a flow chart of the target discharge line temperature control by means of the outdoor unit electric valves.
Fig. 24 is a flow chart of the target discharge line temperature control by means of the outdoor unit electric valves.
Fig. 25 is a flow chart of a control condition ①.
Fig. 26 is a flow chart of a temporary target discharge line temperature calculation during cooling.
Fig. 27 is a flow chart of a temporary target discharge line temperature calculation during heating.
Fig. 28 is a flow charge of a target discharge line temperature calculation.
Fig. 29 is a flow charge of a control condition ②.

BEST MODE FOR CARRYING OUT THE INVENTION

[Overall construction of the invention]

[0024] In order to achieve the object of the present invention, embodiments that are considered from a variety of viewpoints are shown below.

[First embodiment: Receiver disposed in a bypass circuit]

[0025] As shown in Fig. 1, we will consider a situation in which a plurality of indoor units 200A, 200B, etc. are connected to an outdoor unit 100 via branching units 300A, 300B, etc.

[0026] The outdoor unit 100 is comprised of a compressor 101, a four way directional control valve 102, an outdoor heat exchanger 103, an accumulator 105, and the like. A discharge thermistor 109 for detecting the discharge line temperature is provided on the discharge side of the compressor 101. Further, an outside air thermistor 111 for detecting the outside air temperature, and an outdoor heat exchange thermistor 112 for detecting the temperature of the outdoor heat exchanger 103, are provided in the outdoor unit 100. In addition, a fan 106 for drawing in outside air and exchanging heat between the outside air and the refrigerant that flows inside the outdoor heat exchanger 103, and a fan motor 104 for rotationally driving the fan 106, are provided.

[0027] In order to lead the refrigerant piping from the outdoor unit 100 to the indoor units, a liquid line connector port 114 that is connected to the outdoor heat exchanger 103, and a gas line connector port 115 that is connected to the four way directional control valve 102, is provided in the outdoor unit 100. A liquid line shut off valve 116 and a gas line shut off valve 117 are installed on the inside of each connecting port.

[0028] A receiver 121 is provided in the outdoor unit 121, which temporarily stores surplus refrigerant liquid from the outdoor heat exchanger 103 when it functions as a condenser during air conditioning. The receiver 121 comprises a liquid line connector 122 and a gas line connector 123. The liquid line connector 122 is connected to liquid line piping 131 between the outdoor heat exchanger 103 and the liquid line shut off valve 116, and the gas line connector 123 is connected to gas line piping 132 between the four way directional control valve 102 and the gas line shut off valve 117.

[0029] A plurality of branching units 300A, 300B, etc. are connected to the liquid line connector port 114 and the gas line connector port 115 on the outside unit 100. Because the branching units 300A, 300B, etc. each have an identical construction, a description of the branching unit 300A will be provided, and a description of the other branching units will be omitted.

[0030] The branching unit 300A is comprised of an outdoor liquid line connector port 301 that is connected to the liquid line connector port 114 on the outdoor unit 100, and an outdoor gas line connector port 303 that is connected to the gas line connector port 115 on the outdoor unit 100. The branching unit 300A is comprised of a liquid line branching circuit

that branches on the inside of the outdoor liquid line connector port 301, and on the other side thereof, indoor liquid line connector ports 302 are provided which are connected to a number of indoor units. In addition, the branching unit 300A is comprised of a gas line branching circuit that branches on the inside of the outdoor liquid line connector port 303, and on the other side thereof, indoor liquid line connector ports 304 are provided which are connected to a number of indoor units. Here, indoor liquid line connector ports 302A, 302B, and 302C, and indoor gas line connector ports 304A, 304B, and 304C are provided for three connected indoor units.

[0031] Electric valves 305A - 305C for decompressing the pressurized refrigerant that passes therethrough, and liquid line thermistors 306A - 306C for detecting the temperature of the refrigerant temperature that passes therethrough, are each provided along the branching circuit that spans between the outdoor liquid connector port 301 inside the branching unit 300A to each indoor liquid line connector port 302A - 302C. Further, gas line thermistors 307A - 307C for detecting the temperature of the refrigerant that passes therethrough, are each provided along the branching circuit that spans between the outdoor gas connector port 303 inside the branching unit 300A to each indoor gas line connector port 304A - 304C.

[0032] A plurality of indoor units 200 are connected to each branching unit 300A, 300B, etc. Here, there are 3 indoor units that can be connected to each branching unit 300A, 300B, etc., with the indoor units 200A - 200C connected to the branching unit 300A, and the indoor units 200D - 200F connected to the branching unit 300B. Each indoor unit 200A - 200F is an indoor unit for use with a multi unit, and any of them can be used as a paired unit. Here, indoor device 200A will be described when used as a paired unit.

[0033] Indoor unit 200A is comprised of an indoor heat exchanger 201, and refrigerant piping connected to this indoor heat exchanger 201 is lead to the outdoor unit via a liquid connector port 204 and a gas connector port 205. Further, this indoor device 200A is comprised of a room temperature thermistor 202 for detecting the indoor temperature, and an indoor heat exchange thermistor 203 for detecting the temperature of the indoor heat exchanger 201.

[0034] Note that with the indoor units connected to branching units 300A, 300B, in situations in which indoor units for multi unit use are employed, there are times when liquid line thermistors are provided for detecting the temperature of the refrigerant that flows inside the liquid line piping. In this case, the liquid line thermistors inside the branching units 300A, 300B can be omitted.

[0035] Further, the gas line connector 123 of the receiver 121 can be constructed so that it connects the gas line between the four way directional control valve 102 and the accumulator 105.

[0036] In this embodiment, when the receiver 121 is provided in the bypass circuit that connects the liquid line shut off valve 116 and the gas line shut off valve 117 in the outdoor unit 100, surplus refrigerant can be collected in this receiver 121, and refrigerant can be distributed during heating by means of the electric valves 305A - 305C, 305D - 305F, etc. inside the branching units 300A, 300B, etc., there is a lower occurrence of high-low drift due to the locations in which the indoor units are disposed, and there is no longer any need to provide a large diameter electric valve in the main refrigerant circuit of the outdoor device 100.

[Second embodiment: Provide a decompression circuit before and after the receiver]

[0037] In the first embodiment, it is possible to provide a decompression circuit on the liquid line connector 122 and the gas line connector 123 of the receiver 121.

[0038] For example, as shown in Fig. 2, capillaries 124, 125 for decompression are respectively installed on the liquid line connector 122 and the gas line connector 123 of the receiver 121. Electric valves for decompression may respectively provided thereon instead of the capillaries 124, 125.

[0039] Due to this type of construction, the collection of surplus refrigerant in the receiver 121 can be smoothly performed.

[Third embodiment: Provide functional components that interrupt the flow of refrigerant before and after the receiver]

[0040] In the first embodiment, it is possible to provide functional components that shut off the flow of refrigerant to the liquid line connector 122 and the gas line connector 123 of the receiver 121. Here, as shown in Fig. 3, magnetic valves 126, 127 used as refrigerant shut offs are installed on the liquid line connector 122 and the gas line connector 123 of the receiver 121.

[0041] Due to this type of construction, surplus refrigerant can be reliably collected in the receiver 121, refrigerant can be appropriately distributed by means of each magnetic valve inside the branching units 300A, 300B, etc., and the occurrence of high-low drift can be prevented.

[Fourth embodiment: Provide functional components before and after the receiver that have a decompression function and a refrigerant shut off function]

[0042] In the first embodiment, it is possible to provide functional components that have a decompression function and a refrigerant shut off function in the liquid line connector 121 and the gas line connector 122 of the receiver 121. For this type of functional components, it is possible to employ a combination of electric valves or capillaries that have a decompression function and a shut off function, and magnetic valves.

[0043] In Fig. 4, a liquid line electric valve (EVL) 128 is provided in the liquid line connector 122 of the receiver 121, and a gas line electric valve (EVG) 129 is provided in the gas line connector 123 of the receiver 121.

[0044] Due to this type of construction, there is no need to provide a large diameter electric valve for decompression in the main circuit of the outdoor device 100, and refrigerant can be appropriately distributed during heating operations. In addition, because a main decompression circuit is not needed on the main circuit, the pressure differential before and after the electric valves 305A - 305C, 305D - 305F, etc. in the branching units 300A, 300B, etc. connected to each heat exchanger 201 can be maintained at a high level, and the occurrence of high-low drift can be prevented. Moreover, it also has the effect of making it possible to simultaneously control the SC control on the outdoor heat exchanger 103 and the inlet superheating control on the compressor 101 during cooling operations, optimizing control of the refrigerating cycle, maintaining reliability, improving COP, expanding the range of operational availability, and the like.

[Fifth embodiment: Provide a gas recovery capillary on the receiver and the gas line piping]

[0045] In the third and fourth embodiments, it is possible to provide a capillary for venting gas between the receiver 121 and the gas line piping 132. In this case, as shown in Fig. 5, a gas recovery capillary 130 can be provided which is connected with the gas line piping 132 between the four way directional control valve 102 and the gas shut off valve 117, and serves to collect gaseous refrigerant from the receiver 121.

[0046] In conventional refrigerant circuits, in order to improve the refrigerant collection function during pump down operations, a gas recovery capillary is provided in the piping between the four way directional control valve that becomes continuous low pressure piping, and the accumulator. However, in this case, during normal operations (cooling operations and heating operations), because refrigerant flows from the high pressure side to the low pressure side, the result is that a decline in efficiency is incurred during normal operations. Further, in situations in which surplus refrigerant is handled by the receiver during heating operations, because the gas recovery capillary is connected to a continuous low pressure line, the flow rate characteristics of the capillary must be made smaller, and the result of this is that it becomes difficult to improve refrigerant collection efficiency during pump down operations.

[0047] Due to the construction of this fifth embodiment, gas refrigerant inside the receiver 121 can return to the inlet of the accumulator via the gas recovery capillary 130 during pump down operations, it becomes easy to store liquid refrigerant in the receiver 121, and during normal operations, the flow of refrigerant from the gas recovery capillary 130 can be interrupted during cooling operations by shutting liquid line electric valve 128. Further, high pressure can be maintained inside the receiver 121 during heating operations, the back flow of refrigerant from the liquid line electric valve 128 can be prevented, and it becomes possible to handle surplus refrigerant during heating operations.

[Sixth embodiment: Provide an auxiliary heat exchanger in the gas line connector]

[0048] In the embodiments described above, it is possible to provide an auxiliary heat exchanger in the gas line connector 123 of the receiver 121. An example of this situation is shown in Fig. 6.

[0049] In Fig. 6, a gas line electric valve 129 having a decompression function and a refrigerant shut off function is provided on the gas line connector 123 of the receiver 121. An auxiliary heat exchanger 133 is provided between the gas line electric valve 129 and the portion that connects with the gas line piping 132.

[0050] When the refrigerant circuit in the first to fifth embodiments is employed and cooling operations take place, when surplus refrigerant is discharged from the receiver, it is necessary to control the speed of refrigerant discharge in order to prevent liquid from suddenly backing up toward the accumulator. However, by providing this type of auxiliary heat exchanger 133, it becomes possible to eliminate the occurrence of a sudden liquid backup toward the accumulator, and improve the speed of refrigerant discharge, because the liquid refrigerant vaporizes by means of this auxiliary heat exchanger 133. In addition, during heating operations, because the auxiliary heat exchanger 133 functions as a condenser, it becomes possible to improve the speed in which surplus refrigerant is stored in receiver 121.

[0051] Further, by providing the liquid line electric valve 128 and the gas line electric valve 129 connected to the receiver 121, and providing the auxiliary heat exchanger 133 between the liquid line electric valve 129 and the gas line electric valve 132, it becomes possible to control the state of the refrigerant in the outlet of the outdoor heat exchanger 103 (liquid line piping 131). Because of this, when the temperature of the discharge pipe is high, the quantity of refrigerant discharged from the receiver 121 is made large in order to cool it, and when there is liquid refrigerant in the accumulator

105, it becomes possible to control the discharge temperature by reducing the quantity of refrigerant discharge from the receiver 121. In addition, because it becomes possible to adjust the temperature of the surplus refrigerant stored during heating operations, and because the condensing ability of the auxiliary heat exchanger 133 is variable, under conditions in which high pressure is easily raised during heating overload operations, the condensing ability of the auxiliary heat exchanger 133 can be enlarged by enlarging the opening of the gas line electric valve 129, and this can contribute to a decrease in the high pressure.

[Seventh embodiment: Place an auxiliary heat exchanger on the lower portion of the outdoor heat exchanger]

[0052] Like the sixth embodiment, when the auxiliary heat exchanger 133 is disposed on the gas line connector 123 of the receiver 121, it is possible to provide the auxiliary heat exchanger 133 inside the outdoor heat exchanger 103, and, it is possible to place it on the lowermost portion of the outdoor heat exchanger 103. This seventh embodiment is shown in Fig. 7.

[0053] In Fig. 7, the auxiliary heat exchanger 133 connected to the gas line connector 123 of the receiver 121 is provided inside the outdoor heat exchanger 103, and, is disposed on the lowermost portion of the outdoor heat exchanger 103.

[0054] During heating operations in which the outdoor temperature is low, there is a danger that water condensed after defrosting operations will refreeze in the lower frame of the outdoor unit 100, will grow until it reaches the outdoor heat exchanger 103, and a decrease in operational performance will result. Like this seventh embodiment, by placing an auxiliary heat exchanger 133 in the lowermost portion of the outdoor heat exchanger 103, and due to the refrigerant that flows inside the auxiliary heat exchanger 133 during heating operations in low outdoor temperatures, condensed water can be prevented from refreezing, and it becomes possible to prevent a decline in the performance of the outdoor heat exchanger 103.

[Eighth embodiment: Place a subcooling heat exchanger adjacent to the auxiliary heat exchanger]

[0055] The situation in which a subcooling heat exchanger is disposed on the liquid line of a outdoor heat exchanger will be considered. This subcooling heat exchanger is a device for placing refrigerant from the outlet of the outdoor heat exchanger into the supercooled state during cooling. The configuration shown in Fig. 8 will be considered, in which the auxiliary heat exchanger in the seventh embodiment is disposed in the outdoor heat exchanger and is adjacent to the subcooling heat exchanger.

[0056] A subcooling heat exchanger 134 is disposed below the outdoor heat exchanger 103, and below that, the auxiliary heat exchanger 133 is disposed on the lowermost portion of the outdoor heat exchanger 103.

[0057] With this type of construction, due to the vaporizing abilities of the auxiliary heat exchanger 133, cooling abilities can be increased by means of the subcooling heat exchanger 134 disposed adjacent thereto, and the degree to which the refrigerant from the outlet of the outdoor heat exchanger 103 is supercooled can be increased.

[Ninth embodiment: Place an auxiliary heat exchanger upwind of the subcooling heat exchanger]

[0058] In the eighth embodiment, it is possible to place an auxiliary heat exchanger cooling line upwind of a subcooling heat exchanger cooling line.

[0059] The outdoor heat exchanger 103, for example, as shown in Fig. 10, is composed of a plurality of cooling lines 171 that have one end thereof bent back, and a plurality of heat radiating fins 172, which are metallic plate members that have insertion holes formed therein for inserting the cooling lines 171. Distributors 173, 174 are provided on both ends of each cooling line 171. When each cooling line 171 functions as a vaporizer, one end thereof serves as a refrigerant port, and when each cooling line 171 functions as a condenser, the other end serves as a refrigerant port.

[0060] Fig. 9 shows an enlarged lateral view of only the lower portion of this type of outdoor heat exchanger 103. Here, a pipe plate 175 that supports both ends of cooling lines 171 is provided on the side surface of the outdoor heat exchanger 103. This pipe plate 175 is formed into approximately the same shape as the heat radiating fins 172, and has insertion holes 176 formed therein for inserting the cooling lines 171. The cooling lines 171 disposed between the distributors 173, 174 are inserted into each insertion hole 176.

[0061] The distributor 174 on the outdoor heat exchanger 103 is connected to the four way directional control valve 102, and the distributor 173 is connected to the subcooling heat exchanger 134. The subcooling heat exchanger 134 is comprised of an SC cooling line 177, one end of which is connected to the distributor 173, and the other end thereof is connected to the liquid shut off valve 116. Further, the auxiliary heat exchanger 133 is comprised of an auxiliary cooling line 178, one end of which is connected to the gas line electric valve 129, and the other end thereof is connected to the gas line piping 132.

[0062] Here, if we assume that the direction of the wind generated by a fan 106 is that shown by the arrow A in Fig.

9 (from right to left in Fig. 9), then the SC cooling line 177 is disposed on the downwind side (the left side of Fig. 9), and the auxiliary cooling line 178 is disposed on the upwind side (the right side of Fig. 9).

[0063] Due to this type of construction, heat exchange can not only occur by means of the thermal conduction of the SC cooling line 177, the heat radiating fins 172, and the auxiliary cooling line 178, but the heat radiated outward by the airflow produced by the fan 106 can be used, the efficiency of the subcooling heat exchanger 134 is increased, and refreezing in the lower portion of the outdoor heat exchanger 103 can be prevented.

[Preferred Embodiment]

[0064] By appropriately combining the above described first through eighth embodiments, it is expected that large efficiencies will be obtained. A preferred embodiment that is a combination of these embodiments will be described below.

[0065] The preferred embodiment of the present invention is shown in Fig. 11.

[0066] The outdoor device 100 is comprised of an outdoor refrigerant circuit, which is comprised of a compressor 101, a four way directional control valve 102, a heat exchanger 103, an accumulator 105, and the like. A discharge pressure protection switch 108 for detecting an abnormal rise in the discharge pressure is provided on the discharge side of the compressor 101, and an inlet pressure sensor 110 for detecting the inlet pressure is provided on the inlet side of the compressor 101.

[0067] Further, an oil separator 107 for separating the lubricating oil that is included in the refrigerant and returning it to the accumulator 105 is provided on the discharge side of the compressor 101. A discharge line thermistor 109 for detecting the temperature on the discharge side of the compressor 101 is installed in the oil separator 107.

[0068] A discharge - intake capillary 141 for adjusting the discharge pressure and the inlet pressure, and a discharge - intake electric valve (EVP) 142 for controlling capacity, are provided in a discharge - intake bypass that connects the outlet side of the oil separator 107 and the inlet side of the accumulator 105. In addition, an outside air thermistor 111 for detecting the outside air temperature, and an outdoor heat exchange thermistor 112 for detecting the temperature of the outdoor heat exchanger 103, are provided in the outdoor unit 100. Further provided are fans 106 for drawing in air from outside and exchanging heat between the refrigerant that flows inside the outdoor heat exchanger 103 and the air drawn in, and fan motors 104 for rotationally driving the fans 106.

[0069] In order to lead refrigerant piping from the outdoor unit 100 to the indoor units, the outdoor unit 100 comprises a liquid line connector port 114 that is connected to the outdoor heat exchanger 103, and a gas line connector port 115 that is connected to the four way directional control valve 102. A liquid line shut off valve 116 and a gas line shut off valve 117 are provided on the inner sides of each connector port.

[0070] A receiver 121 is provided in the outdoor unit 100, which temporarily stores surplus refrigerant from the outdoor heat exchanger 103 when it functions as a condenser during cooling operations. The receiver 121 is comprised of a liquid line connector 122 and a gas line connector 123. The liquid line connector 122 is connected to liquid line piping 131 between the outdoor heat exchanger 103 and the liquid line shut off valve 116, and the gas line connector 123 is connected to gas line piping 132 between the four way directional control valve 102 and the gas line shut off valve 117.

[0071] A liquid line electric valve (EVL) 128 having a decompression function and a refrigerant cut-off function is provided in the liquid line connector 122 on the receiver 121, and a gas line electric valve (EVG) 129 is provided on the gas line connector 123 on the receiver 121.

[0072] An auxiliary heat exchanger 133 is provided in between the gas line electric valve 129 and a portion that connects to the gas line piping 132. As shown in Fig. 9, the auxiliary heat exchanger 133 is constructed by placing an auxiliary cooling line 178 in the lowermost portion of the outdoor heat exchanger 103. A subcooling heat exchanger 134 is disposed on the liquid line outlet of the outdoor heat exchanger 103. As shown in Fig. 9, the subcooling heat exchanger 134 can be constructed so that it is disposed adjacent to the auxiliary heat exchanger 133, by positioning an SC cooling line 177 on the downwind side of the auxiliary cooling line 178 of the auxiliary heat exchanger 133.

[0073] A gas recovery capillary 130 for collecting gaseous refrigerant from the receiver 121 is provided, and is connected to the gas line piping 132 in between the four way directional control valve 102 and the gas shut off valve 117.

[0074] A plurality of branching units 300A, 300B, etc. are connected to the liquid line connector port 144 and the gas line connector port 115 on the outdoor unit 100. Because each outdoor unit 300A, 300B, etc. are constructed identically, a description of the branching unit 300A will be provided, and a description of the other branching units will be omitted.

[0075] The branching unit 300A is comprised of an outdoor liquid line connector port 301 that is connected to the liquid line connector port 114 on the outdoor unit 100, and an outdoor gas line connector port 303 that is connected to the gas line connector port 115 on the outdoor unit 100. The branching unit 300A is comprised of a liquid line branching circuit that branches on the inner side of the outdoor liquid line connector port 301, and on the opposite end thereof, indoor liquid line connector ports 302 for a number of connected indoor units are provided. Further, the branching unit 300A is comprised of a gas line branching circuit that branches on the inner side of the outdoor gas line connector port 303, and on the opposite end thereof, indoor gas line connector ports 304 for a number of connected indoor units are provided. Here, if we assume that there are three connected indoor units, then indoor liquid line connector ports 302A, 302B, and

302C, and indoor gas line connector ports 304A, 304B, and 304C, will be provided. In addition, an electric valve 308 for use as a bypass is provided between the outdoor liquid line connector port 301 and the outdoor gas line connector port 303.

[0076] Electric valves 305A - 305C for decompressing the pressurized refrigerant that passes therethrough, and liquid line thermistors 306A - 306C for detecting the temperature of the refrigerant that passes therethrough, are each provided in the branching circuit that spans between the outdoor liquid line connector port 301 inside the branching unit 300A and each indoor liquid line connector port 302A - 302C. In addition, gas line thermistors 307A - 307C for detecting the temperature of the refrigerant that passes therethrough, are each provided in the branching circuit that spans between the outdoor gas line connector port 303 inside the branching unit 300A and each indoor gas line connector port 307A - 307C.

[0077] A plurality of indoor units 200 are connected to each branching unit 300A, 300B, etc. As illustrated in the figure, three indoor units can be connected to each branching unit 300A, 300B, etc., with the indoor units 200A - 200C connected to the branching unit 300A, and the indoor units 200D - 200F connected to the branching unit 300B. Each indoor unit 200A - 200F can be used either as an indoor unit for multi unit use, or as an indoor unit for paired unit use. Here, the indoor unit 200A will be described as an indoor unit for paired unit use.

[0078] The indoor device 200A is comprised of an indoor heat exchanger 201, and refrigerant piping that is connected to this indoor heat exchanger 201 is lead to the outdoor unit via a liquid line connector port 204 and a gas line connector port 205. Further, a room temperature thermistor 202 for detecting the indoor room temperature, and an indoor heat exchange thermistor 203 for detecting the temperature of the indoor heat exchanger 201 are provided in the indoor unit 200A.

[0079] Note that when the indoor units connected to the branching units 300A, 300B are employed as indoor units for multi unit use, there are times when a liquid line thermistor for detecting the temperature of the refrigerant that flows inside the liquid line piping is provided. In this situation, it is also possible to omit the liquid line thermistor inside the branching units 300A, 300B.

[Refrigeration circuit control system]

[0080] In the refrigeration circuit described above, when the refrigerant capacity of the indoor units is small (when the number of units operating is small, when the capacity of the indoor heat exchangers used by the indoor units operating is small, etc.), the discharge - intake bypass electric valve 142 is opened wide, a rise in the discharge pressure during heating operations is prevented, and freezing of the low pressure piping during cooling operations is prevented.

[0081] In addition, during heating operations, the overall system can be controlled with the liquid line electric valve 128 by controlling the opening and closing thereof when the gas line electric valve 129 is in the open state and there is surplus refrigerant in the receiver 121. During cooling operations, the liquid line electric valve 128 distinguishes between the presence or absence of surplus refrigerant, and controls the surplus refrigerant in the outdoor unit SC control.

[0082] Moreover, during heating operations, the gas line electric valve 129 stores surplus refrigerant in the receiver 121 by opening to a predetermined aperture when it is necessary to handle surplus refrigerant. During cooling operations, the gas line electric valve 129 controls the overall system by controlling the opening and closing thereof when the liquid line electric valve 128 is in the open state and there is surplus refrigerant in the receiver 121.

[Control during heating operations]

[0083] A working example during heating operations is shown in Fig. 12.

[0084] In Fig. 12, it is determined in Step S1 whether or not there is not surplus refrigerant in the refrigerant circuit, and whether or not there is no need to control capacity. When there is no surplus refrigerant in the refrigerant circuit, and no need to control capacity, the process moves to Step S2. In Step S2, the discharge - intake bypass electric valve 142 is placed in the fully closed state, the liquid line electric valve 128 is placed in the fully open state, and the gas line electric valve 129 is placed in the fully closed state.

[0085] As shown in Fig. 13, in the state in which there is no surplus refrigerant in the refrigerant circuit and there is no need for capacity control, it is possible for all of the connected indoor units 200A - 200F to operate.

[0086] In this situation, the outdoor heat exchanger 103 functions as a vaporizer, and each indoor heat exchanger 201 in each indoor unit functions as a condenser. The electric valves 305A - 305C, 305D - 305F that are inside the branching units 300A, 300B are constructed such that the apertures thereof are respectively controlled in accordance with the settings in each indoor unit, and refrigerant is distributed to each indoor heat exchanger 201. Here, the electric valve 308 used as a bypass is in the fully closed state.

[0087] Thus, the appropriate amount of refrigerant can be distributed to each indoor heat exchanger 201 by means of the electric valves 305A - 305C, 305D - 305F disposed inside the branching units 300A, 300B. Further, because surplus refrigerant is not produced in the circuit, the receiver 121 is placed in the non-operational state, and control of any of the discharge - intake bypass electric valve 142, the liquid line electric valve 128, and the gas line electric valve

128 is not required.

[0088] In Step S3, it is determined whether or not there is surplus refrigerant in the refrigerant circuit, and whether or not capacity control is unnecessary. When there is surplus refrigerant in the refrigerant circuit, and capacity control is unnecessary, the process moves to Step S4. At Step S4, the discharge - intake electric valve 142 is placed in the fully closed position, the gas line electric valve 129 is opened a fixed amount, and the liquid line electric valve 128 is controlled in response to the target discharge line temperature.

[0089] For example, as shown in Fig. 14, in situations when only the indoor units 200A - 200C connected to the branching units 300A operate, it is possible for the outdoor unit 100 to generate surplus refrigerant. In this situation, the refrigerant that was condensed by the auxiliary heat exchanger 133 by opening the gas line electric valve 129 a fixed amount, can be introduced and stored in the receiver 121. Because the refrigerant that passes through the gas line electric valve 129 is condensed by the auxiliary heat exchanger 133, the temperature thereof will not exceed the heat resistant temperature of a standard electric valve, and it becomes possible to select a gas line electric valve 129 that is inexpensive. In addition, by controlling the aperture of the liquid line electric valve 128 in response to the target discharge line temperature, the surplus refrigerant inside the receiver 121 can be adjusted, and the overall system can be controlled by controlling the intake superheating.

[0090] At Step S5, it is determined whether or not there is surplus refrigerant in the refrigerant circuit, and whether or not there is a need to control capacity. For example, when there is surplus refrigerant in the refrigerant circuit, and the peak-cut control is in the suspend zone even though the operational frequency of the compressor 101 is at the lower limit, it will be determined that that there is surplus refrigerant and that capacity control is necessary, and the process will move to Step S6.

[0091] At Step S6, the discharge - intake electric valve 142 is maintained in the closed state, and the aperture of the gas line electric valve 129 is controlled so that the peak-cut control remains stable in a no-change zone. In addition, the aperture of the liquid line electric valve 128 is controlled in response to the target discharge line temperature.

[0092] For example, as shown in Fig. 15, when, from amongst the indoor units 200 connected to the branching units 300A, 300B, only indoor unit 200C is operating, and this indoor unit 200C is a large capacity indoor unit, it is possible for this type of operational state to exist.

[0093] In this situation, the condensing capability of the auxiliary heat exchanger 133 is improved by opening the gas line electric valve 129, and the aperture of the gas line electric valve 129 is controlled so that the peak-cut control remains stable in a no-change zone. Because of this, refrigerant condensed via the auxiliary heat exchanger 133 is introduced into the receiver 121, surplus refrigerant is collected in the receiver 121, the high pressure refrigerant capacity is stabilized, and control of the operational frequency of the compressor 101 is stabilized in the no-change zone of the peak-cut control. In addition, because the gas line electric valve 129 is open, the control of the overall system (intake superheating control) occurs by adjusting the surplus refrigerant inside the receiver 121 by controlling the aperture of the liquid line valve 128 in response to the target discharge line temperature.

[0094] At Step S7, it is determined whether or not the peak-cut control is still in the suspend zone even though the gas line electric valve 129 is completely open. When the peak-cut control is in the suspend zone even though the number of operational cycles of the compressor 101 is below a lower limit, and the peak-cut control is still in the suspend zone even though the gas line electric valve 129 is completely open, then the process moves to Step S8.

[0095] At Step S8, the aperture of the discharge - intake bypass electric valve 142 is controlled so that the operational frequency of the compressor 101 remains stable in a no-change zone of the peak-cut control. At this time. the gas line electric valve 129 is in the fully open state, and the aperture of the liquid line electric valve 128 is controlled in response to the target discharge line temperature.

[0096] For example, as shown in Fig. 16, when, from amongst the indoor units 200 that are connected to the branching units 300A, 300B, only the indoor unit 200C is operating, and the capacity of this indoor unit 200C is small, despite the fact that the gas line electric valve 129 is completely open, it is possible for the peak-cut control to be in the suspend zone. In this situation, capacity control occurs by controlling the discharge - intake bypass electric valve 142, and stabilizing the operational frequency of the compressor 101 in the no-change zone of the peak-cut control. In addition, because the gas line electric valve 129 is open, the control of the overall system (intake superheating control) occurs by adjusting the surplus refrigerant inside the receiver 121 by controlling the aperture of the liquid line electric valve 128 in response to the target discharge line temperature.

[Control during cooling operations]

[0097] A working example during cooling operations is shown in Fig. 17.

[0098] In Fig. 17, it is determined at Step S11 whether or not there is surplus refrigerant in the refrigerant circuit, and whether or not capacity control is unnecessary. When it is determined that there is no surplus refrigerant in the refrigerant circuit, and that capacity control is not necessary, the process moves to Step S12. At Step S12, the discharge - intake bypass electric valve 142 is placed into the fully closed state, the gas line electric valve 129 is placed in the fully open

state, and the liquid line electric valve 128 for conducting SC control by means of the subcooling heat exchanger 134 is placed in the fully open state.

[0099] As shown in Fig. 18, in the state in which there is no surplus refrigerant in the refrigerant circuit, and capacity control is not necessary, it is possible for all of the connected indoor units 200A - 200F to be operating.

[0100] In this situation, the outdoor heat exchanger 103 functions as a condenser, and the indoor heat exchangers 201 in each indoor unit function as vaporizers. The electric valves 305A - 305C, 305D - 305F inside the branching units 300A, 300B are constructed such that each respective aperture thereof is controlled in accordance with the settings in each indoor unit, and refrigerant is distributed to each indoor heat exchanger 201. Here, the bypass electric valve 308 is placed in the fully open state.

[0101] Thus, refrigerant can be appropriately distributed to each indoor heat exchanger 201 by means of the electric valves 305A - 305C, 305D - 305F disposed inside the branching units 300A, 300B. Further, because surplus refrigerant is not generated inside the circuit, the receiver is placed into a non-operational state, and none of the discharge - intake bypass electric valve 142, liquid line electric valve 128, or the gas line electric valve 129 need be controlled.

[0102] In Step S13, it is determined whether or not there is surplus refrigerant in the refrigerant circuit, and whether or not capacity control is unnecessary. When it is determined that there is surplus refrigerant and capacity control is unnecessary, the process moves to Step S14. At Step S14, the discharge - intake bypass electric valve 142 is placed in the fully closed state, and the liquid line electric valve 128 is opened to a degree in which SC control by means of the subcooling heat exchanger 134 becomes possible (not fully open). Further, the aperture of the gas line electric valve 129 is controlled, and the overall system is controlled (intake superheating control), in order to place the discharge line temperature of the compressor 101 at the desired temperature.

[0103] For example, as shown in Fig. 19, when only the indoor units 200A - 200C connected to the branching unit 300A are operating, it is possible to generate surplus refrigerant by means of the outdoor device 100. In this case, surplus refrigerant can be introduced to and stored in the receiver 121 by opening the liquid line electric valve 128. In addition, by controlling the aperture of the gas line electric valve 129 to correspond with the target discharge line temperature, the surplus refrigerant inside the receiver 121 can be adjusted, and the overall system can be controlled due to the control of intake superheating.

[0104] As shown in Fig. 20, when, from amongst the connected indoor units 200, only the indoor unit 200C connected to the branching unit 300A is in the operational state, and this indoor unit 200C has a large capacity, the identical operational state is possible. In this case as well, the appropriate surplus refrigerant handling and system control is make possible by means of the identical control shown in Fig. 19.

[0105] In Step S15, it is determined whether or not there is surplus refrigerant in the refrigerant circuit, and whether or not capacity control is necessary. When it is determined that there is surplus refrigerant and capacity control is necessary, the process moves to Step S16. For example, when there are few indoor units operating, there is a surplus of refrigerant, and the freezing prevention control is in the suspend zone even though the operational frequency of the compressor 101 is at a lower limit, it is determined that capacity control is necessary and the process moves to Step S16.

[0106] At Step S16, the aperture of the discharge - intake bypass electric valve 142 is controlled so that control of the number of cycles of the compressor 101 stabilizes in an antifreeze control no-change zone. At this time, the aperture of the liquid line electric valve 128 is controlled (not fully opened) in order to handle the surplus refrigerant from the liquid line piping 131, and the liquid refrigerant is stored in the receiver 121. In addition, because the liquid line electric valve 128 is open, the amount of refrigerant inside the receiver 121 is adjusted by controlling the aperture of the gas line electric valve 129 to correspond with the target discharge line temperature, thereby controlling the overall system.

[0107] This type of operational state, for example, as shown in Fig. 21, will be attained when, from amongst the connected indoor units 200C, only the indoor unit 200C is in the operational state, and this indoor unit 200C has a small capacity. The aperture of the electric valve 305C corresponding to the indoor heat exchanger 201 of the operational indoor unit is controlled in response to the indoor temperature setting and the like, and the other electric valves 305A, 305B, and the electric valves 305D - 305F inside the branching unit 300B, are placed in the closed state. In this state, the aperture of the discharge - intake bypass electric valve 142 can be controlled, the number of cycles of the compressor 101 can be stabilized, surplus refrigerant can be handled by adjusting the aperture of the liquid line electric valve 128, and the overall system can be controlled by adjusting the aperture of the gas line electric valve 129.

[0108] At Step S17, it is determined whether or not the outside air temperature is lower than a predetermined temperature. When the outside air temperature is below a predetermined temperature, and when the liquid line electric valve 128 is placed in the fully closed state, there is a danger that the pressure inside the receiver 121 will become lower than the intake pressure of the compressor 101, and the liquid refrigerant stored in the receiver 121 will not be able to drain out. In this situation, there is a danger that a refrigerant shortage will occur in the refrigerant circuit. Thus, when it is determined that this state will be created and that the outside air temperature is lower than a predetermined temperature, the process moves to Step S18.

[0109] At Step S18, the pressure inside the receiver 121 is made higher than the pressure inside the gas line piping 132 by opening the aperture of the liquid line electric valve 128 to a predetermined degree, and the liquid refrigerant

inside the receiver 121 is discharged into the auxiliary heat exchanger 133. Further, because the liquid line electric valve 128 is open, by controlling the aperture of the gas line electric valve 129, the target discharge line temperature can be controlled, and the overall system can be controlled. Moreover, the intake pressure of the compressor 101 can be increased by controlling the discharge - intake bypass electric valve 142 in order to prevent freezing.

[0110] As shown in Fig. 22, even during times in which, from amongst the connected indoor units 200, only the indoor unit 200C is operating, when the outside air temperature is low, surplus refrigerant will not be generated. In this type of situation, it is possible for the liquid line electric valve 128 to be placed in the fully closed state, and liquid refrigerant not to be introduced into the receiver 121. However, when the liquid line electric valve 128 is placed in the fully closed state, the temporarily accumulated liquid refrigerant cannot be drained out. Thus, liquid refrigerant can be discharged to the auxiliary heat exchanger 133, and the overall system can be controlled, by opening the aperture of the liquid line electric valve 128 to a predetermined degree and controlling the aperture of the gas line electric valve 129.

[0111] With regard to the antifreeze control, by controlling the aperture of the discharge - intake bypass electric valve 142, the indoor unit vaporization temperature is stably controlled in a no-change antifreeze control area.

[Operational control during defrosting]

[0112] When the outside air temperatures are low during the winter, there is a possibility that the outdoor heat exchanger 103 of the outdoor device 100 will freeze. In this situation, a defrost operation can be performed following cooling operations, and the outdoor heat exchanger 103 can be thawed out.

[0113] Normally, as shown in Fig. 18, the discharge - intake bypass electric valve 142 is placed in the fully closed state, the liquid line electric valve 128 is placed in the fully closed state, the gas line electric valve is placed in the fully opened state, the outside heat exchanger 103 is made to function as a condenser, and defrost operations take place. When the defrost operation has run for a fixed period of time, the outdoor heat exchanger 103 is presumed to be thawed out, and the defrost operation ends. Heating operations will occur following this type of defrost operation, because defrost operations generally occur in the wintertime.

[0114] In defrost operations, liquid refrigerant returns to the accumulator 105 because the ventilation fan inside the indoor unit 200 stops, and because the indoor heat exchanger 201 is not made to function as a vaporizer at the maximum level. In other words, the liquid refrigerant accumulates and backs up. Thus, after the completion of this type of defrost operation, it is difficult to promptly start heating operations, and the startup capabilities of the heater worsen.

[0115] Because of this, the liquid line electric valve 128 is opened, and the aperture of the gas line electric valve 129 is controlled so that the amount of refrigerant that the compressor 101 takes in is equivalent thereto. Because of this, liquid refrigerant can be introduced to and stored in the receiver 121, and will not accumulate and back up in the accumulator 105. Thus, the startup capabilities of the heater after the completion of defrost operations can be improved.

[Target discharge line temperature control]

[0116] As shown with the fourth to ninth embodiments, when the gas line electric valve 129 is provided in the gas line connector 123 of the receiver 121, by controlling the opening and closing of the gas line electric valve 129, the surplus refrigerant in the receiver 121 that is injected back into the compressor 101 as a liquid can be adjusted. In this way, the discharge line temperature can be controlled. Further, when the liquid line electric valve 128 is provided in the liquid line connector 122 of the receiver, and the gas line electric valve 129 is provided in the gas line connector 123 of the receiver, during both cooling and heating, the amount of liquid refrigerant injected from the receiver 121 to the compressor 101 can be adjusted, and operational efficiency can be improved.

[0117] Control of the target discharge line temperature will now be described in detail.

[0118] The target discharge line temperature is determined from the indoor heat exchanger temperature and the outdoor heat exchanger temperature, and the apertures of the liquid line electric valve 128 and the gas line electric valve 129 are adjusted so that the actual discharge line temperature comes close to the target discharge line temperature.

[0119] For example, if we assume that the target discharge line temperature = α x condenser temperature - β x vaporizer temperature + γ, then the amount of adjustment in the liquid line electric valve 128 and the gas line electric valve 129 can be determined, and each electric valve can be driven, from a table that corresponds the deviation between the target discharge line temperature and the actual discharge line temperature with the amount of change in the discharge temperature per unit of time. Here, the table that corresponds the deviation between the target discharge line temperature and the actual discharge line with the amount of change in the discharge temperature per unit of time can be a fuzzy table.

[0120] In fact, because the fluctuation in the condenser temperature and the vaporizer temperature is large due to disturbances, by using the average value of the previous target discharge line temperature and the current target discharge line temperature, fluctuation in the target discharge line temperature can be minimized.

[0121] An example of the control of the target discharge line temperature by controlling the apertures of the liquid line

electric valve 128 and the gas line electric valve 129 connected to the receiver 121 of the outside unit 100 will be described based upon the flow charts shown in Figs. 23 and 24.

[0122] In Step S21, it is determined whether or not control condition ① is satisfied in order to begin target discharge line temperature control by means of the outside electric valves.

-BEGIN control condition ① determination flow

[0123] Control condition ① is determined based upon the flow chart shown in Fig. 25.

[0124] At Step S41, it is determined whether or not the air conditioner is operating normally. If the air conditioner is in normal cooling operations or normal heating operations, then the process moves to Step S44, and if not, then the process moves to Step S42.

[0125] At Step S42, it is determined whether or not the air conditioner is in a test mode. When the air conditioner is in cooling test operation or in heating test operation, the process moves to Step S44, and if not, the process moves to Step S43.

[0126] At Step S43, it is determined whether or not the air conditioner is in defrost preheating operation. When the air conditioner is in defrost preheating operation, the process moves to Step S44, and if not, the process moves to Step S49.

[0127] At Step S44, it is determined whether or not the electric valves 305 inside the branching unit 300 are being controlled when the room in which heating or cooling is occurring changes. When the electric valves 305 inside each branching unit 300 are being controlled when the room in which heating or cooling is taking place is changed immediately after any of the indoor units 200 begin operating, or immediately after any of the indoor units 200 cease operation, then the process moves to Step S49, and if not, the process moves to Step S45.

[0128] At Step S45, it is determined whether or not control is occurring during a change in the operational frequency. When the air conditioning load changes in the indoor units 200 during operation, and when control is occurring during a change in the number of operational cycles of the compressor 101, the process moves to Step S49, and if not, the process moves to Step S46.

[0129] At Step S46, it is determined whether or not discharge line high temperature control is occurring. When the discharge temperature of the compressor 100 is above a predetermined temperature, the apertures of the liquid line valve 128 and the gas line valve 129 open a fixed amount, and discharge line high temperature control occurs such that the liquid refrigerant inside the receiver 121 backs up into the accumulator 103. When this type of discharge line high temperature control occurs, the process moves to Step S49, and if it does not, the process moves to Step S47.

[0130] As Step S47, it is determined whether or not discharge line thermistor removal control is occurring. In situations in which the discharge temperature detected by the discharge line thermistor 109 does not rise above a predetermined temperature, even though the air conditioner runs for a fixed period of time from startup, there is a possibility that the discharge line thermistor 109 has been removed, or that it is due to environmental conditions, such as the outside air temperature being unusually cold. When the latter is true, because it is not necessary to take the system down and inspect it, the discharge temperature will be estimated from other temperature sensors and the like, a test operation will be run, and it will be confirmed that the discharge line thermistor 109 has in fact not been removed. When this operational control instigates the discharge line thermistor omission control, and this discharge line thermistor removal control occurs, the process moves to Step S49. If not, the process moves to Step S48.

[0131] At Step S48, the apertures of the electric valves 128, 129 inside the outdoor device 100 are controlled, the target discharge line temperature control mode is set, and at Step S49, a mode in which this control does not occur is set.

-END Control condition ① determination flow-

[0132] At Step S21, when control condition ① is satisfied, and the target discharge line temperature control mode has been set by means of the outdoor unit electric valves, the process moves to Step S23. When the mode in which this control does not occur is set, the process moves to Step S22.

[0133] At Step S22, a flag that shows whether or not a sampling timer has started for the first time is set initially to be on, and the process returns to the overall control main routine.

[0134] In Step S23, the sampling timer is started. This sampling timer counts the sampling timing of the discharge line temperature data in order to control the discharge line temperature. At Step S24, it is determined whether or not the sampling time counted exceeds a predetermined sampling time TTHS1. This sampling time TTHS1 can be set in a range between 0 to 255 x 100 msec. For example, it can be set at 20 seconds.

[0135] In Step S24, when it is determined that the count value of the sampling timer exceeds the sampling time TTHS1, the process moves to Step S25. At Step S25, the target discharge line temperature DOSET is determined.

-BEGIN Target discharge temperature DOSET-

[0136] At the time the target discharge temperature DOSET is determined, as described above, the average value of the previous target discharge line temperature and the current target discharge line temperature is used (temporary target discharge line temperature) in order to minimize fluctuations due to disturbances. The method of determining the temporary target discharge line temperature DOSETN is shown in Fig. 26 and 27.

--BEGIN Temporary target discharge line temperature DOSETN during cooling operations--

[0137] First, the determination of the temporary discharge line temperature DOSETN during cooling operations can be performed by means of the flow chart in Fig. 26.

[0138] At Step S51, it is determined whether or not the desired operational frequency FMK for the compressor 101 exceeds a condensing temperature correction coefficient switching frequency FEVFDC for calculating the target discharge line temperature during cooling operations. When the desired frequency FMK > FEVFDC, then the process moves to Step S52. If not, the process moves to Step S53.

[0139] At Step S52, a condensing temperature correction coefficient KEVFD is set to be a condensing temperature correction coefficient KEVFDC for calculating the target discharge line temperature during high frequency cooling. At Step S53, the condensing temperature correction coefficient KEVFDC is set to be a condensing temperature correction coefficient KEVFDC1 for calculating the target discharge line temperature during low frequency cooling.

[0140] At Step S54, it is determined whether or not the lowest temperature of a indoor heat exchanger operating in a room DCMNU is equal to or above a vaporizing temperature threshold for calculating the target discharge line temperature during cooling DZC. When the lowest temperature of a indoor heat exchanger operating in a room DCMNU is equal to or above the vaporizing temperature threshold for calculating the target discharge line temperature during cooling DZC, the process moves to Step S55. If not, the process moves to Step S56.

[0141] At Step S55, the lowest temperature of a indoor heat exchanger operating in a room DCMNU is set as a vaporizing temperature DZ. At Step S56, the current vaporizing temperature DZ is set to be the vaporizing temperature threshold for calculating the target discharge line temperature DZC.

[0142] At Step S57, based on the number of indoor units 200 currently operating, intercept points DSHC are established for calculating the target discharge line temperature during cooling. An intercept point DSHC1 for use when one room is being cooled, an intercept point DSHC2 for use when two rooms are being cooled, and an intercept point DSHC3 for use when three rooms are being cooled, are established in predetermined memory regions. Any of these values are set as the value of DSHC in accordance with the operating conditions at the time.

[0143] At Step S58, it is determined whether or not the aperture EVP of the discharge - intake electric valve 142 is equal to or greater than a predetermined value EVPMIN. When the aperture EVP of the discharge - intake electric valve 142 is equal to or greater than the predetermined value EVPMIN, then the process moves to Step S59, and if not, the process moves to Step S60.

[0144] At Step S59, a target discharge line temperature correction value DEVP is set to be a target discharge line temperature value during cooling operations capacity control DEVPC. At Step S60, the value of the target discharge line temperature correction value DEVP is set to zero.

[0145] At Step S61, the value of the temporary target discharge line temperature DOSETN is calculated from the condensing temperature correction coefficient for calculating the target discharge line temperature KEVFD, the outdoor heat exchanger temperature DE, a vaporizing temperature correction coefficient for calculating the target discharge line temperature during cooling KEVFDEC, the minimum indoor heat exchanger temperature (vaporizing temperature) DZ, the intercept points for calculating the target discharge line temperature during cooling DSHC, and the target discharge line temperature correction value DEVP. Here, DOSETN = KEVFD x DE - KEVFDEC x DZ + DSHC - DEVP.

--END Temporary target discharge line temperature during cooling operations DOSTN--

--BEGIN Temporary target discharge line temperature during heating operations DOSETN--

[0146] Next, the method of calculating a temporary target discharge line temperature during heating operations DOSETN will be described based upon the flow chart in Fig. 27.

[0147] At Step S71, it is determined whether or not a desired operational frequency FMK for the compressor 101 exceeds a condensing temperature correction coefficient switching frequency for calculating the target discharge line temperature during heating operations FEVFDW. When the desired frequency FMK > FEVFDW, then the process moves to Step S72. If not, the process moves to Step S73.

[0148] At Step S72, a condensing temperature correction coefficient KEVFD is set to be a condensing temperature correction coefficient for calculating the target discharge line temperature during high frequency heating KEVFDW. At

Step S73, the condensing temperature correction coefficient KEVFD is set to be a condensing temperature correction coefficient for calculating the target discharge line temperature during low frequency heating KEVFDW1.

[0149] At Step S74, it is determined whether or not the outdoor heat exchanger temperature DE is equal to or above a vaporizing temperature threshold for calculating the target discharge line temperature during heating DZW. When the outdoor heat exchanger temperature DE is equal to or above the vaporizing temperature threshold for calculating the target discharge line temperature during heating DZW, the process moves to Step S75. If not, the process moves to Step S76.

[0150] At Step S75, the lowest temperature of a indoor heat exchanger operating in a room DCMNU is set as a vaporizing temperature DZ. At Step S76, the vaporizing temperature DZ is set to be the vaporizing temperature threshold for calculating the target discharge line temperature during heating DZW.

[0151] At Step S77, based on outdoor temperature DOA, an intercept point for calculating the target discharge line temperature during heating DSHW is established. When the outdoor temperature DOA is smaller than an intercept point switching outside air temperature for calculating the target discharge line temperature during low temperature heating DOASH1, the intercept point for calculating the target discharge line temperature during heating DSHW is set as the intercept point for calculating the target discharge line temperature during low temperature heating DSHW1. When the outdoor temperature DOA is equal to or greater than the intercept point switching outside air temperature for calculating the target discharge line temperature during low temperature heating DOASH1, and the outdoor temperature DOA is under an intercept point switching outside air temperature for calculating the target discharge line temperature during high temperature heating DOASH2, the value of the intercept point for calculating the target discharge line temperature during heating DSHW is set to be an intercept point for calculating the target discharge line temperature during moderate temperature heating DSHW2. When the outdoor temperature DOA is equal to or greater than the intercept point switching outside air temperature for calculating the target discharge line temperature during high temperature heating DOASH2, the value of the intercept point for calculating the target discharge line temperature during heating DSHW is set to be an intercept point for calculating the target discharge line temperature during high temperature heating DSHW3.

[0152] At Step S78, it is determined whether or not the aperture EVP of the discharge - intake electric valve 142 is equal to or greater than a predetermined value EVPMIN. When the aperture EVP of the discharge - intake electric valve 142 is equal to or greater than the predetermined value EVPMIN, then the process moves to Step S79, and if not, the process moves to Step S80.

[0153] At Step S79, a target discharge line temperature correction value DEVP is set to be a target discharge line temperature value during heating operations capacity control DEVPW. At Step S80, the value of the target discharge line temperature correction value DEVP is set to zero.

[0154] At Step S81, the value of the temporary target discharge line temperature DOSETN is calculated from the condensing temperature correction coefficient for calculating the target discharge line temperature KEVFD, the maximum indoor heat exchanger temperature DCMXT, a vaporizing temperature correction coefficient for calculating the target discharge line temperature during heating KEVFDEW, the vaporizing temperature DZ, the intercept point for calculating the target discharge line temperature during heating DSHC, and the target discharge line temperature correction value DEVP. Here, DOSETN = KEVFD x DCMXT - KEVFDEW x DZ + DSHW - DEVP.

--END Temporary target discharge line temperature during heating operations DOSETN-

[0155] After the temporary discharge line temperature DOSETN is determined by the method shown in the flow charts in Fig. 26 and Fig. 27, another method of calculating the target discharge line temperature DOSET is shown in Fig. 28.

[0156] At Step S91, it is determined whether or not the first time flag is on. Because a target discharge line temperature control mode is set by the outdoor unit electric valves, the first time flag indicates the first time the value of the sampling timer has exceeded the sampling time TTHS1. When the first time flag is on, the process moves to Step S92, and when it is not, the process moves to Step S93.

[0157] At Step S92, the target discharge line temperature DOSET is set as the temporary target discharge line temperature DOSETN. In addition, the previous target discharge line temperature DOSETZ is set as the temporary target discharge line temperature.

DOSET = DOSETN

DOSETZ = DOSETN

[0158] At Step S93, the average of the temporary target discharge line temperature DOSETN and the previous target discharge line temperature DOSETZ is calculated, and the target discharge line temperature DOSET is set to this value. In addition, the previous target discharge line temperature DOSETZ is set to the temporary target discharge line temperature.

$$DOSET = (DOSETN + DOSETZ) / 2$$

$$DOSETZ = DOSETN$$

[0159] Note that in each operational mode, the largest and smallest values for the discharge line temperature during normal operations are considered, and are set as the upper and lower limits for the target discharge line temperature DOSETN. As described above, the target discharge line temperature DOSET requested is controlled so as to be within these upper and lower limits.

-END Target discharge line temperature DOSET-

[0160] At Step S26, the current discharge line temperature DO is detected. The current discharge line temperature DO can be detected by reading the discharge line temperature thermistor 109. At Step S27, the variation in the discharge line temperature EDO is calculated. Here, the discharge line temperature variation EDO = the target discharge line temperature DOSET - the discharge line temperature DO. As Step S28, amount of change in the discharge line temperature dDO is calculated. Here, the amount of change in the discharge line temperature = the previous discharge line temperature DOZ - the current discharge line temperature DO.

[0161] At Step S29, the discharge line temperature EDO and amount of change in the discharge line temperature dDO is used to search the fuzzy table, and the value for the amount of change in the electric valves PEVHN is determined.

[0162] As Step S32, it is determined whether or not the air conditioner is in cooling operation mode. When the air conditioner is in cooling operation mode, the process moves to Step S33, and if not, the process moves to Step S34. At Step S33, the amount of change in the electric valves PEVHN is corrected by means of a cooling correction coefficient KPOTD.

PEVHN = KPOTD x PEVHN

[0163] At Step S34, the electric valve cumulative pulse PHNA is calculated based upon the amount of change in the electric valves PEVHN.

PHNA = PHNA + PEVHN

[0164] At Step S35, an integral part and fractional part of the electric valve cumulative pulse PHNA are each calculated, with the integral part set as PHN and the fractional part set as PHNA.

[0165] As Step S36, it is determined whether or not the control condition ② has been satisfied.

-BEGIN Control condition ②-

[0166] As Step S101, it is determined whether or not the operational mode is set to cooling operations. When the operational mode is set to cooling operations, the process moves to Step S102, and if not, the process proceeds in the direction of D (Step S37 of Fig. 4).

[0167] At Step S102, it is determined whether or not an indicator signal has been received from the connected branching unit 300 that indicates that the apertures of the electric valves 305 are at a minimum, which corresponds to the air conditioning in all rooms being halted. When an indicator signal has been received from the connected branching unit 300 that indicates that the apertures of the electric valves 305 are at a minimum, which corresponds to the air conditioning in all rooms being halted, the process proceeds in the direction of C (Step S38 of Fig. 24). When the conditions of Step S102 are not fulfilled, then the process moves to Step S103.

[0168] At Step S103, it is determined whether or not a gas line electric valve aperture EVG is equal to or larger than a predetermined valve EVGMIN. When the gas line electric valve aperture EVG is equal to or larger than the predetermined valve EVGMIN, the process proceeds in the direction of C (Step S38 of Fig. 24), and if not, it proceeds in the direction of D (Step S37 of Fig. 24).

-END Control condition ②-

[0169] As Step S37, the desired apertures of the electric valves are changed. When in the cooling operation mode, the gas line electric valve aperture EVG = EVG - an electric valve change pulse PHN, and when in the heating operation mode, the liquid line electric valve aperture EVL = EVL - PHN.

[0170] At Step S38, the desired aperture of the gas line electric valve is changed. Here, the gas line electric valve aperture EVG = EVG + the electric valve change pulse PHN.

[0171] At Step S39, the first time flag is placed in the off state, the sampling timer is reset, and the process moves to Step S21.

[0172] In this way, it becomes possible to continuously control the liquid injection amount, and the appropriate discharge line temperature of the compressor 101 can be set by controlling the apertures of the liquid line electric valve 128 and the gas line electric valve 129 connected to the receiver 121. In particular, by controlling not only the gas line electric valve 129, but also the liquid line electric valve 128, the liquid injection amount can be appropriately controlled during not only cooling but also during heating, and it becomes possible to increase reliability and operational efficiency regardless of the operational mode.

INDUSTRIAL APPLICABILITY

[0173] In the air conditioner refrigerant circuit according to the present invention, a refrigerant circuit can be provided that minimizes the occurrence of refrigerant high-low drift even though a plurality of indoor units are placed in different vertical intervals, and in which cost reductions can be provided.

[0174] In addition, with the air conditioner of the present invention, by controlling the refrigerant opening and closing means connected to the receiver, the discharge line temperature of the compressor can be controlled, and reliability and operational efficiency can be improved.

Embodiments of the Invention

Further embodiments are listed below:

[0175]

1. An air conditioner refrigerant circuit having an outdoor unit refrigerant circuit that includes a compressor (101), a four way directional control valve (102), and an outdoor heat exchanger (103) that are disposed inside an outdoor unit (100), and an indoor heat exchanger (201) disposed inside an indoor unit (200), connected thereto by means of liquid line piping and gas line piping, the air conditioner refrigerant circuit comprising:

    a bypass circuit that is provided to bypass said liquid line piping (131) and said gas line piping (132); and
    a liquid receiving circuit (121, 128, 129) that is provided in said bypass circuit and collects liquid refrigerant.

2. The air conditioning refrigerant circuit according to
1, further comprising a liquid line shut off valve (116) and a gas line shut off valve (117) disposed inside said outdoor unit (100) and provided between said outdoor unit refrigerant circuit and said indoor unit heat exchanger (201);
wherein said bypass circuit is provided between said gas line piping (132) between said four way directional control valve (102) and said gas line shut off valve (117), and said liquid line piping (131) between said heat exchanger (103) and said liquid line shut off valve (116); and
said liquid receiving circuit is comprised of a receiver (121) that is provided in said bypass circuit and collects liquid refrigerant, and refrigerant opening and closing means (124, 125, 126, 127, 128, and 129) that are provided in said liquid line connector (122) that connects said receiver (121) to said liquid line piping (131) and a gas line connector (123) that connects said receiver (121) to said gas line connector (132).

3. The air conditioner refrigerant circuit according to
2, wherein said refrigerant opening and closing means (124, 125) is a functional component that is capable of decompressing refrigerant.

4. The air conditioner refrigerant circuit according to
3, wherein said refrigerant opening and closing means (124, 125) are electric valves or capillaries.

5. The air conditioner refrigerant circuit according to
2, wherein said refrigerant opening and closing means (126, 127) are functional components that are capable of shutting off the flow of refrigerant.

6. The air conditioner refrigerant circuit according to
5, wherein said refrigerant opening and closing means (126, 127) are selected from the group consisting of electric valves, magnetic valves, and check valves.

7. The air conditioner refrigerant circuit according to
2, wherein said refrigerant opening and closing means (128, 129) function to decompress the refrigerant and shut off the flow of the refrigerant.

8. The air conditioner refrigerant circuit according to
7, wherein said refrigerant opening and closing means (128, 129) are a combination of an electric valve or capillary and a magnetic valve.

9. The air conditioner refrigerant circuit according to any of 1-8, further comprising a gas recovery capillary (130)

that is interposed between said gas line piping (132) between said four way directional control valve (102) and said gas line, and said receiver (121).

10. The air conditioner refrigerant circuit according to any of 1-9, further comprising an auxiliary heat exchanger (133) interposed between said refrigerant opening and closing means (129) provided in said gas line connector (123) of said receiver (121), and said gas line piping (132) in between said four way directional control valve (102) and said gas line shut off valve (117).

11. The air conditioner refrigerant circuit according to
10, wherein said refrigerant opening and closing means (129) provided in said gas line connector (123) of said receiver (121) is a decompression circuit that employs an electric valve.

12. The air conditioner refrigerant circuit according to
10 or 11, wherein said auxiliary heat exchanger (133) is provided in the lower portion of said outdoor heat exchanger (103).

13. The air conditioner refrigerant circuit according to
12, wherein said outdoor heat exchanger (103) comprises a subcooling heat exchanger (134) positioned on the liquid line, and disposed adjacent to said auxiliary heat exchanger (133) and said subcooling heat exchanger (134).

14. The air conditioner refrigerant circuit according to
13, wherein said auxiliary heat exchanger (133) is disposed upwind of said subcooling heat exchanger (134).

15. The air conditioner refrigerant circuit according to
1 to 14, wherein a decompression circuit (305) is disposed in the liquid line piping between said outdoor refrigerant circuit and said indoor heat exchanger (201).

16. The air conditioner refrigerant circuit according to
15, wherein said decompression circuit (305) is comprised of partial pressure electric valves that correspond to a plurality of connected indoor units (200).

17. The air conditioner refrigerant circuit according to
16, wherein said compression circuit (305) is provided inside said refrigerant branching unit (300) disposed between said outdoor unit refrigerant circuit and said indoor heat exchanger (201).

18. An air conditioner comprising a refrigeration circuit that includes:

an outdoor unit refrigerant circuit that includes a compressor (101), a four way directional control valve (102) and an outdoor heat exchanger (103) each disposed inside an outdoor unit (100);
an indoor heat exchanger (201) disposed inside an indoor unit (200) connected to said outdoor refrigerant circuit via liquid line piping (131) and gas line piping (132);
a receiver (121) that is disposed in a bypass circuit that bypasses said liquid line piping (131) and said gas line piping (132) and collects surplus refrigerant in a refrigerant circuit; and
refrigerant opening and closing means (124, 125, 126, 127, 128, and 129) that are disposed in a liquid line connector (122) that connects said receiver (121) to said liquid line piping (131), and a gas line connector (123) that connects said receiver (121) to said gas line piping (132);
wherein said air conditioner controls a discharge line temperature of said compressor (101) at a predetermined value by controlling the opening and closing of said refrigerant opening and closing means (124, 125, 126, 127, 128, and 129).

19. The air conditioner according to 18, wherein said refrigerant opening and closing means (129) provided in said gas line connector (123) of said receiver (121) is a decompression circuit that employs an electric valve.

Claims

1. An air conditioner refrigerant circuit having an outdoor unit refrigerant circuit that includes a compressor (101), a four way directional control valve (102), and an outdoor heat exchanger (103) that are disposed inside an outdoor unit (100), and an indoor heat exchanger (201) disposed inside an indoor unit (200), connected thereto by means of liquid line piping and gas line piping, the air conditioner refrigerant circuit comprising:

a bypass circuit that is provided to bypass said liquid line piping (131) and said gas line piping (132); and
a liquid receiving circuit (121, 128, 129) that is provided in said bypass circuit and collects liquid refrigerant, said liquid receiving circuit having a receiver (121) **characterized in that**
a gas recovery capillary (130) is connected to said gas line piping (132), between said four way directional control valve (102) and a gas line shut off valve (117), and said receiver (121).

2. The air conditioning refrigerant circuit according to Claim 1, further comprising a liquid line shut off valve (116), which as said gas line shut off valve (117) is disposed inside said outdoor unit (100) and provided between said outdoor unit refrigerant circuit and said indoor unit heat exchanger (201);
wherein said bypass circuit is provided between said gas line piping (132) between said four way directional control valve (102) and said gas line shut off valve (117), and said liquid line piping (131) between said heat exchanger (103) and said liquid line shut off valve (116); and
said liquid receiving circuit is comprised of a receiver (121) that is provided in said bypass circuit and collects liquid refrigerant, and refrigerant opening and closing means (128, 129) that are provided in said liquid line connector (122) that connects said receiver (121) to said liquid line piping (131) and a gas line connector (123) that connects said receiver (121) to said gas line connector (132).

3. The air conditioner refrigerant circuit according to Claim 2, wherein said refrigerant opening and closing means (128, 129) function to decompress the refrigerant and shut off the flow of the refrigerant.

4. The air conditioner refrigerant circuit according to Claim 3, wherein said refrigerant opening and closing means (128, 129) are a combination of an electric valve or capillary and a magnetic valve.

5. The air conditioner refrigerant circuit according to any of Claims 1-4, further comprising an auxiliary heat exchanger (133) interposed between said refrigerant opening and closing means (129) provided in said gas line connector (123) of said receiver (121), and said gas line piping (132) in between said four way directional control valve (102) and said gas line shut off valve (117).

6. The air conditioner refrigerant circuit according to Claim 5, wherein said refrigerant opening and closing means (129) provided in said gas line connector (123) of said receiver (121) is a decompression circuit that employs an electric valve.

7. The air conditioner refrigerant circuit according to Claims 5 or 6, wherein said auxiliary heat exchanger (133) is provided in the lower portion of said outdoor heat exchanger (103).

8. The air conditioner refrigerant circuit according to Claim 7, wherein said outdoor heat exchanger (103) comprises a subcooling heat exchanger (134) positioned on the liquid line, and disposed adjacent to said auxiliary heat exchanger (133) and said subcooling heat exchanger (134).

9. The air conditioner refrigerant circuit according to Claim 8, wherein said auxiliary heat exchanger (133) is disposed upwind of said subcooling heat exchanger (134).

10. The air conditioner refrigerant circuit according to Claims 1 to 9, wherein a decompression circuit (305) is disposed in the liquid line piping between said outdoor refrigerant circuit and said indoor heat exchanger (201).

11. The air conditioner refrigerant circuit according to Claim 10, wherein said decompression circuit (305) is comprised of partial pressure electric valves that correspond to a plurality of connected indoor units (200).

12. The air conditioner refrigerant circuit according to Claim 11, wherein said compression circuit (305) is provided inside said refrigerant branching unit (300) disposed between said outdoor unit refrigerant circuit and said indoor heat exchanger (201).

Fig. 1

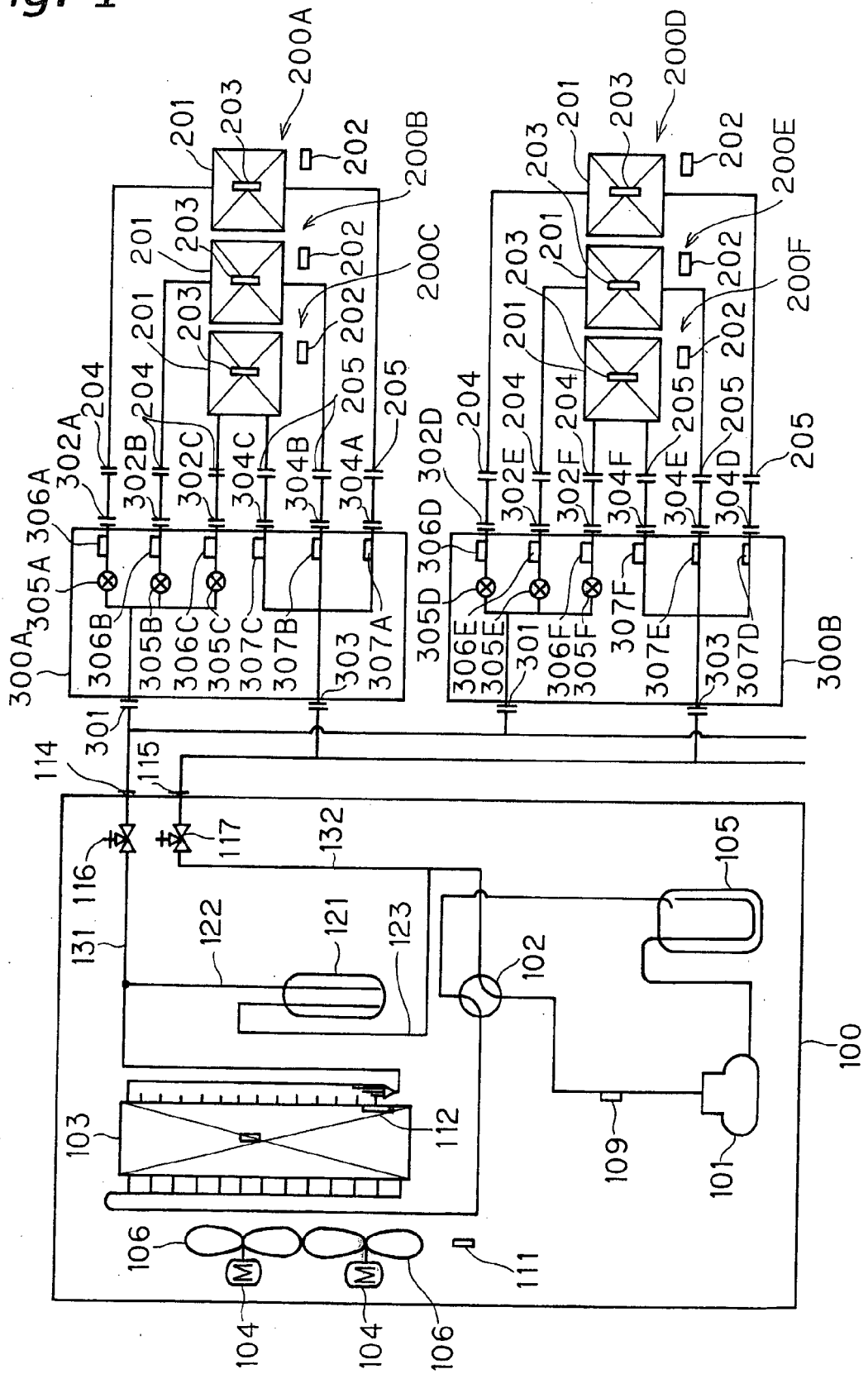

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Fig. 2

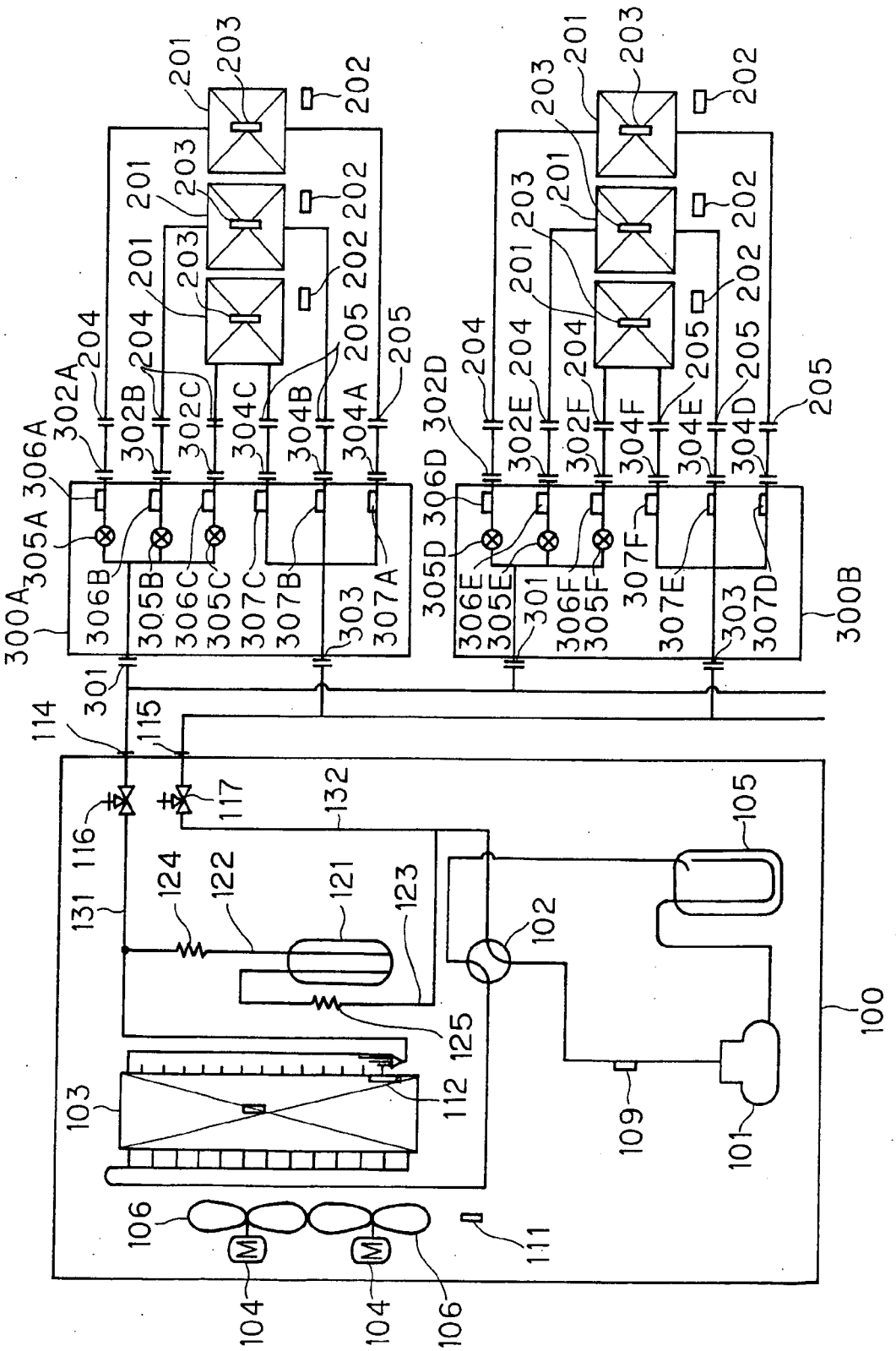
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Fig. 3

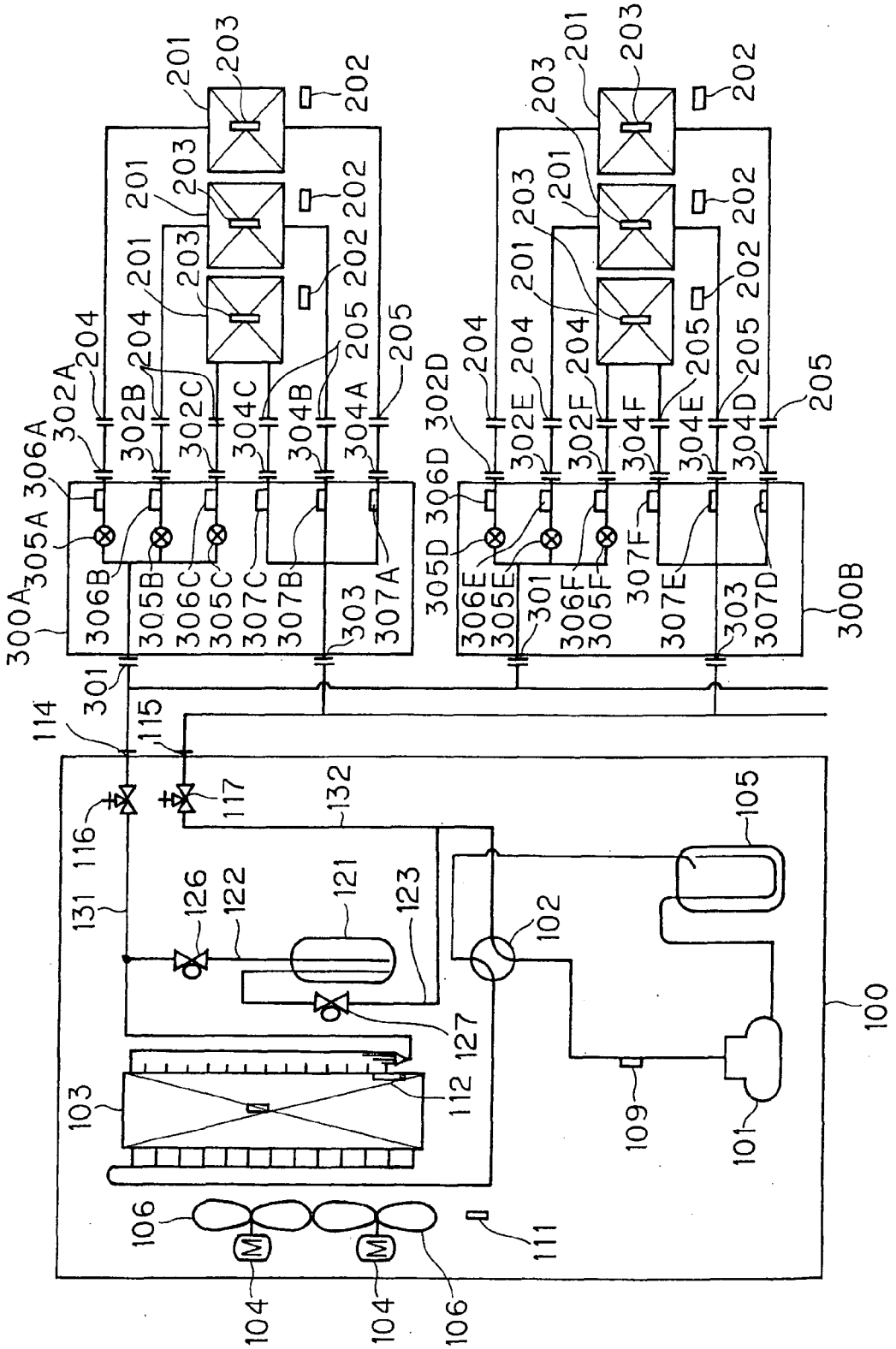
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Fig. 4

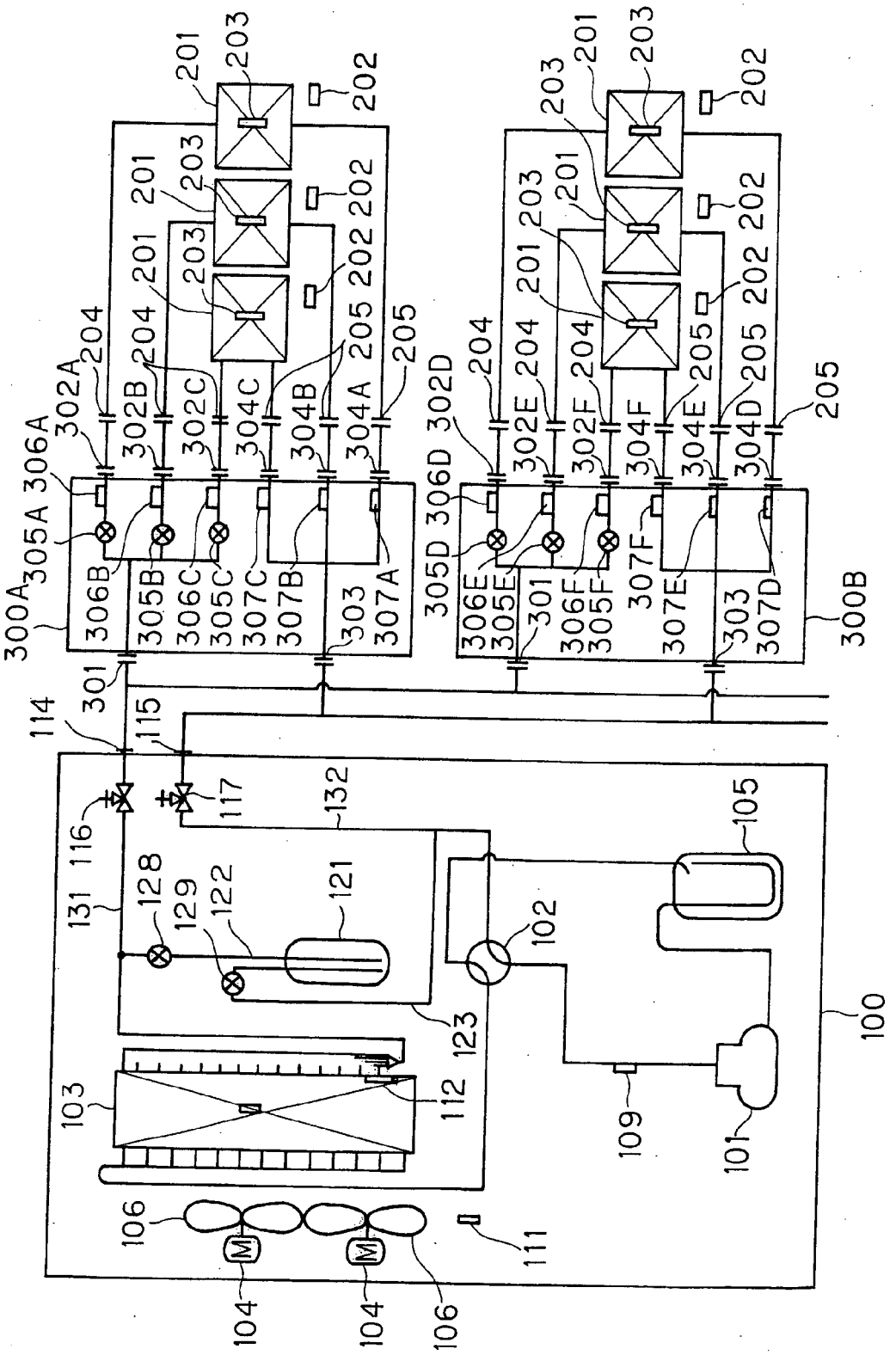
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Fig. 5

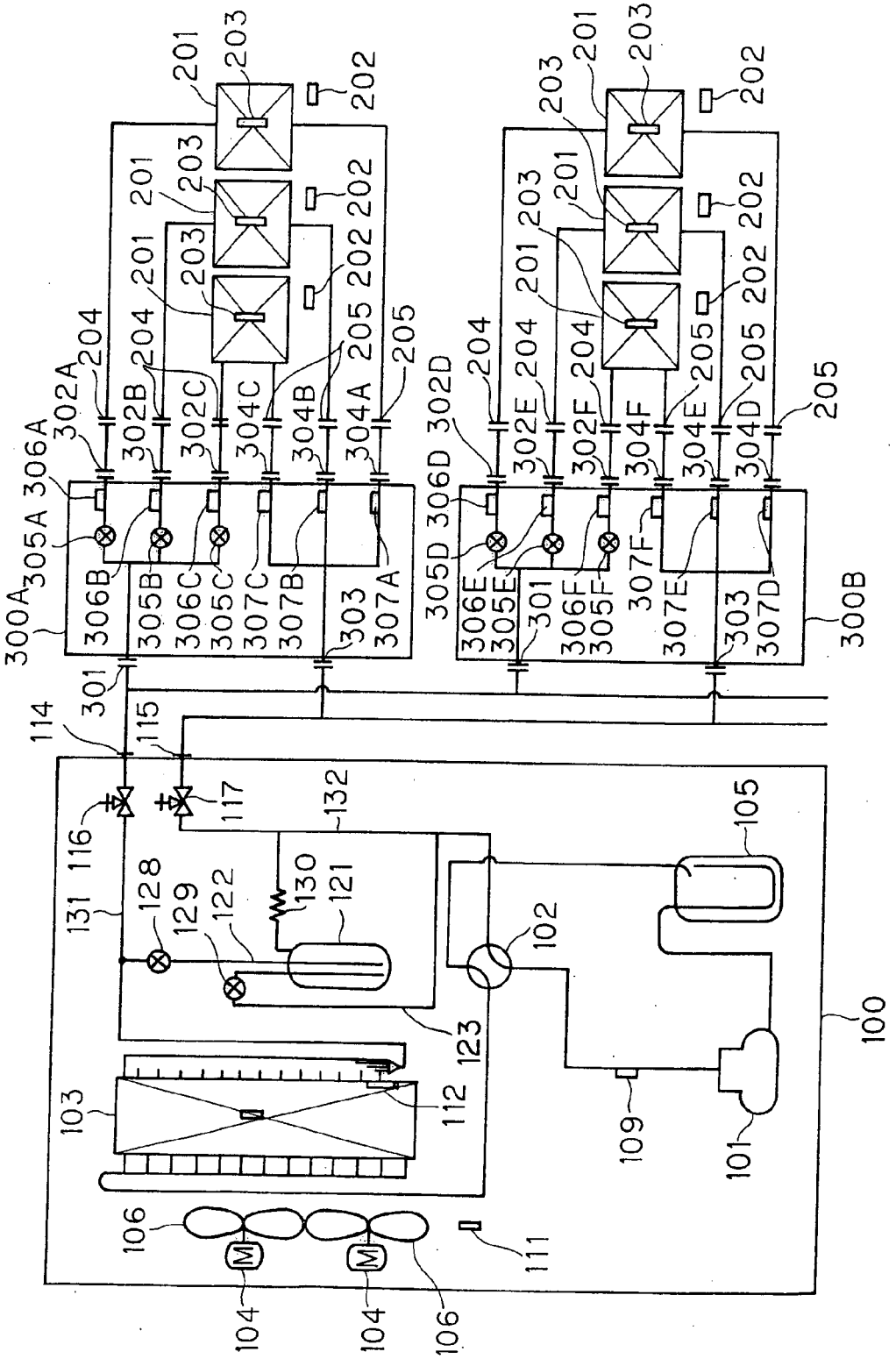
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Fig. 6

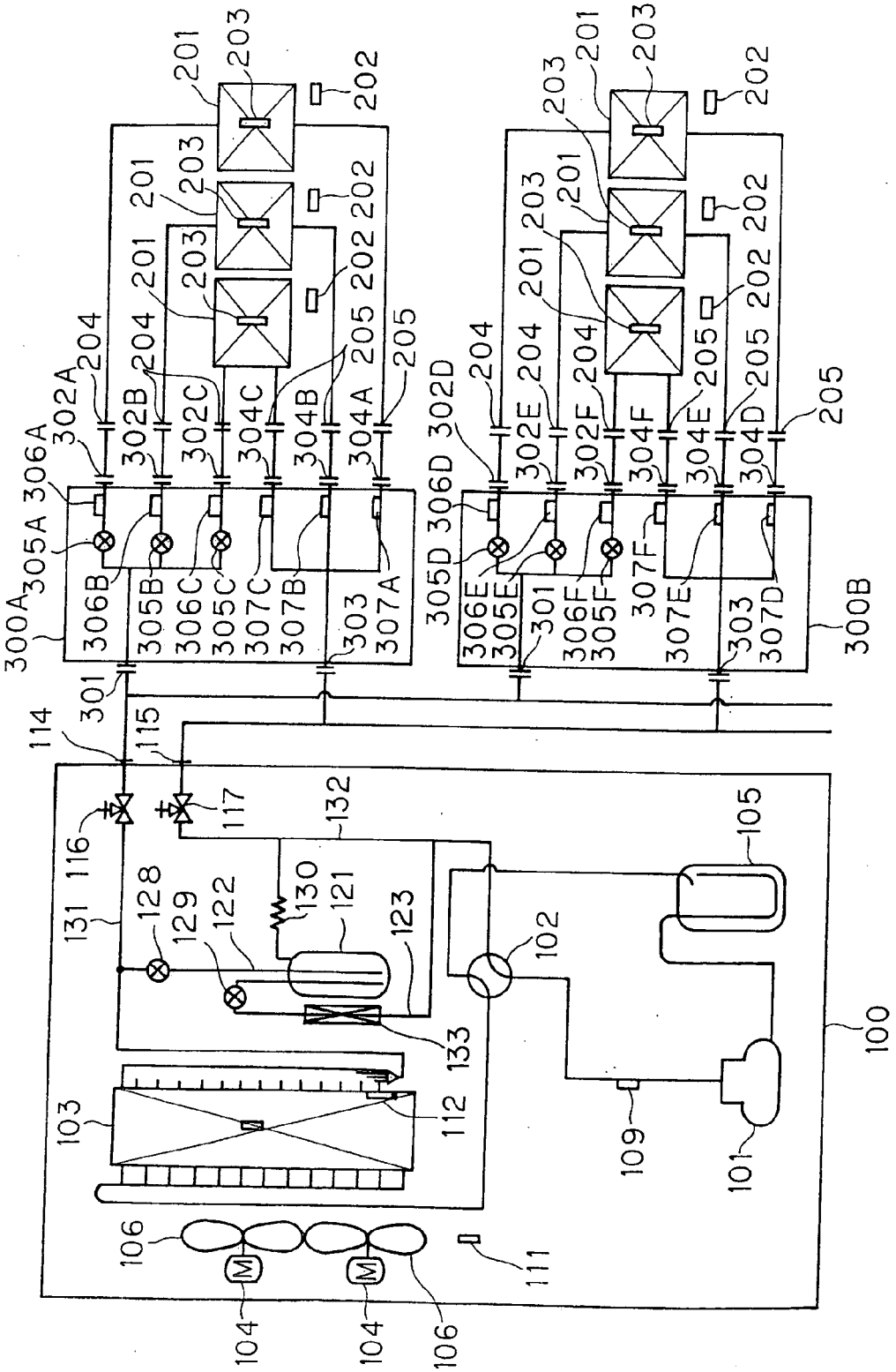
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Fig. 7

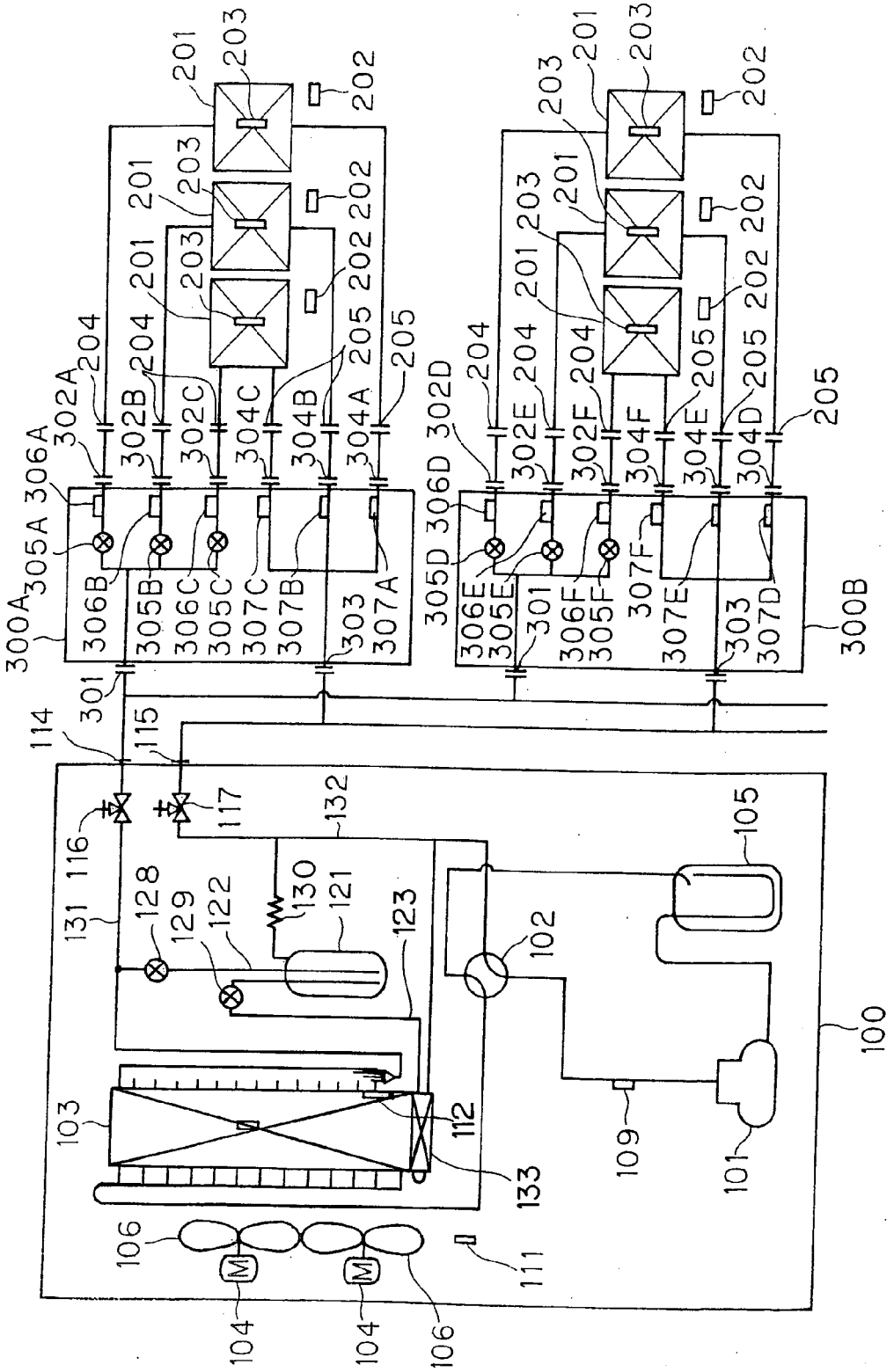
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Fig. 8

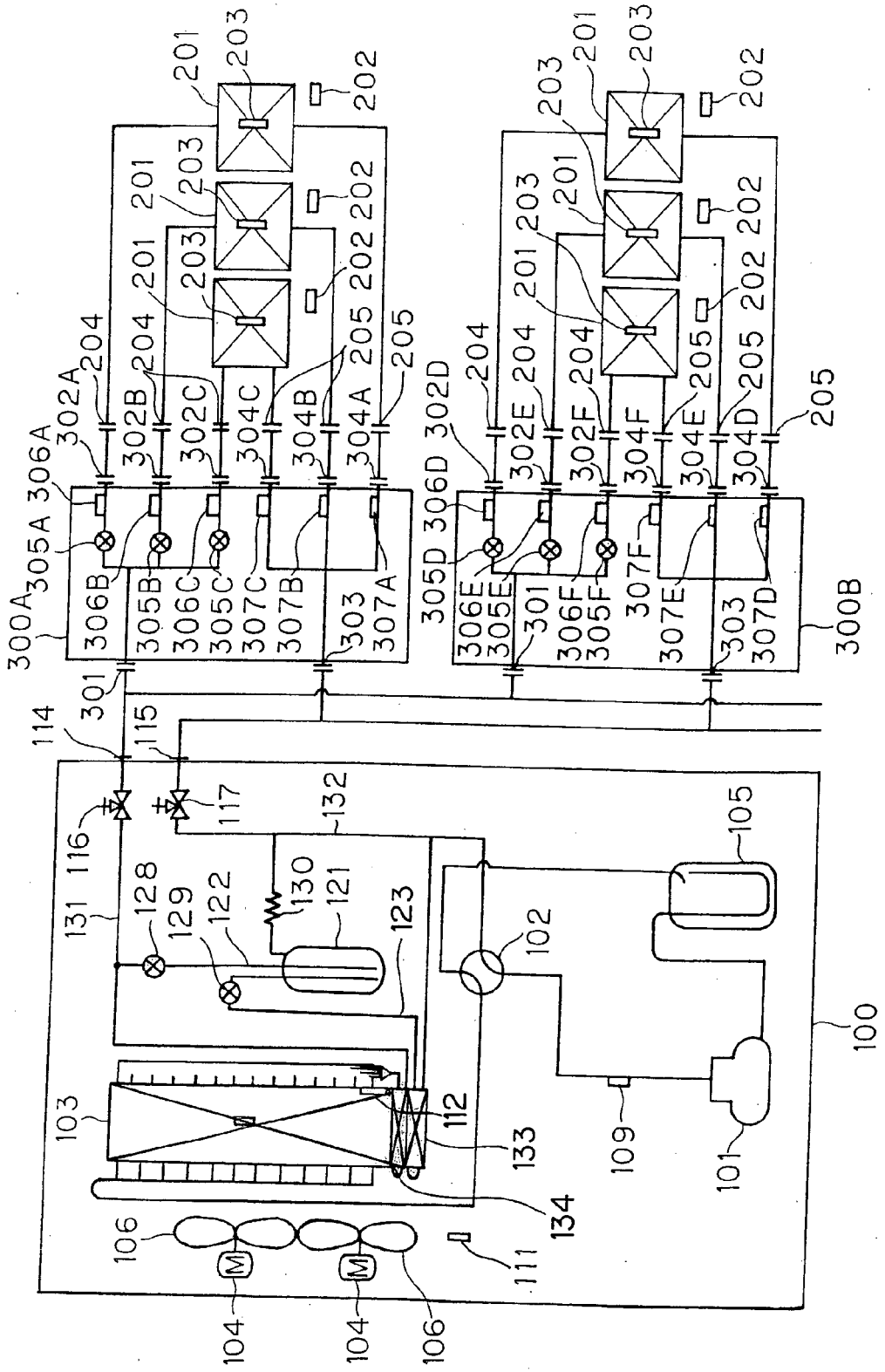
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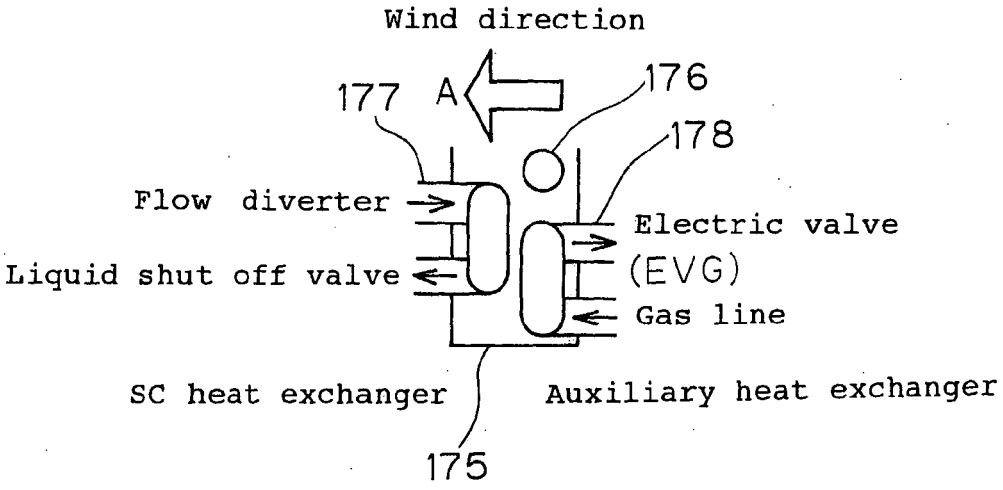
Fig. 9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Electric valve
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Gas line
SC heat exchanger
Auxiliary heat exchanger
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Fig. 10

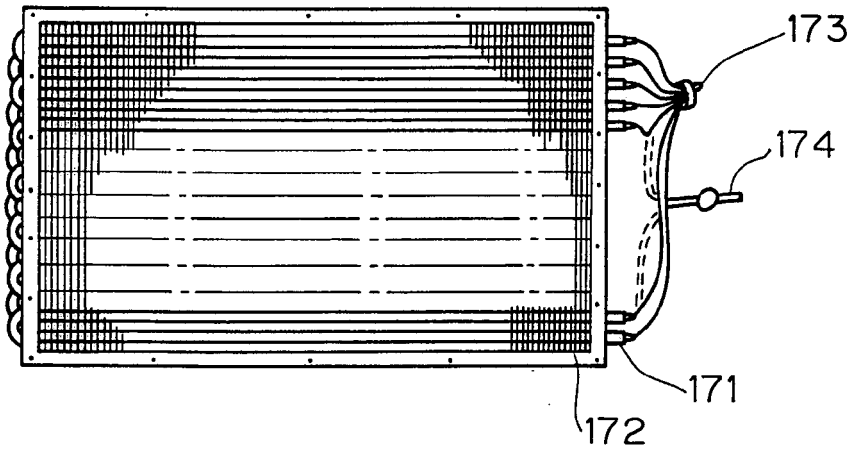
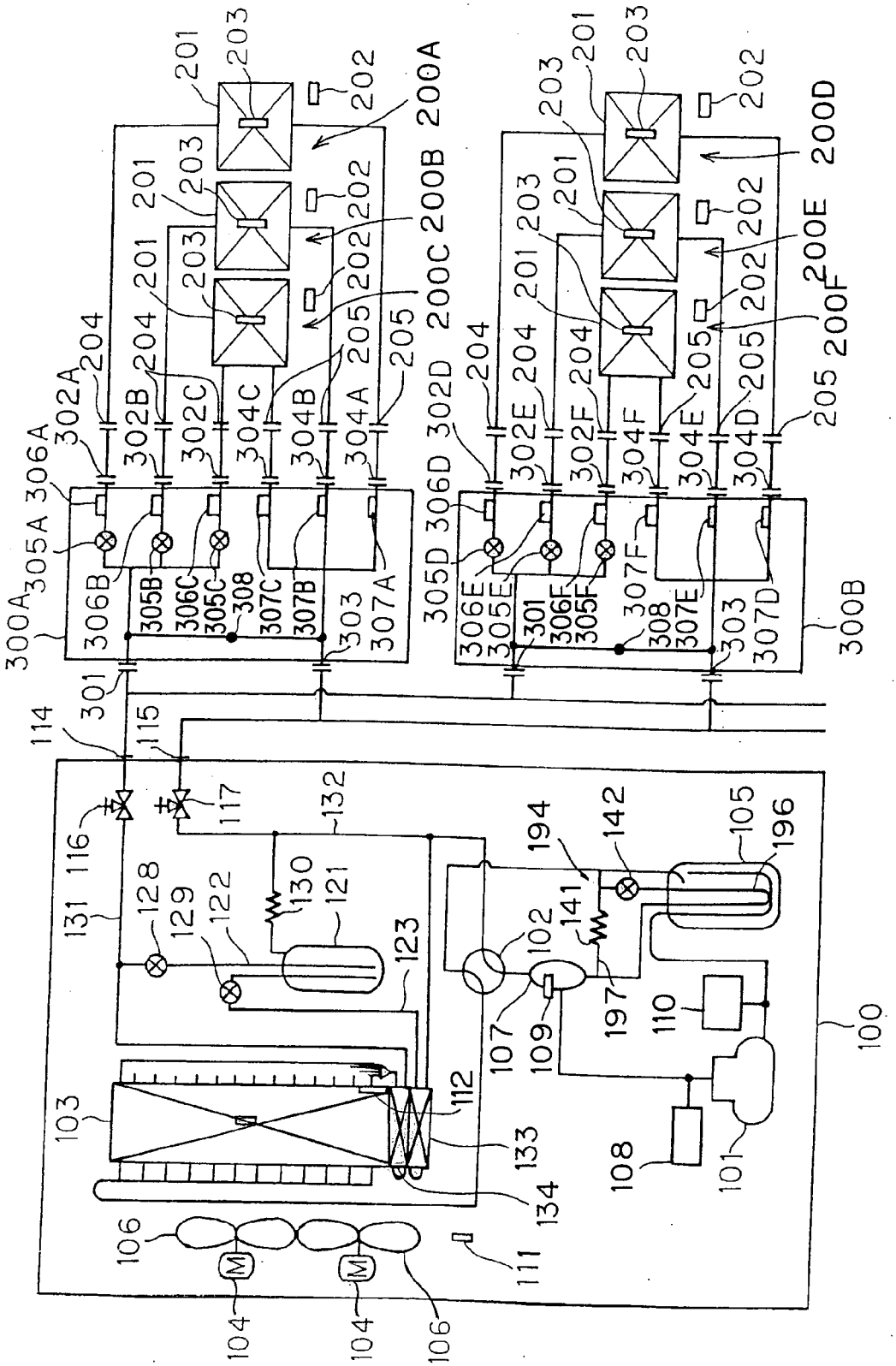


Fig. 11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141
142
194
196
197
200A
200B
200C
200D
200E
200F
201
202
203
204
205
300A
300B
301
302A
302B
302C
302D
302E
302F
303
304A
304B
304C
304D
304E
304F
305A
305B
305C
305D
305E
305F
306A
306B
306C
306D
306E
306F
307A
307B
307C
307D
307E
307F
308
M

Fig. 12

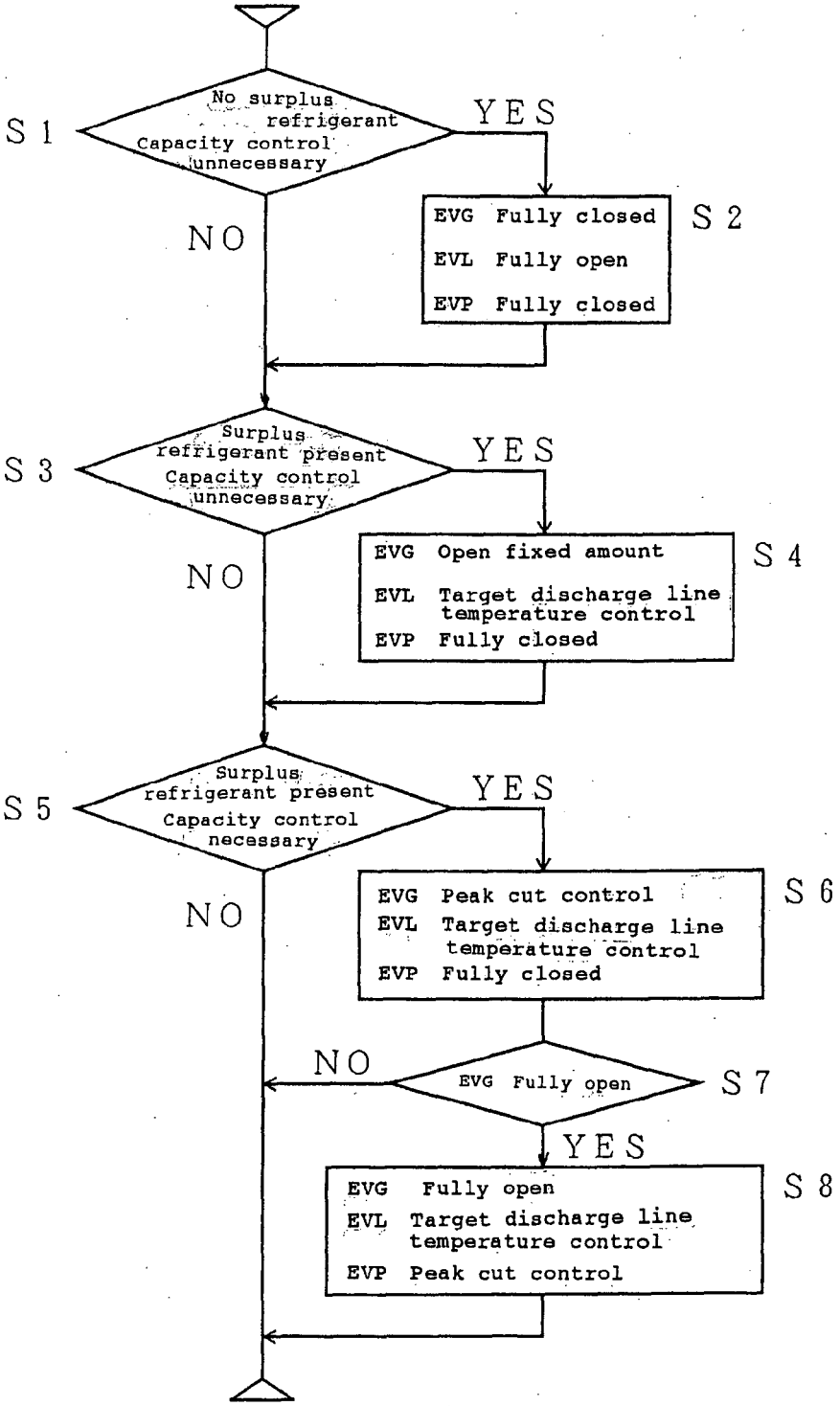

S 1
No surplus refrigerant
Capacity control unnecessary
YES
NO
EVG Fully closed
EVL Fully open
EVP Fully closed
S 2
S 3
Surplus refrigerant present
Capacity control unnecessary
YES
NO
EVG Open fixed amount
EVL Target discharge line temperature control
EVP Fully closed
S 4
S 5
Surplus refrigerant present
Capacity control necessary
YES
NO
EVG Peak cut control
EVL Target discharge line temperature control
EVP Fully closed
S 6
NO
EVG Fully open
S 7
YES
EVG Fully open
EVL Target discharge line temperature control
EVP Peak cut control
S 8

Fig. 13

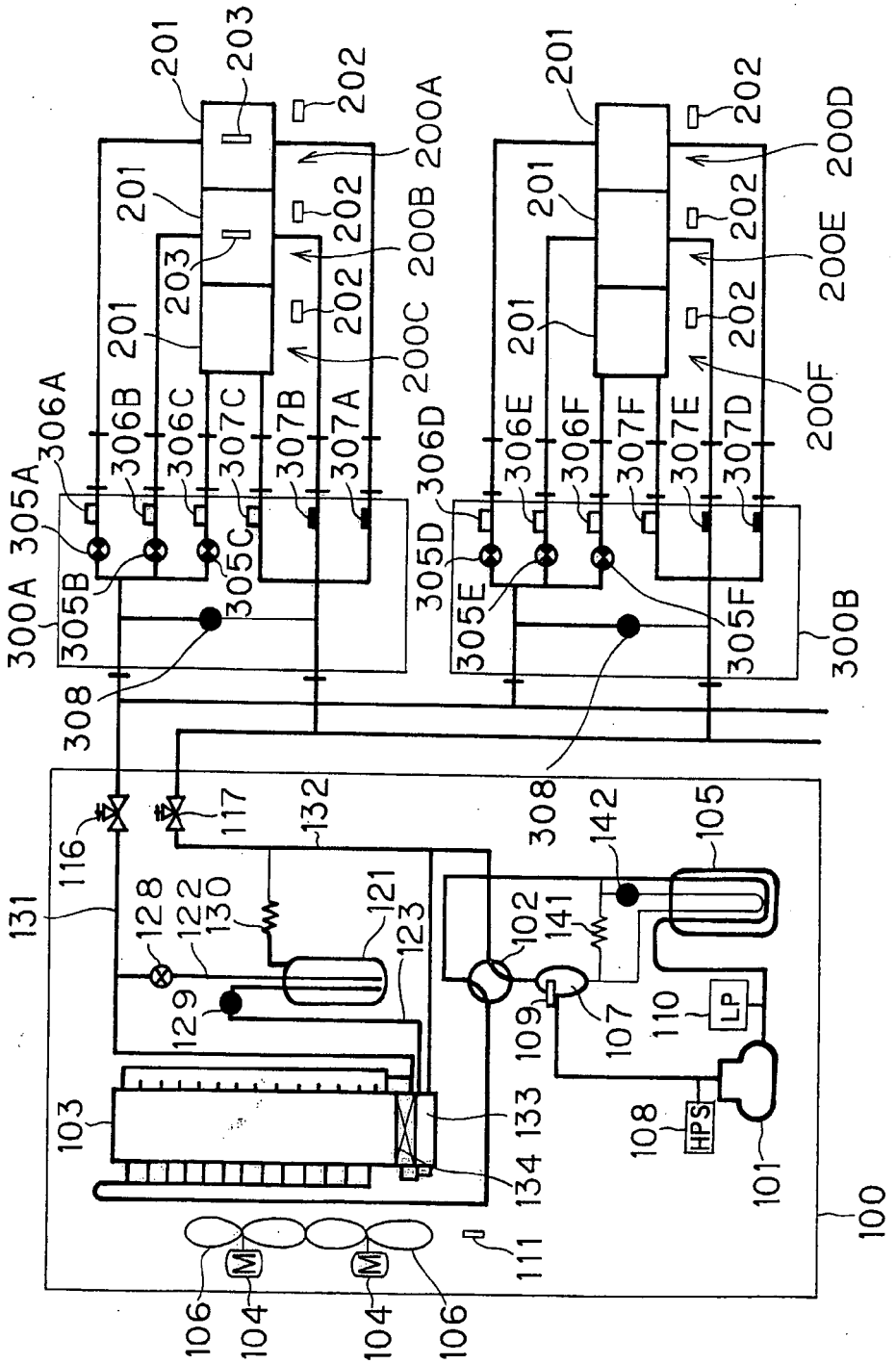

201
203
202
200A
200B
200C
200D
200E
200F
306A
306B
306C
306D
306E
306F
307A
307B
307C
307D
307E
307F
305A
305B
305C
305D
305E
305F
300A
300B
308
116
117
132
131
128
122
130
121
123
129
103
133
134
111
106
104
M
102
141
142
105
107
109
110
LP
108
HPS
101
100

Fig. 14

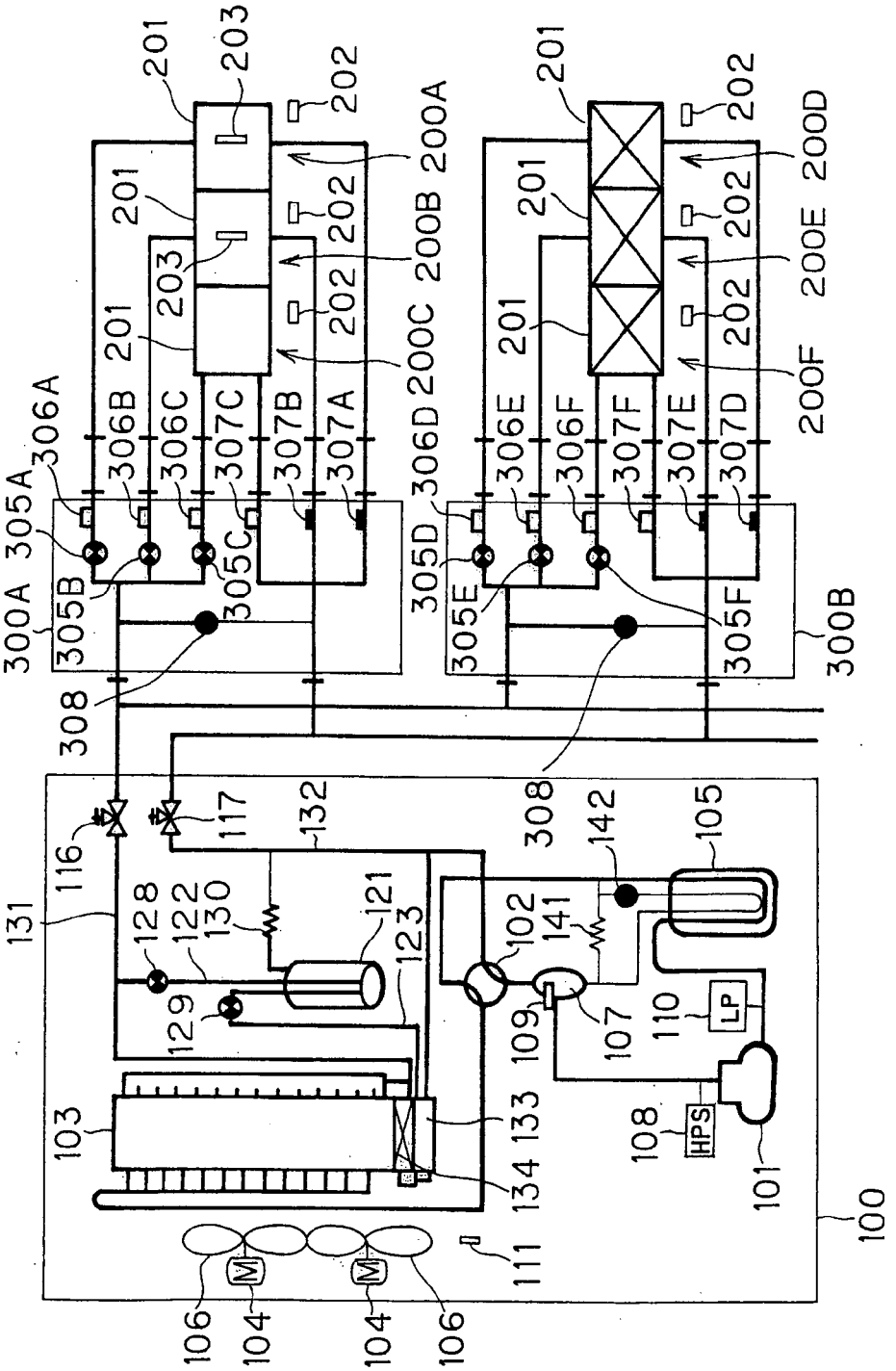

201
203
202
200A
200B
200C
200D
200E
200F
306A
306B
306C
306D
306E
306F
307A
307B
307C
307D
307E
307F
305A
305B
305C
305D
305E
305F
300A
300B
308
117
132
116
131
128
122
130
121
123
129
102
141
142
105
109
107
110
LP
108
HPS
101
103
133
134
111
106
104
M
100

Fig. 15

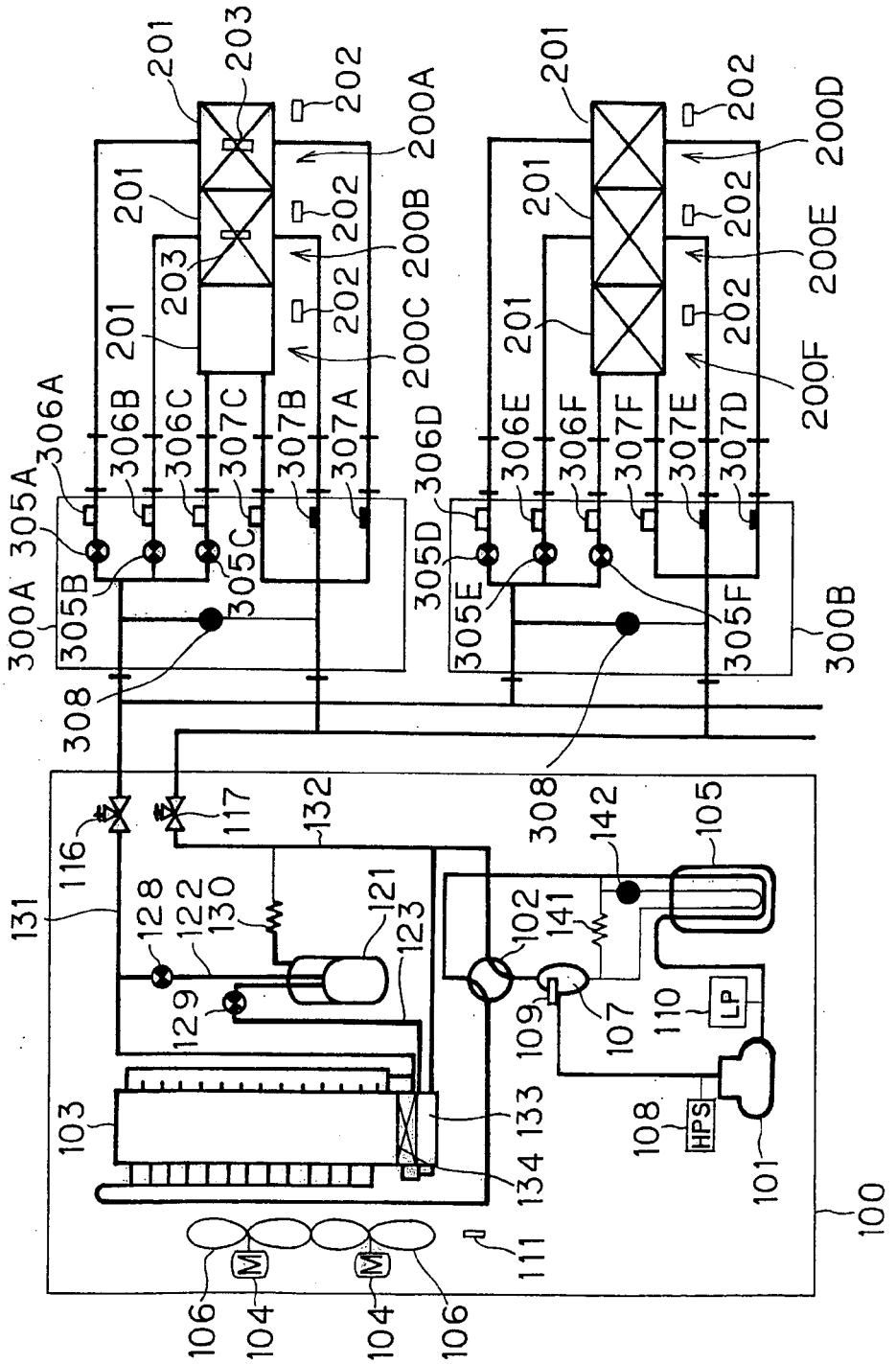

201
203
202
200A
200B
200C
200D
200E
200F
306A
306B
306C
307C
307B
307A
306D
306E
306F
307F
307E
307D
305A
305B
305C
305D
305E
305F
300A
300B
308
117
132
116
131
128
122
130
121
123
129
102
141
142
105
107
109
110
LP
HPS
108
101
103
133
134
111
100
106
104
M

Fig. 16

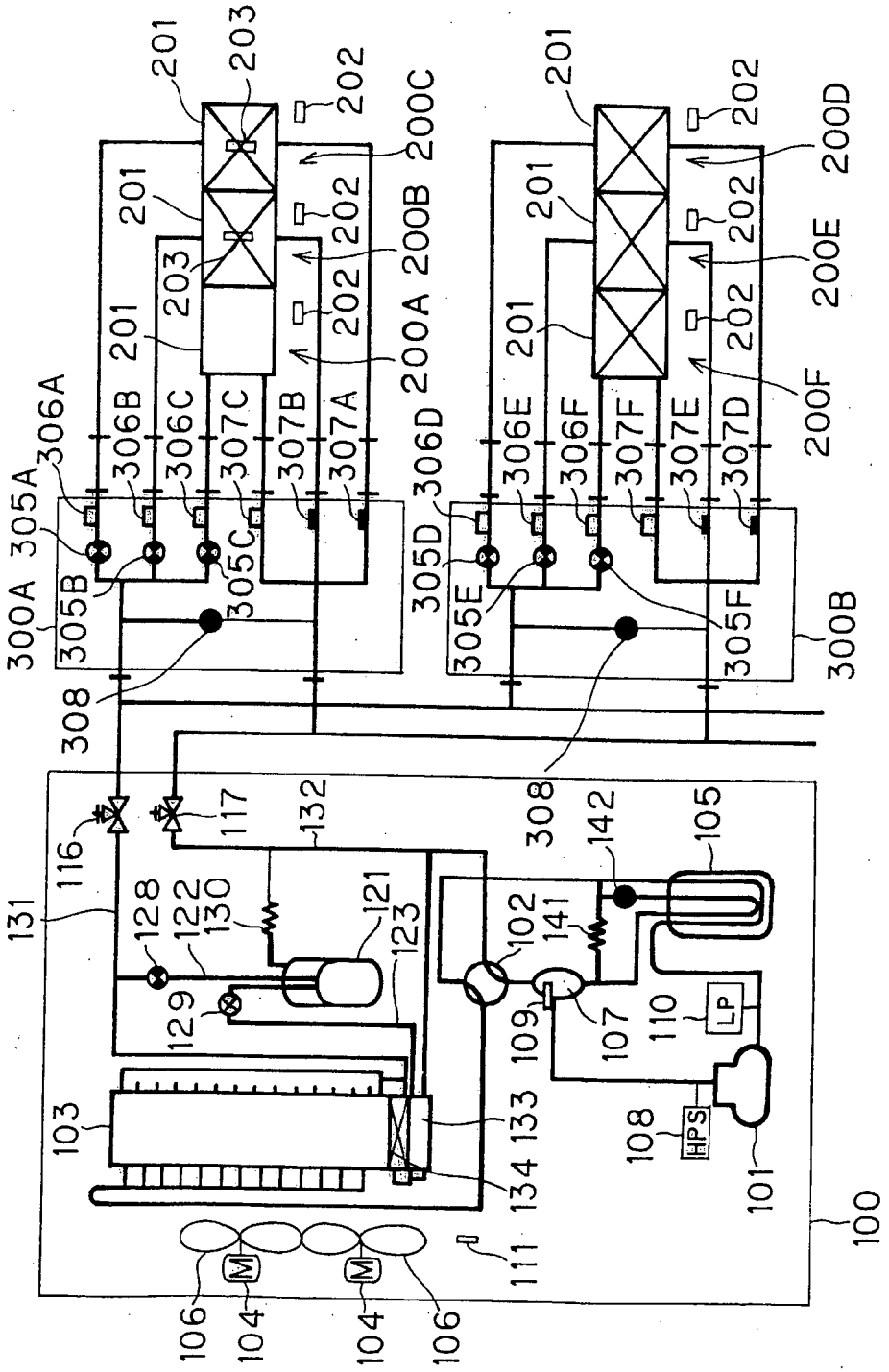

201
203
202
200C
200B
200A
306A
306B
306C
307C
307B
307A
305A
305B
305C
300A
308
306D
306E
306F
307F
307E
307D
305D
305E
305F
200D
200E
200F
300B
117
132
116
131
128
122
130
121
123
129
103
133
134
111
106
104
102
141
142
105
107
109
110
LP
108
HPS
101
100

Fig. 17

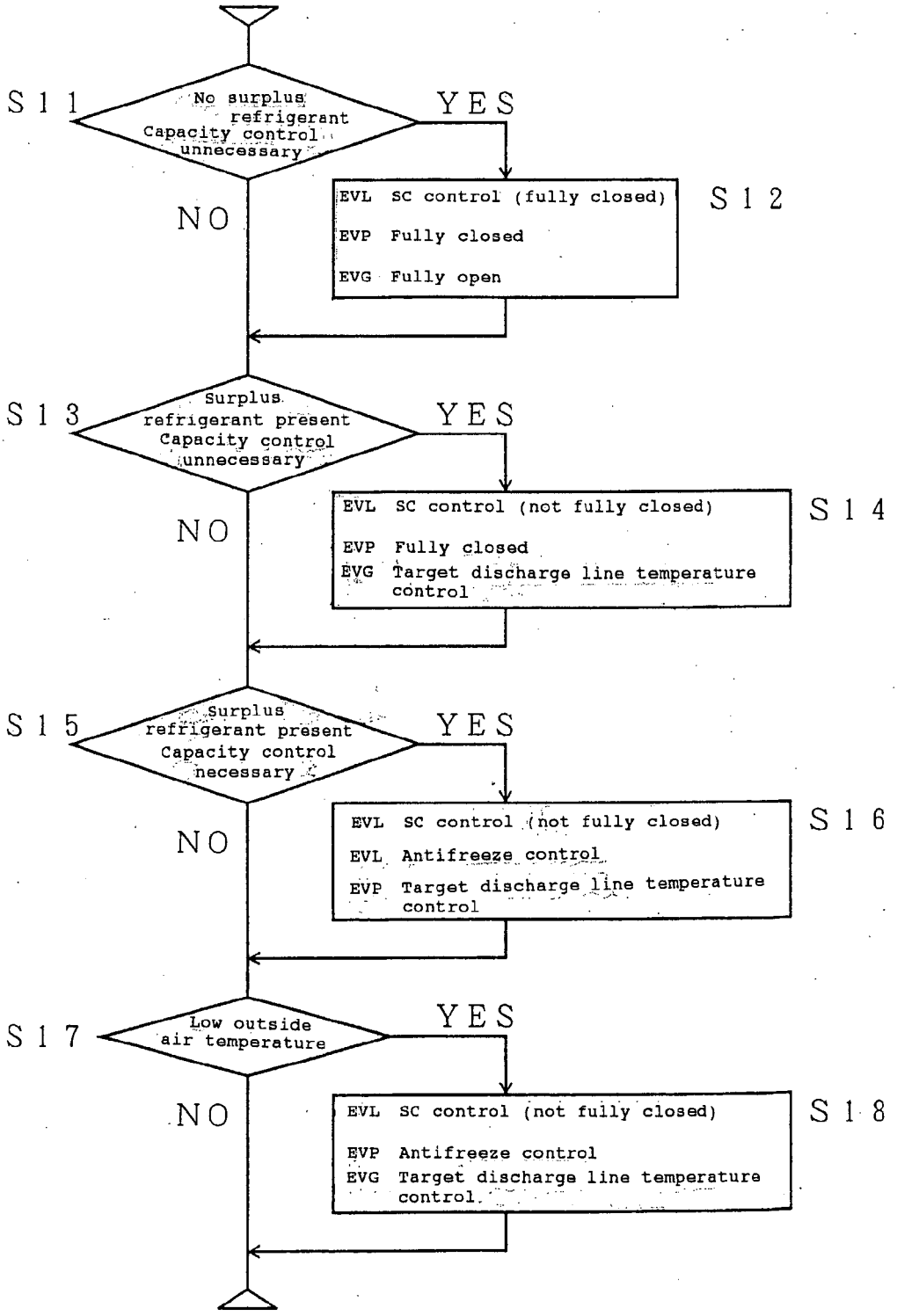

S11
No surplus refrigerant
Capacity control unnecessary
YES
NO
EVL SC control (fully closed)
EVP Fully closed
EVG Fully open
S12
S13
Surplus refrigerant present
Capacity control unnecessary
YES
NO
EVL SC control (not fully closed)
EVP Fully closed
EVG Target discharge line temperature control
S14
S15
Surplus refrigerant present
Capacity control necessary
YES
NO
EVL SC control (not fully closed)
EVL Antifreeze control
EVP Target discharge line temperature control
S16
S17
Low outside air temperature
YES
NO
EVL SC control (not fully closed)
EVP Antifreeze control
EVG Target discharge line temperature control
S18

Fig. 18

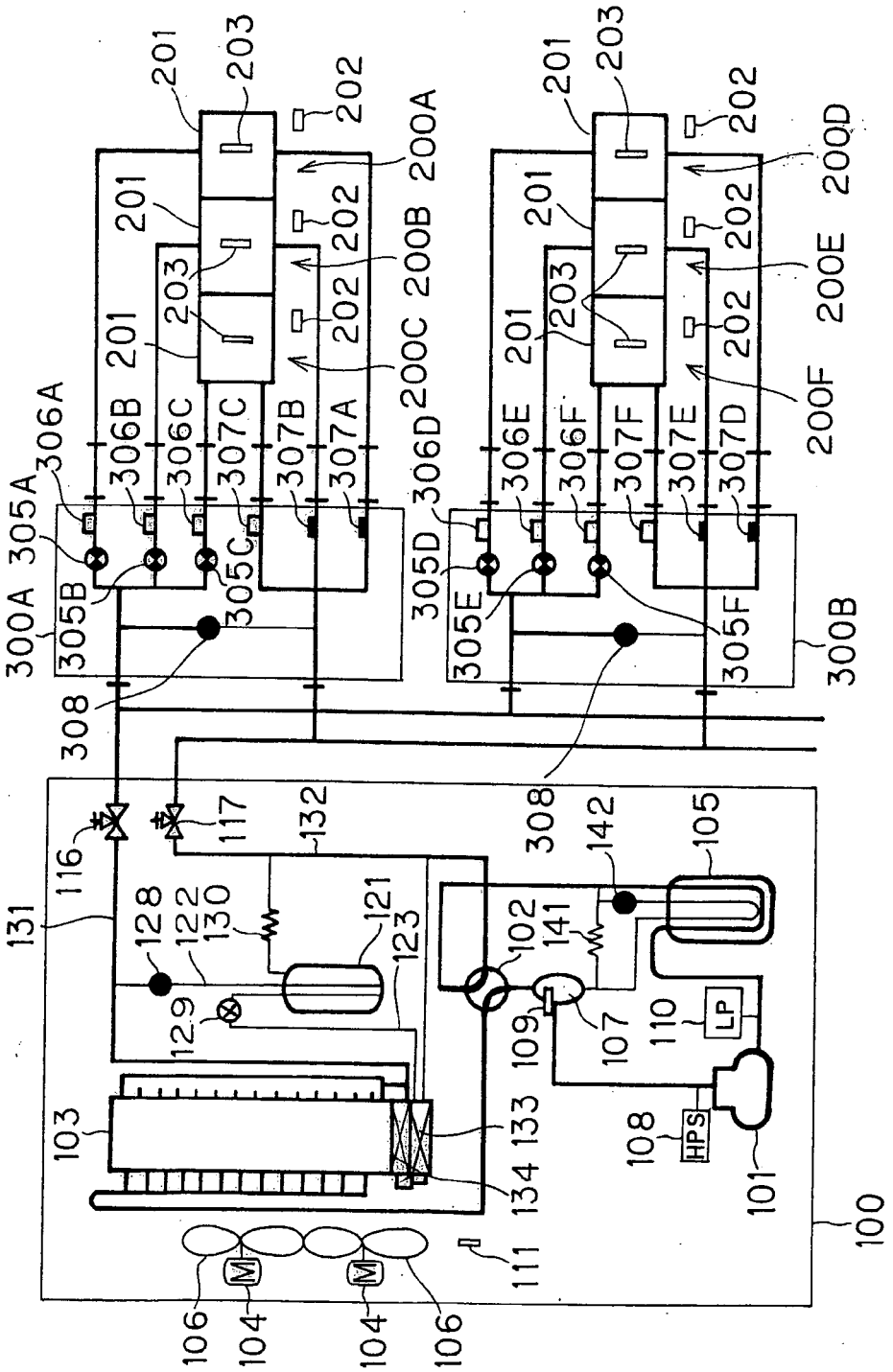

201
203
202
200A
200B
200C
200D
200E
200F
306A
306B
306C
306D
306E
306F
307A
307B
307C
307D
307E
307F
305A
305B
305C
305D
305E
305F
300A
300B
308
131
116
117
132
128
122
130
121
123
129
102
141
142
105
107
109
110
LP
HPS
108
101
103
133
134
111
106
104
M
100

Fig. 19

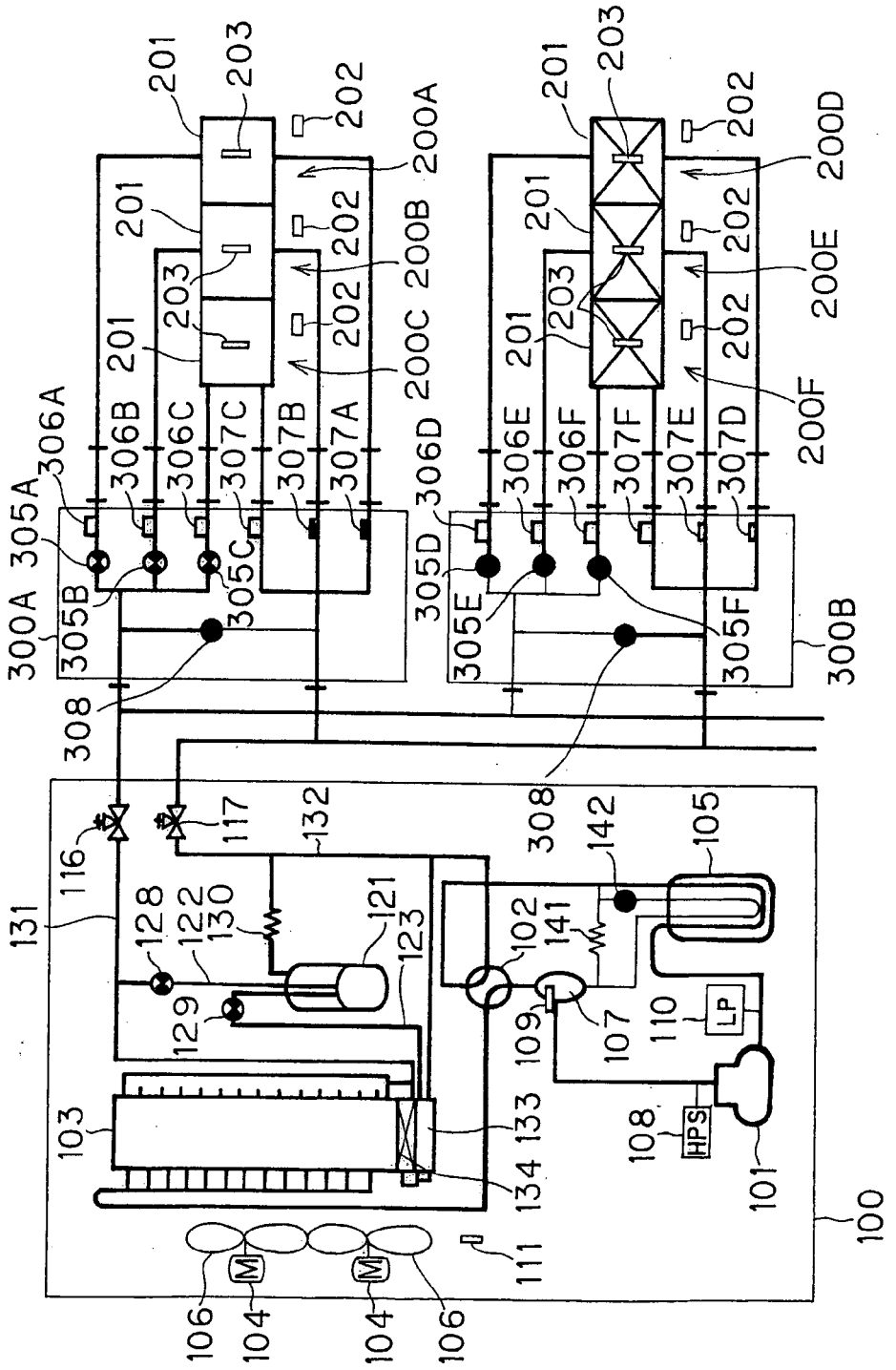
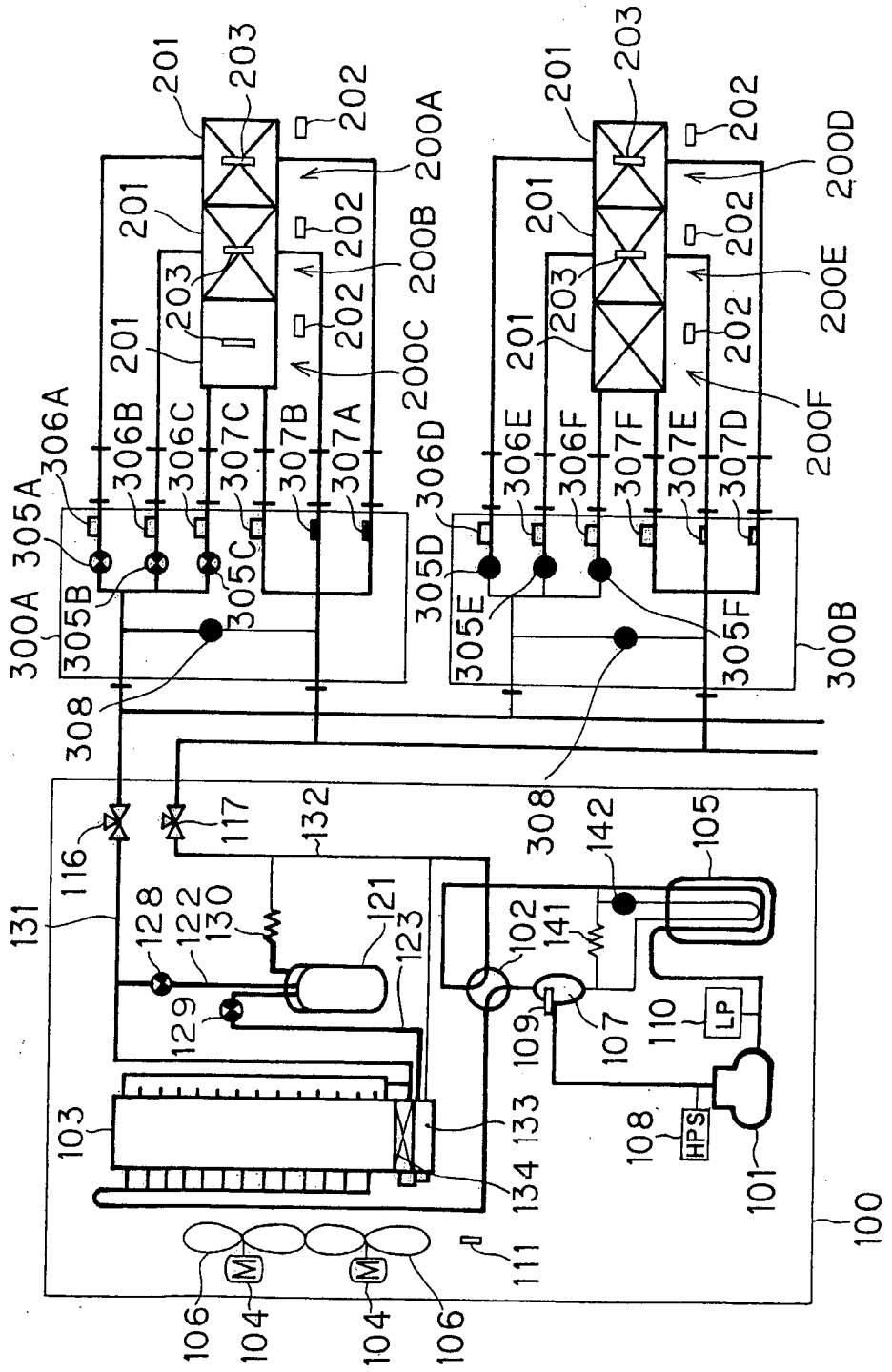

201
203
202
200A
200B
200C
200D
200E
200F
306A
306B
306C
307C
307B
307A
306D
306E
306F
307F
307E
307D
305A
305B
305C
305D
305E
305F
300A
300B
308
117
132
116
131
128
122
130
121
123
129
102
141
142
105
107
109
110
LP
108
HPS
101
103
133
134
111
100
106
104
M

Fig. 20


100
101
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110
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116
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121
122
123
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128
129
130
131
132
133
134
141
142
200A
200B
200C
200D
200E
200F
201
202
203
300A
300B
305A
305B
305C
305D
305E
305F
306A
306B
306C
306D
306E
306F
307A
307B
307C
307D
307E
307F
308
HPS
LP
M

Fig. 21

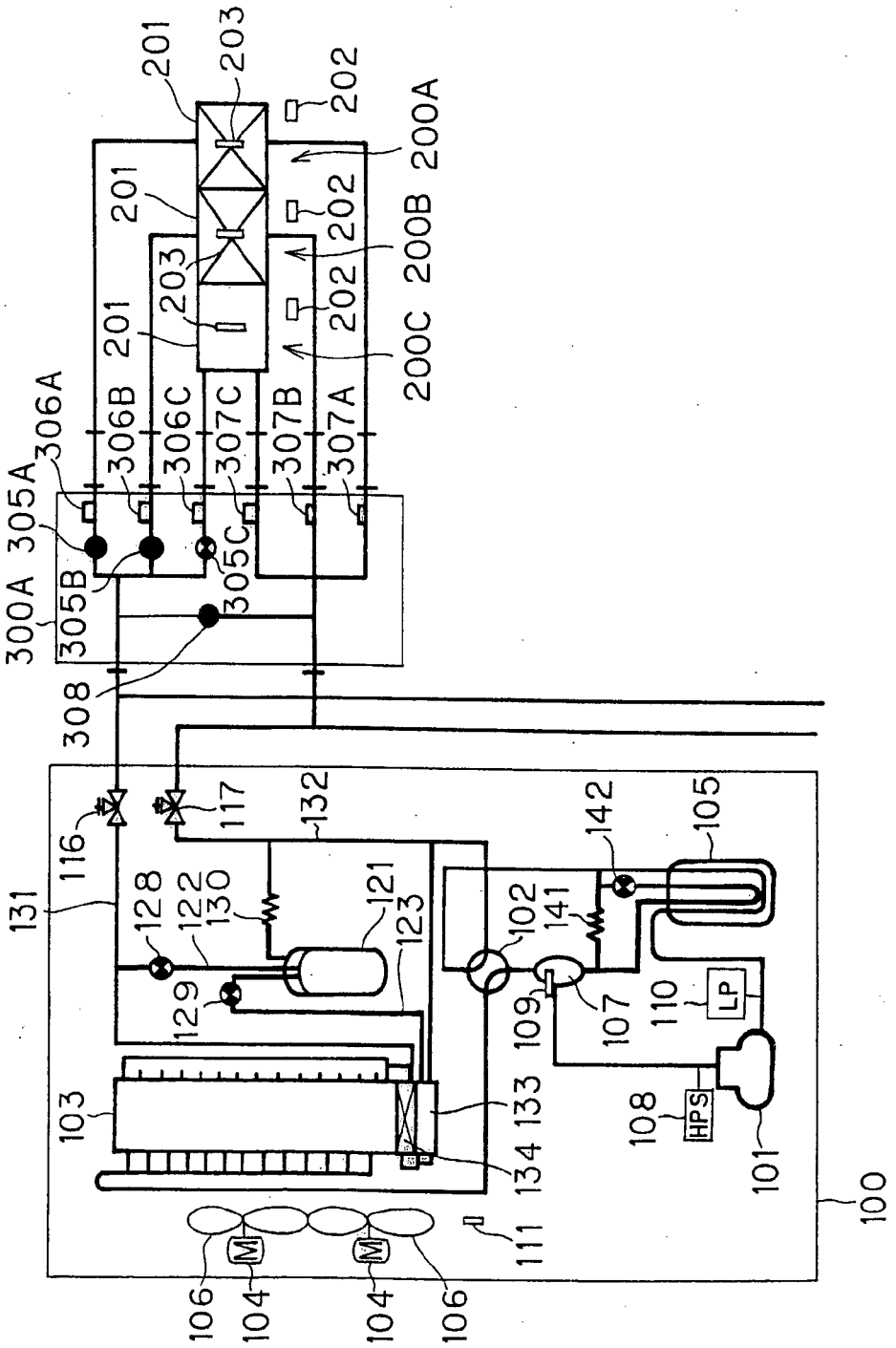
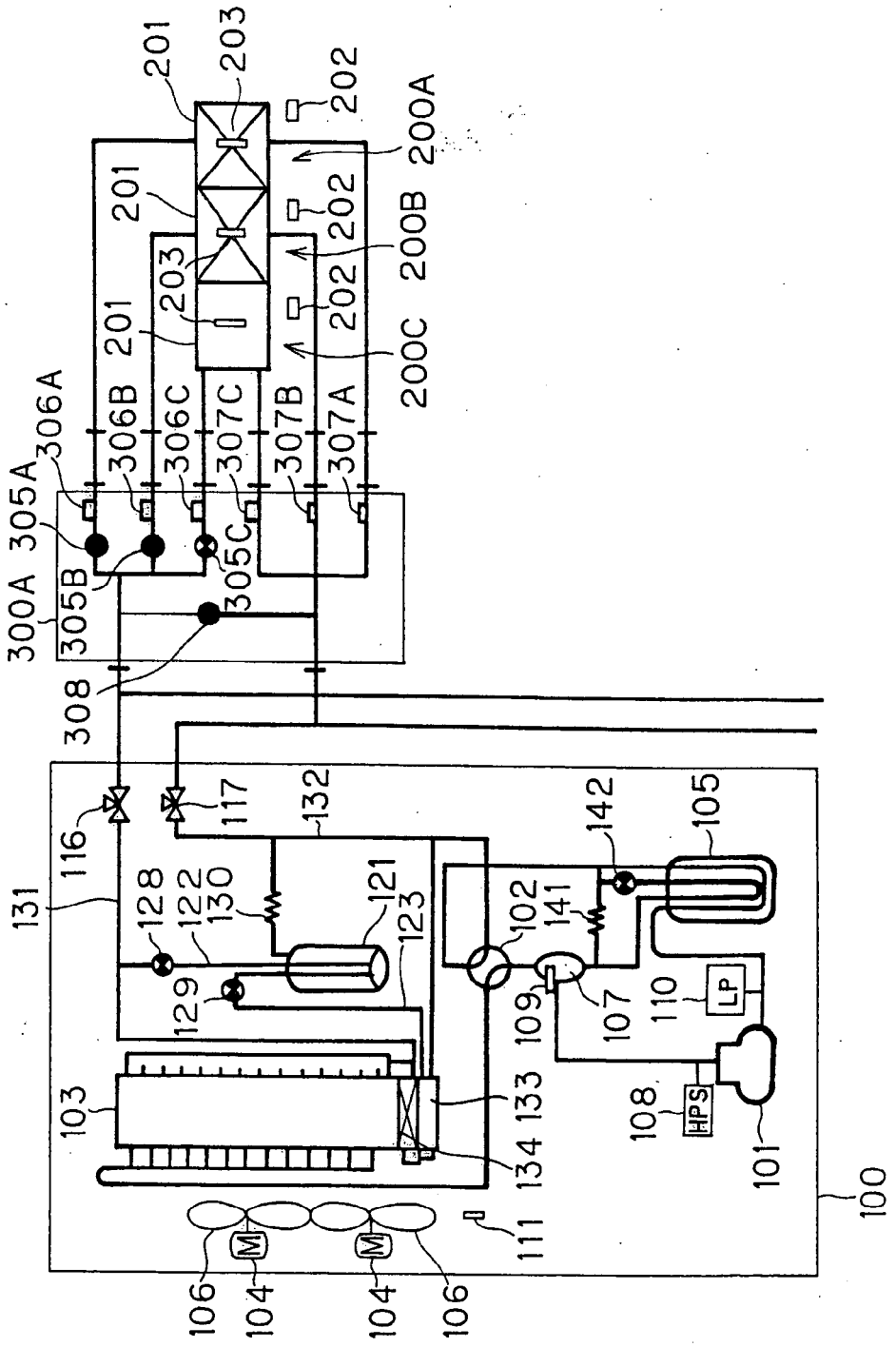

201
203
202
200A
200B
200C
306A
306B
306C
307C
307B
307A
305A
305B
305C
300A
308
116
117
132
131
128
122
130
121
123
129
142
105
102
141
107
109
110
LP
HPS
108
101
100
103
133
134
111
106
104
M

Fig. 22


201
203
202
200A
201
202
200B
203
201
202
200C
306A
306B
306C
307C
307B
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305A
305C
305B
300A
308
116
117
132
142
105
131
128
122
130
121
123
102
141
129
109
107
110
LP
103
133
134
108
HPS
101
100
111
106
104
104
106
M
M

Fig. 23

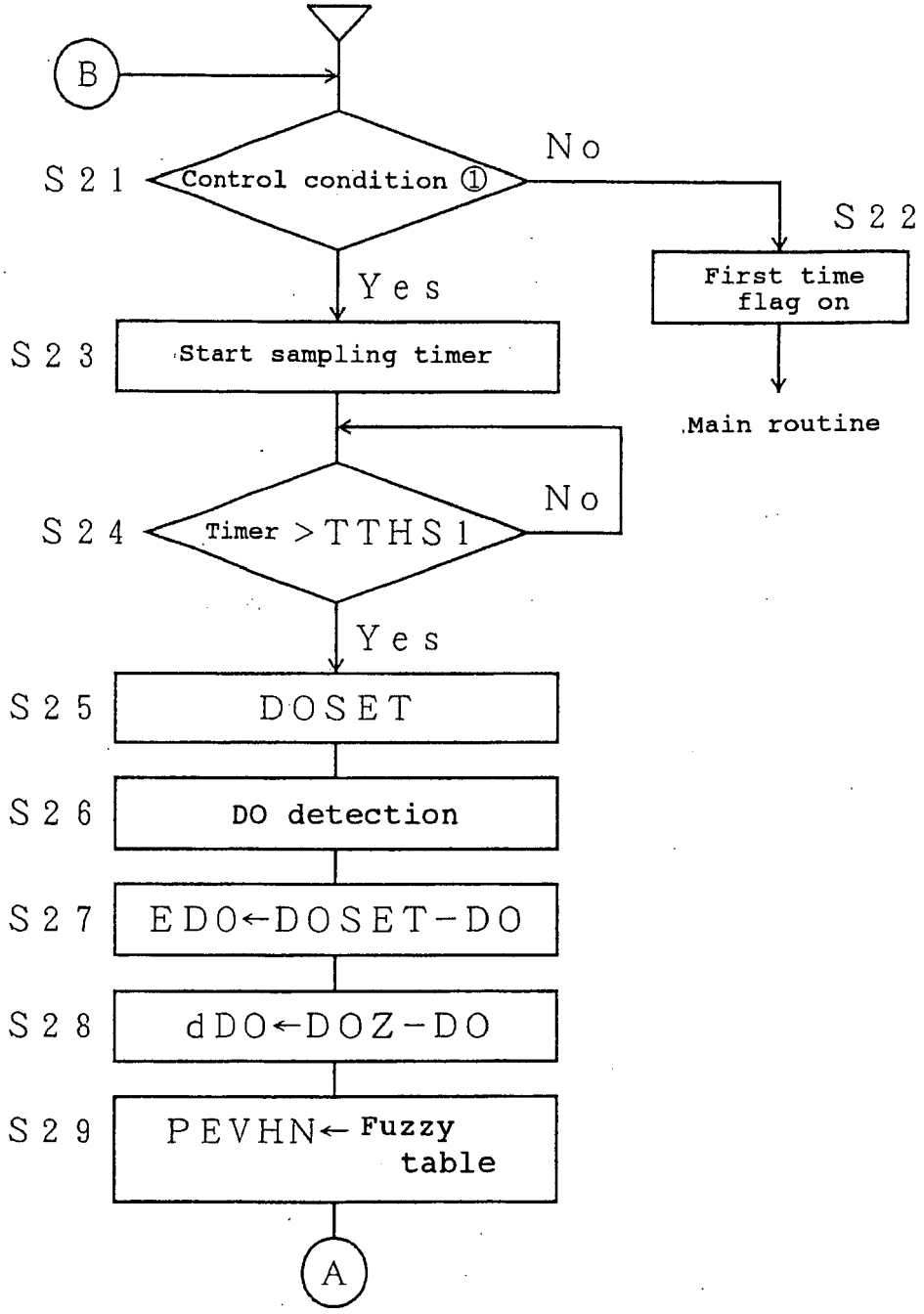

B
S21
Control condition ①
No
S22
First time flag on
Main routine
Yes
S23
Start sampling timer
S24
Timer > TTHS1
No
Yes
S25
DOSET
S26
DO detection
S27
EDO←DOSET−DO
S28
dDO←DOZ−DO
S29
PEVHN← Fuzzy table
A

Fig. 24

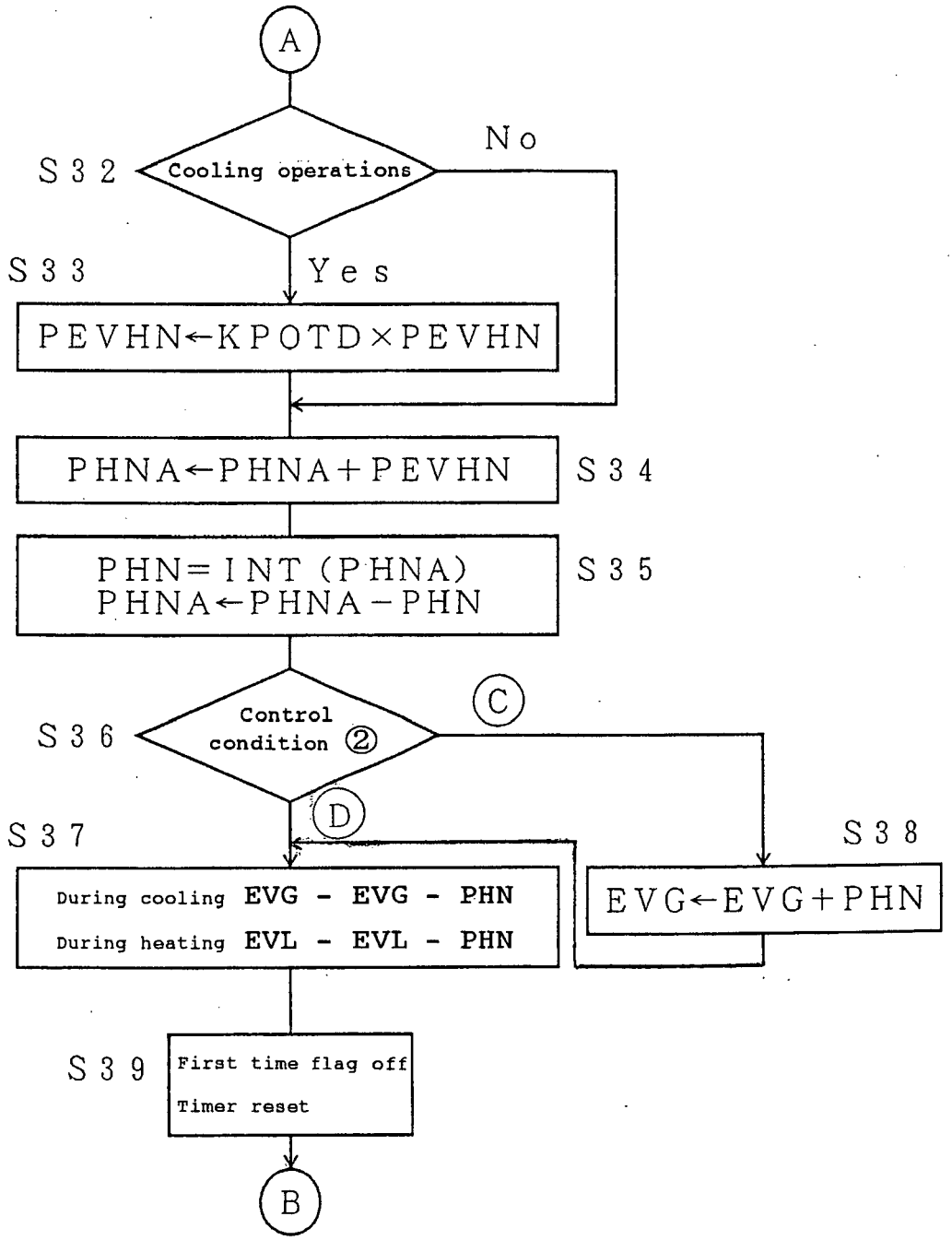

A
S32
Cooling operations
No
Yes
S33
PEVHN←KPOTD×PEVHN
PHNA←PHNA+PEVHN
S34
PHN=INT(PHNA)
PHNA←PHNA−PHN
S35
S36
Control condition ②
C
D
S37
S38
During cooling EVG - EVG - PHN
During heating EVL - EVL - PHN
EVG←EVG+PHN
S39
First time flag off
Timer reset
B

Fig. 25

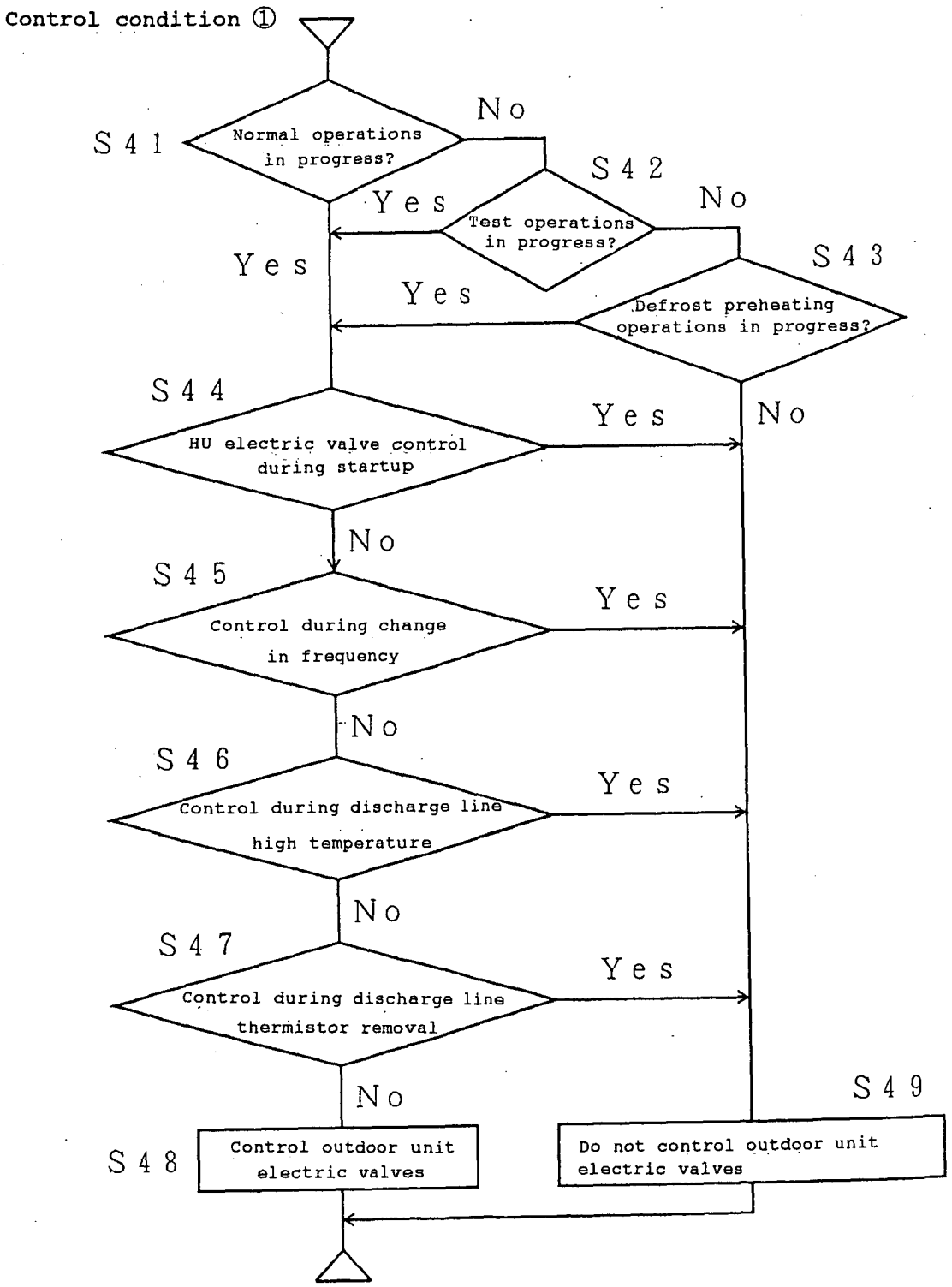

Control condition ①
S41
Normal operations in progress?
No
Yes
S42
Test operations in progress?
No
Yes
S43
Defrost preheating operations in progress?
Yes
No
S44
HU electric valve control during startup
Yes
No
S45
Control during change in frequency
Yes
No
S46
Control during discharge line high temperature
Yes
No
S47
Control during discharge line thermistor removal
Yes
No
S48
Control outdoor unit electric valves
S49
Do not control outdoor unit electric valves

Fig. 26

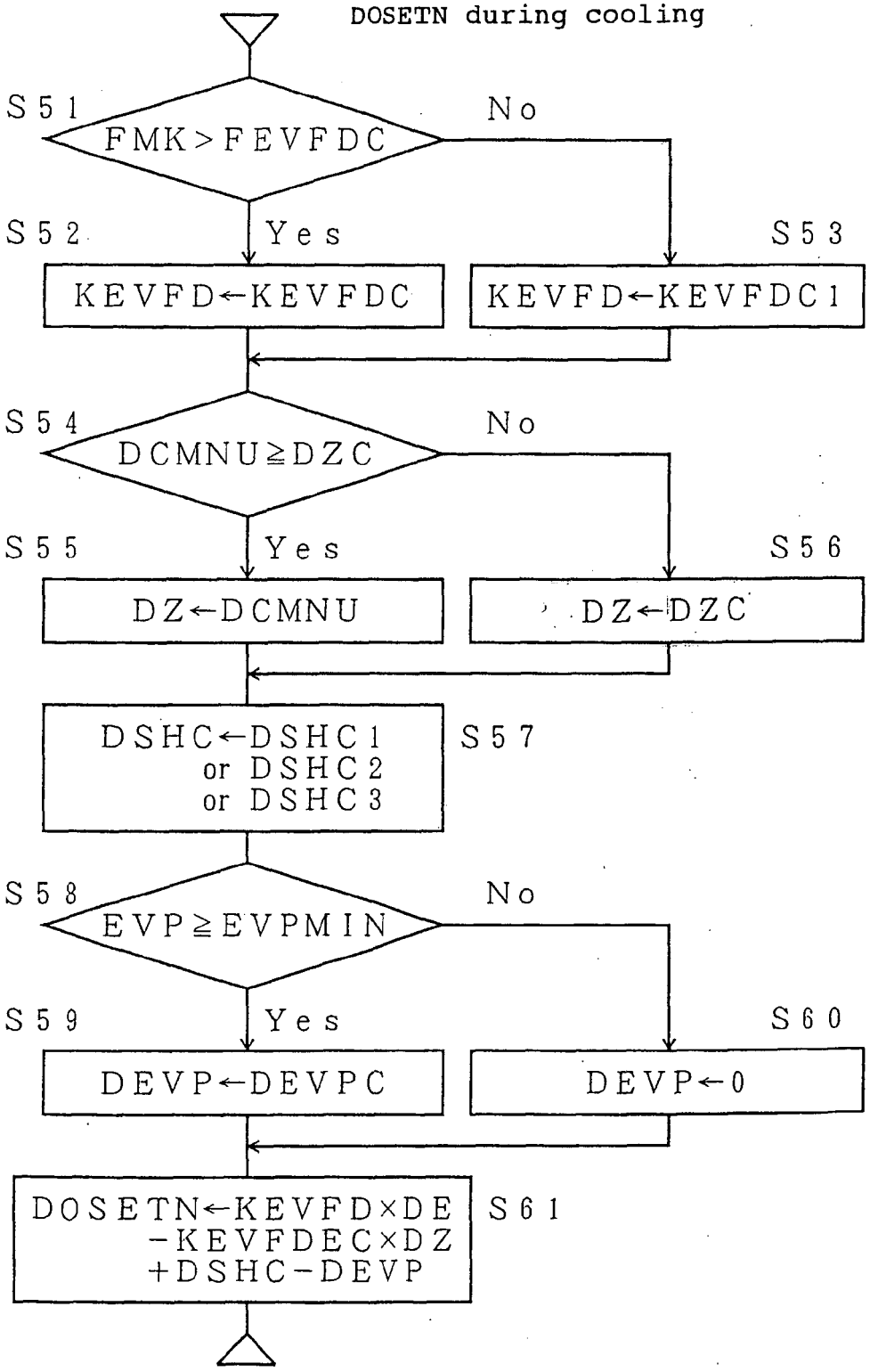

DOSETN during cooling
S51
FMK>FEVFDC
No
Yes
S52
KEVFD←KEVFDC
S53
KEVFD←KEVFDC1
S54
DCMNU≧DZC
No
Yes
S55
DZ←DCMNU
S56
DZ←DZC
DSHC←DSHC1
or DSHC2
or DSHC3
S57
S58
EVP≧EVPMIN
No
Yes
S59
DEVP←DEVPC
S60
DEVP←0
DOSETN←KEVFD×DE
−KEVFDEC×DZ
+DSHC−DEVP
S61

Fig. 27

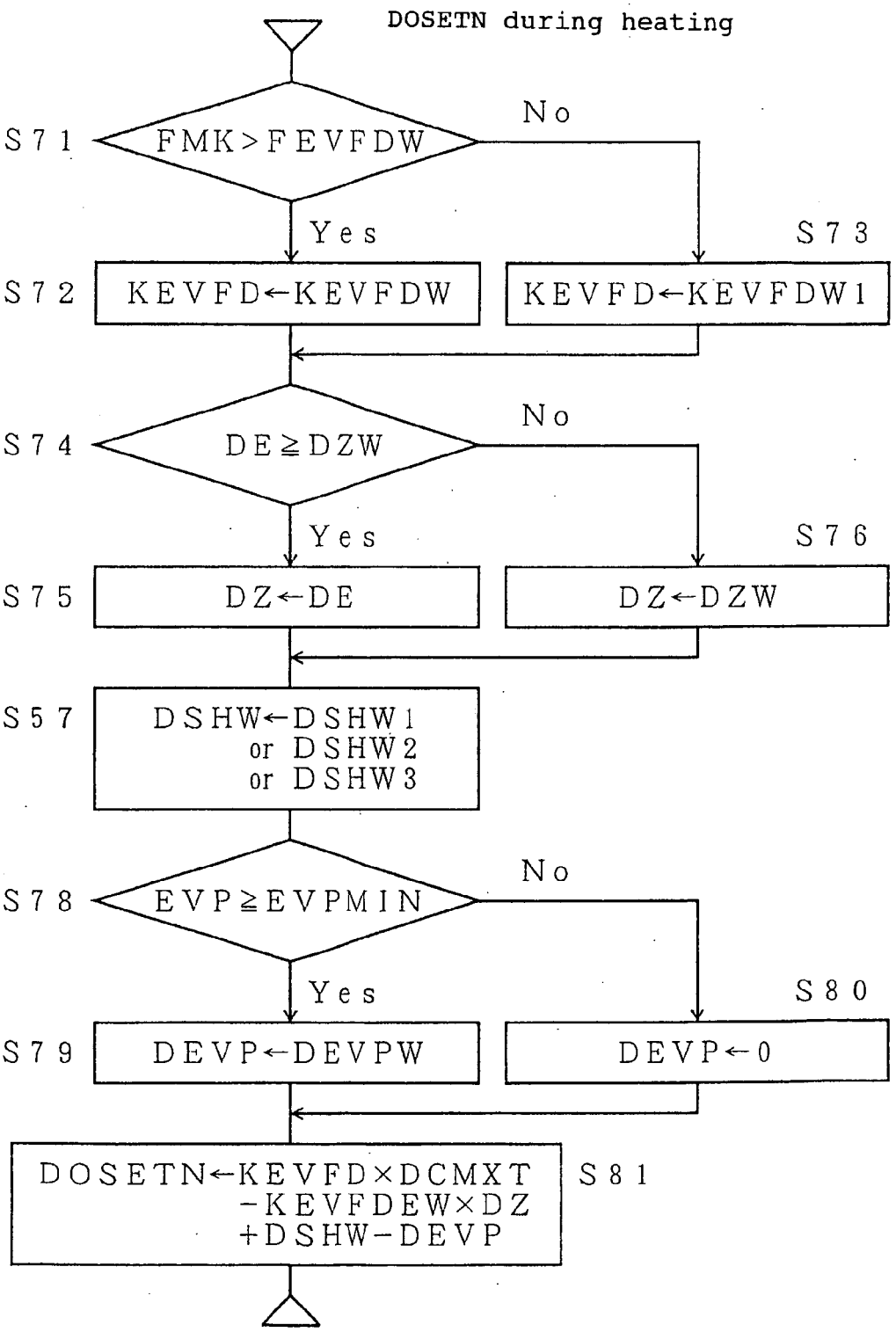

DOSETN during heating
S71
FMK>FEVFDW
No
Yes
S72
KEVFD←KEVFDW
S73
KEVFD←KEVFDW1
S74
DE≧DZW
No
Yes
S75
DZ←DE
S76
DZ←DZW
S57
DSHW←DSHW1
or DSHW2
or DSHW3
S78
EVP≧EVPMIN
No
Yes
S79
DEVP←DEVPW
S80
DEVP←0
DOSETN←KEVFD×DCMXT
-KEVFDEW×DZ
+DSHW-DEVP
S81

Fig. 28

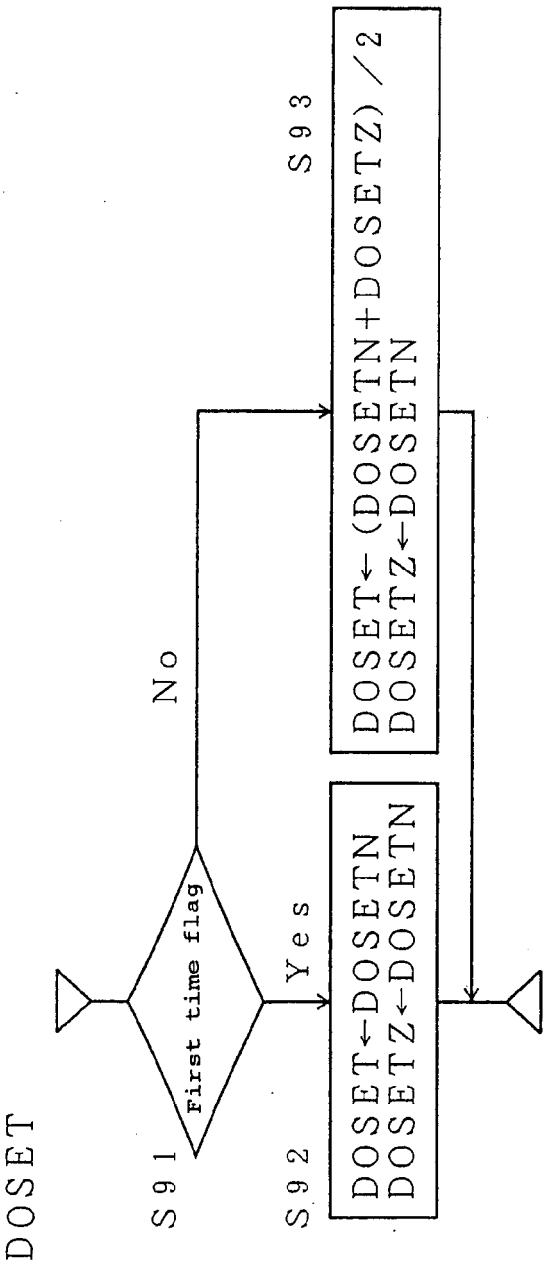
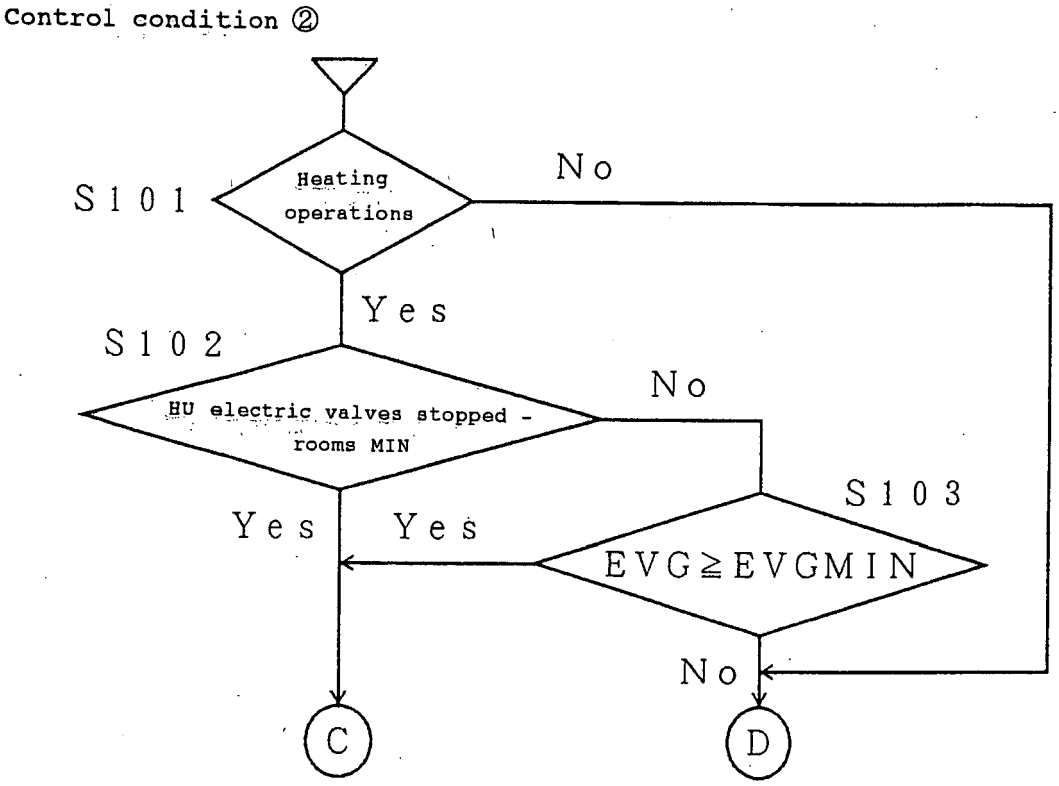

DOSET
S91
First time flag
No
Yes
S92
DOSET←DOSETN
DOSETZ←DOSETN
S93
DOSET←(DOSETN+DOSETZ)/2
DOSETZ←DOSETN

Fig. 29


Control condition ②
S101
Heating operations
No
Yes
S102
HU electric valves stopped - rooms MIN
No
S103
Yes
Yes
EVG≧EVGMIN
No
C
D

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 08 00 3787

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 784 892 A (REEDY WAYNE P [US]) 28 July 1998 (1998-07-28) * column 2, line 66 - column 6, line 2; figures 1-3 *	1,3,4, 10-12	INV. F25B1/00 F25B13/00
Y	* the whole document *	2	
Y	EP 0 971 183 A1 (DAIKIN IND LTD [JP]) 12 January 2000 (2000-01-12) * figure 2 *	2	
A	JP 60 114669 A (TOSHIBA KK) 21 June 1985 (1985-06-21) * the whole document *	1,3,4	
A	US 5 937 660 A (LAU ET AL) 17 August 1999 (1999-08-17) * column 2, line 61 - column 8, line 32; figures 1-25 *	1	
A	US 5 140 827 A (REEDY WAYNE R [US]) 25 August 1992 (1992-08-25) * column 2, line 66 - column 6, line 7; figures 1-3 *	1,3,4, 10-12	TECHNICAL FIELDS SEARCHED (IPC) F25B
A	JP 07 120092 A (FUJITSU GENERAL LTD) 12 May 1995 (1995-05-12) * the whole document *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 April 2008	Szilagyi, Barnabas

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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T : theory or principle underlying the invention
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L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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15-04-2008

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		DE 69824161 T2	25-05-2005
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JP 60114669 A	21-06-1985	NONE	
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EPO FORM P0459

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