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(54) **AIR CONDITIONING DEVICE**

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Description

Technical Field

[0001] The present invention relates to an air-conditioning apparatus.

Background Art

[0002] A known air-conditioning apparatus includes a plurality of heat-source-unit-side heat exchangers and a plurality of use-side heat exchangers and independently controls the outlet temperature of a use-side heat exchanger that is performing a cooling operation during a cooling and heating simultaneous operation (see, for example, Patent Literature 1).

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Patent No. 4675810 (Paragraph [0034]) US2010/0101256 discloses an air conditioner according to the preamble of claim 1.
[0004] US2006/0254294 discloses an air conditioner according to the preamble of claim 1.
[0005] US2009/0272135 discloses an air conditioner according to the preamble of claim 1.

Summary of Invention

Technical Problem

[0006] However, in the case where a plurality of use-side heat exchangers are performing a cooling operation, the pipe temperatures on the outlet side of the use-side heat exchangers differ from one another, and it is therefore necessary to individually control the outlet temperatures of the use-side heat exchangers.
[0007] Consequently, a problem occurs in which control for performing a cooling operation is complicated.
[0008] The present invention has been made to solve the above problem. An object of the present invention is to provide an air-conditioning apparatus which is able to simplify control for performing a cooling operation even in the case where a plurality of use-side heat exchangers are performing a cooling operation during a cooling and heating simultaneous operation.

Solution to Problem

[0009] An air-conditioning apparatus according to the present invention is set out in claim 1.

Advantageous Effects of Invention

[0010] According to the present invention, by controlling the temperature detected by the temperature detection means provided in the relay unit, even in the case where a plurality of use-side heat exchangers are performing a cooling operation during a cooling and heating simultaneous operation, it is possible to simplify control for performing a cooling operation. Therefore, an effect of being able to continue a cooling operation with low cost can be achieved.

Brief Description of Drawings

[0011]

Fig. 1 is a diagram illustrating an example of the configuration of an air-conditioning apparatus 1 according to Embodiment 1 of the present invention.
Fig. 2 illustrates a modeled connection relationship between a second flow rate control device 122, a third flow rate control device 123, and a third flow rate control unit 115 of a relay unit B according to Embodiment 1 of the present invention.
Fig. 3 is a diagram illustrating an example of the configuration of the air-conditioning apparatus 1 for explaining a cooling main operation state in a cooling and heating simultaneous operation according to Embodiment 1 of the present invention.
Fig. 4 is a diagram illustrating an example of the configuration of the air-conditioning apparatus 1 for explaining a heating main operation state in a cooling and heating simultaneous operation according to Embodiment 1 of the present invention.
Fig. 5 is a diagram illustrating an example of a temperature difference between an indoor unit temperature and a relay unit temperature at the time of cooling according to Embodiment 1 of the present invention.
Fig. 6 is a diagram for explaining an example of the correlation between the outside air temperature and the heating capacity ratio in accordance with the opening degree of the second flow rate control device 122 according to Embodiment 1 of the present invention.
Fig. 7 is a diagram for explaining an example of the correlation between the outside air temperature and the flow rate ratio in accordance with the opening degree of the second flow rate control device 122 and the opening degree of the third flow rate control device 123 according to Embodiment 1 of the present invention.
Fig. 8 is a diagram for explaining an example of the correlation between the outside air temperature and the flow rate ratio in accordance with the opening degree of the second flow rate control device 122, the opening degree of the third flow rate control device 123, and the opening degree of the third flow rate control unit 115 according to Embodiment 1 of the present invention.
Fig. 9 is a diagram for explaining an example of the correlation between the outside air temperature and

the heating capacity ratio in accordance with the case where the second flow rate control device 122 is properly controlled and the case where the second flow rate control device 122 is not properly controlled according to Embodiment 1 of the present invention. Fig. 10 is a diagram for explaining an example of the correlation between the outside air temperature and the heating capacity ratio in accordance with the case where a fourth flow rate control valve 124 is properly controlled and the case where the fourth flow rate control valve 124 is not properly controlled according to Embodiment 1 of the present invention. Fig. 11 is a flowchart for explaining an operation example of a controller 141 provided in a heat source unit A and an operation example of a controller 151 provided in the relay unit B according to Embodiment 1 of the present invention.

Description of Embodiments

[0012] Hereinafter, embodiments of the present invention will be described with reference to the drawings.

Embodiment 1.

[0013] Fig. 1 is a diagram illustrating an example of the configuration of an air-conditioning apparatus 1 according to Embodiment 1 of the present invention. As illustrated in Fig. 1, the air-conditioning apparatus 1 forms a refrigeration cycle for cooling and a refrigeration cycle for heating within the air-conditioning apparatus 1 using an indoor unit C, an indoor unit D, a relay unit B, check valves 118 to 121, a four-way valve 102, and the like to perform a cooling and heating simultaneous operation.

[0014] In the case where the outside air temperature drops during the cooling and heating simultaneous operation, as described in detail later, the relay unit B side controls the relay unit temperature detected by temperature detection means 125 provided in the relay unit B, and therefore the temperature difference between the liquid pipe temperature of a use-side heat exchanger 105 provided in each of the indoor units and the relay unit temperature can be maintained constant.

[0015] By this operation, the necessity to control the liquid pipe temperature of each of the use-side heat exchangers 105 to maintain the temperature difference from the relay unit constant can be eliminated.

[0016] Consequently, even in the case where the outside air temperature drops during the cooling and heating simultaneous operation, a cooling operation can be continued with low cost.

[0017] Hereinafter, the above details will be explained in order.

[0018] The air-conditioning apparatus 1 includes a heat source unit A, the relay unit B, the indoor unit C, the indoor unit D, and the like. The relay unit B is provided between the heat source unit A and each of the indoor unit C and the indoor unit D. The heat source unit A and the relay unit B are connected to each other by a first connection pipe 106 and a second connection pipe 107, which has a pipe diameter smaller than the first connection pipe 106. The relay unit B and the indoor unit C are connected to each other by first connection pipes 106c and second connection pipes 107c. The relay unit B and the indoor unit D are connected to each other by first connection pipes 106d and second connection pipes 107d.

[0019] With this connection configuration, the relay unit B relays a refrigerant flowing between the heat source unit A and each of the indoor unit C and the indoor unit D.

[0020] An example in which one heat source unit and two indoor units are provided will be explained below. However, the present invention is not limited to this. For example, two or more indoor units may be provided. Furthermore, for example, a plurality of heat source units may be provided. Moreover, for example, a plurality of relay units B may be provided.

[0021] The heat source unit A includes a compressor 101, the four-way valve 102, a heat-source-unit-side heat exchanger 103, and an accumulator 104. The heat source unit A also includes the check valve 118, the check valve 119, the check valve 120, and the check valve 121. The heat source unit A also includes a second flow rate control device 122, a third flow rate control device 123, a fourth flow rate control valve 124, and a controller 141. The heat source unit A also includes outside air temperature detection means 131 that measures the outside air temperature and supplies a measurement result to the controller 141.

[0022] The compressor 101 is provided between the four-way valve 102, the accumulator 104, and the second flow rate control device 122. The compressor 101 compresses the refrigerant and discharges the compressed refrigerant. The discharge side of the compressor 101 is connected to the four-way valve 102, and the suction side of the compressor 101 is connected to the accumulator 104 and the second flow rate control device 122.

[0023] The four-way valve 102 includes four ports which are connected to the discharge side of the compressor 101, the heat-source-unit-side heat exchanger 103, the accumulator 104, and the outlet side of the check valve 119 and the inlet side of the check valve 120, so that switching of the flow passage of the refrigerant can be performed.

[0024] The heat-source-unit-side heat exchanger 103 is provided between the four-way valve 102, the third flow rate control device 123, and the fourth flow rate control valve 124. The heat-source-unit-side heat exchanger 103 is connected to a pipe whose one end is connected to the four-way valve 102 and whose other end is connected to the third flow rate control device 123 and the fourth flow rate control valve 124. The heat-source-unit-side heat exchanger 103 exchanges heat between the refrigerant flowing inside the heat-source-unit-side heat exchanger 103 and the ambient air of the heat-source-unit-side heat exchanger 103.

[0025] The accumulator 104 is connected between the four-way valve 102 and the suction side of the compressor 101, performs separation of a liquid refrigerant, and supplies a gas refrigerant to the compressor 101.

[0026] The compressor 101, the four-way valve 102, and the heat-source-unit-side heat exchanger 103 explained above constitute part of a refrigerant circuit.

[0027] The check valve 118 is provided between the fourth flow rate control valve 124, which is connected to the heat-source-unit-side heat exchanger 103, and the outlet side of the check valve 121; and the second connection pipe 107 and the outlet side of the check valve 120. The inlet side of the check valve 118 is connected to a pipe connected to the fourth flow rate control valve 124 and the outlet side of the check valve 121. The outlet side of the check valve 118 is connected to a pipe connected to the second connection pipe 107 and the outlet side of the check valve 120. The check valve 118 allows the refrigerant to circulate only in one direction from the heat-source-unit-side heat exchanger 103 through the fourth flow rate control valve 124 to the second connection pipe 107.

[0028] The check valve 119 is provided between the four-way valve 102 and the inlet side of the check valve 120; and the first connection pipe 106 and the inlet side of the check valve 121. The inlet side of the check valve 119 is connected to a pipe connected to the first connection pipe 106 and the inlet side of the check valve 121. The outlet side of the check valve 119 is connected to a pipe connected to the four-way valve 102 and the inlet side of the check valve 120. The check valve 119 allows the refrigerant to circulate only in one direction from the first connection pipe 106 to the four-way valve 102.

[0029] The check valve 120 is provided between the four-way valve 102 and the outlet side of the check valve 119; and the outlet side of the check valve 118 and the second connection pipe 107. The inlet side of the check valve 120 is connected to a pipe connected to the four-way valve 102 and the outlet side of the check valve 119. The outlet side of the check valve 120 is connected to a pipe connected to the outlet side of the check valve 118 and the second connection pipe 107. The check valve 120 allows the refrigerant to circulate only in one direction from the four-way valve 102 to the second connection pipe 107.

[0030] The check valve 121 is provided between the inlet side of the check valve 119 and the first connection pipe 106; and the inlet side of the check valve 118 and the fourth flow rate control valve 124 connected to the heat-source-unit-side heat exchanger 103. The inlet side of the check valve 121 is connected to a pipe connected to the inlet side of the check valve 119 and the first connection pipe 106. The outlet side of the check valve 121 is connected to a pipe connected to the inlet side of the check valve 118 and the fourth connection pipe 124. The check valve 121 allows the refrigerant to circulate only in one direction from the first connection pipe 106 through the fourth flow rate control valve 124 to the heat-source-unit-side heat exchanger 103.

[0031] The check valves 118 to 121 explained above form a flow switching valve of the refrigerant circuit. The flow switching valve and the relay unit B, the indoor unit C, and the indoor unit D, which will be described in detail later, form a refrigeration cycle for the cooling operation and a refrigeration cycle for a heating operation in the refrigerant circuit during the cooling and heating simultaneous operation.

[0032] One end of the second flow rate control device 122 is connected to the inlet side of the check valve 121 and the other end of the second flow rate control device 122 is connected to the suction side of the compressor 101. The inlet side of the check valve 121 is connected to one end of the first connection pipe 106. The other end of the first connection pipe 106 is connected to the relay unit B.

[0033] With this connection configuration, the second flow rate control device 122 is connected in series to the relay unit B, so that the refrigerant is supplied from the relay unit B. Furthermore, the second flow rate control device 122 is a flow rate control device whose opening degree is variable.

[0034] Therefore, the second flow rate control device 122 adjusts the opening degree thereof to control the amount of refrigerant which has flowed from the relay unit B, and supplies the controlled amount of refrigerant to the suction side of the compressor 101.

[0035] The second flow rate control device 122 corresponds to a compressor flow rate control device according to the present invention.

[0036] The third flow rate control device 123 is provided between the second flow rate control device 122 and the heat-source-unit-side heat exchanger 103 and is connected in parallel to the second flow rate control device 122. More specifically, the third flow rate control device 123 is connected to one of end portions of the second flow rate control device 122 that is connected to the inlet side of the check valve 121.

[0037] With this connection configuration, the third flow rate control device 123 is connected in series to the relay unit B, so that the refrigerant is supplied from the relay unit B. Furthermore, the third flow rate control device 123 is a flow rate control device whose opening degree is variable.

[0038] Therefore, the third flow rate control device 123 adjusts the opening degree thereof to control the amount of refrigerant which has flowed from the relay unit B, and supplies the controlled amount of refrigerant to the heat-source-unit-side heat exchanger 103.

[0039] The third flow rate control device 123 corresponds to a heat-source-unit-side heat exchanger flow rate control device according to the present invention.

[0040] Furthermore, with the connection configuration described above, the third flow rate control device 123 is connected in parallel to the second flow rate control device 122 and is connected in series to the relay unit B.

[0041] Therefore, the refrigerant flowing from the relay unit B is distributed and supplied to the second flow rate control device 122 and the third flow rate control device 123 in accordance with the opening degree of the second flow rate control device 122 and the opening degree of the third flow rate control device 123.

[0042] The fourth flow rate control valve 124 is provided between the outlet side of the check valve 121, the inlet side of the check valve 118, and the heat-source-unit-side heat exchanger 103, and is connected in parallel to the third flow rate control device 123. More specifically, one end of the fourth flow rate control valve 124 is connected to a pipe connected to the outlet side of the check valve 121 and the inlet side of the check valve 118. The other end of the fourth flow rate control valve 124 is connected to a pipe on a side of one of end portions of the third flow rate control device 123 that is connected to the heat-source-unit-side heat exchanger 103.

[0043] With this connection configuration, the fourth flow rate control valve 124 is connected in series to the relay unit B via the check valve 121, so that the refrigerant is supplied from the relay unit B. Furthermore, the fourth flow rate control valve 124 is a flow rate control valve whose opening degree is variable.

[0044] Therefore, the fourth flow rate control valve 124 adjusts the opening degree thereof to control the amount of refrigerant which has flowed from the relay unit B, and supplies the controlled amount of refrigerant to the heat-source-unit-side heat exchanger 103.

[0045] With this connection configuration, the fourth flow rate control valve 124 is connected in parallel to the second flow rate control device 122 and the third flow rate control device 123 via the check valve 121, and is connected in series to the relay unit B.

[0046] Therefore, the refrigerant flowing from the relay unit B is distributed and supplied to the second flow rate control device 122, the third flow rate control device 123, and the fourth flow rate control valve 124 in accordance with the opening degree of the second flow rate control device 122, the opening degree of the third flow rate control device 123, and the opening degree of the fourth flow rate control valve 124.

[0047] The controller 141 includes, for example, a microprocessor unit as a main element, and performs the integrated control of the entire heat source unit A, communication with an external device, such as the relay unit B, and various arithmetic operations.

[0048] The outside air temperature detection means 131 is, for example, a thermistor. The outside air temperature detection means 131 supplies a measurement result of the outside air temperature to the controller 141. The outside air temperature detection means 131 may supply the measurement result directly to the controller 141 or may accumulate measurement results for a certain period of time and then supply the accumulated measurement results to the controller 141 with predetermined time intervals.

[0049] Although an example in which the outside air temperature detection means 131 is a thermistor has been explained above, the present invention is not particularly limited to this.

[0050] The relay unit B includes a first branch part 110, a second branch part 111, a gas/liquid separator 112, a second flow rate control unit 113, a third flow rate control unit 115, a first heat exchanger 116, a second heat exchanger 117, the temperature detection means 125, pressure detection means 127a, pressure detection means 127b, a controller 151, and the like.

[0051] The relay unit B is connected to the heat source unit A via the first connection pipe 106 and the second connection pipe 107. The relay unit B is connected to the indoor unit C via the first connection pipes 106c and the second connection pipe 107c. The relay unit B is connected to the indoor unit D via the first connection pipes 106d and the second connection pipes 107d.

[0052] The first branch part 110 includes solenoid valves 108a and solenoid valves 108b. The solenoid valves 108a and the solenoid valves 108b are connected to the indoor unit C via the first connection pipes 106c. The solenoid valves 108a and the solenoid valves 108b are connected to the indoor unit D via the first connection pipes 106d.

[0053] The solenoid valves 108a are valves that can be opened and closed. One end of each of the solenoid valves 108a is connected to the first connection pipe 106, and the other end of each of the solenoid valves 108a is connected to the corresponding first connection pipe 106c, the corresponding first connection pipe 106d, and one terminal of the corresponding solenoid valve 108b. The solenoid valves 108b are valves that can be opened and closed. One end of each of the solenoid valves 108b is connected to the second connection pipe 107, and the other end of each of the solenoid valves 108b is connected to the corresponding first connection pipe 106c, the corresponding first connection pipe 106d, and one terminal of the corresponding solenoid valve 108a.

[0054] The first branch part 110 is connected to the indoor unit C via the first connection pipes 106c. The first branch part 110 is connected to the indoor unit D via the first connection pipes 106d. The first branch part 110 is connected to the heat source unit A via the first connection pipe 106 and the second connection pipe 107. The first branch part 110 allows connection between the first connection pipes 106c and either the first connection pipe 106 or the second connection pipe 107 using the solenoid valves 108a and the solenoid valves 108b. The first branch part 110 allows connection between the first connection pipes 106d and either the first connection pipe 106 or the second connection pipe 107 using the solenoid valves 108a and the solenoid valves 108b.

[0055] The second branch part 111 includes check valves 137a and check valves 137b. The check valves 137a and the check valves 137b are connected in antiparallel to each other. The input side of the check valves 137a and the output side of the check valves 137b are connected to the indoor unit C via the second connection pipes 107c and are connected to the indoor unit D via the second connection pipes 107d. The output side of the check valves 137a is connected to a junction part 137a_all. The input side of the check valves 137b is connected to a junction part 137b_all.

[0056] The second branch part 111 is connected to the indoor unit C via the second connection pipes 107c. The second branch part 111 is connected to the indoor unit D via the second connection pipes 107d. The second branch part 111 is connected to the second flow rate control unit 113 and the first heat exchanger 116 via the junction part 137a_all. The second branch part 111 is connected to the third flow rate control unit 115 and the first heat exchanger 116 via the junction part 137b_all.

[0057] The gas/liquid separator 112 is provided in the middle of the second connection pipe 107. A gas-phase portion of the gas/liquid separator 112 is connected to the solenoid valves 108b of the first branch part 110, and a liquid-phase portion of the gas/liquid separator 112 is connected to the second branch part 111 via the first heat exchanger 116, the second flow rate control unit 113, the second heat exchanger 117, and the third flow rate control unit 115.

[0058] One end of the second flow rate control unit 113 is connected to the first heat exchanger 116, and the other end of the second flow rate control unit 113 is connected to one end of the second heat exchanger 117 and the junction part 137a_all of the second branch part 111. At a pipe connecting the first heat exchanger 116 and the second flow rate control unit 113, the pressure detection means 127a, which will be described in detail later, is provided. At a pipe connecting the second flow rate control unit 113, the second heat exchanger 117, and the junction part 137a_all, the pressure detection means 127b, which will be described in detail later, is provided.

[0059] The second flow rate control unit 113 is a flow rate control unit whose opening degree is adjustable. The opening degree of the second flow rate control unit 113 is adjusted so that a difference between a pressure value detected by the pressure detection means 127a and a pressure value detected by the pressure detection means 127b is maintained constant.

[0060] One end of the third flow rate control unit 115 is connected to a bypass pipe 114 side of the second heat exchanger 117, and the other end of the third flow rate control unit 115 is connected to a side of a pipe connecting the junction part 137b_all and the second heat exchanger 117. The third flow rate control unit 115 is a flow rate control unit whose opening degree is adjustable. The opening degree of the third flow rate control unit 115 is adjusted in accordance with any one of the outside air temperature detection means 131, the temperature detection means 125, the pressure detection means 127a, and the pressure detection means 127b or a combination thereof.

[0061] One end of the bypass pipe 114 is connected to the first connection pipe 106, and the other end of the bypass pipe 114 is connected to the third flow rate control unit 115.

[0062] Accordingly, the amount of refrigerant to be supplied to the heat source unit A varies according to the opening degree of the third flow rate control unit 115.

[0063] The first heat exchanger 116 is connected between the gas/liquid separator 112, the second heat exchanger 117, and the second flow rate control unit 113, and exchanges heat between the bypass pipe 114 and a pipe provided between the gas/liquid separator 112 and the second flow rate control unit 113.

[0064] The second heat exchanger 117 is connected between the first heat exchanger 116 and the second flow rate control unit 113; and one end of the third flow rate control unit 115 and the other end of the third flow rate control unit 115. In this case, the other end of the third flow rate control unit 115 is connected to the junction part 137b_all. The second heat exchanger 117 exchanges heat between the bypass pipe 114, and a pipe provided between the second flow rate control unit 113 and the third flow rate control unit 115.

[0065] The temperature detection device 125 is, for example, a thermistor. The temperature detection device 125 measures the temperature of the refrigerant flowing between the third flow rate control unit 115 and the second heat exchanger 117, that is, the refrigerant flowing inside a pipe provided on the downstream side of the third flow rate control unit 115, and supplies a measurement result to the controller 151. The temperature detection device 125 may supply the measurement result directly to the controller 151 or may accumulate measurement results for a certain period of time and then supply the accumulated measurement results to the controller 151 with predetermined time intervals.

[0066] Although an example in which the temperature detection means 125 is a thermistor has been explained above, the present invention is not particularly limited to this.

[0067] The pressure detection device 127a measures the pressure of the refrigerant flowing inside a pipe provided between the first heat exchanger 116 and the second flow rate control unit 113, and supplies a measurement result to the controller 151.

[0068] The pressure detection device 127b measures the pressure of the refrigerant flowing inside a pipe provided between the second flow rate control unit 113, the second heat exchanger 117, and the second branch part 111, and supplies a measurement result to the controller 151.

[0069] The pressure detection device 127a and the pressure detection means 127b are collectively referred to as pressure detection means 127. The pressure detection device 127 may supply a measurement result directly to the controller 151 or may accumulate measurement results for a certain period of time and then supply the accumulated measurement results to the controller 151 with predetermined time intervals.

[0070] The controller 151 includes, for example, a microprocessor unit as a main element, and performs the integrated control of the entire relay unit B, communication with an external device, such as the heat source unit A, and various arithmetic operations.

[0071] The indoor unit C includes use-side heat exchangers 105c, liquid pipe temperature detection devices 126c, first flow rate control units 109c, and the like. A plurality of use-side heat exchangers 105c are provided. The liquid pipe temperature detection devices 126c for detecting the temperature of a pipe are provided between the use-side heat exchangers 105c and the first flow rate control units 109c.

[0072] The use-side heat exchangers 105c and the first flow rate control units 109c explained above constitute part of the refrigerant circuit.

[0073] The indoor unit D includes use-side heat exchangers 105d, liquid pipe temperature detection devices 126d, first flow rate control units 109d, and the like. A plurality of use-side heat exchangers 105d are provided. The liquid pipe temperature detection devices 126d for detecting the temperature of a pipe are provided between the use-side heat exchangers 105d and the first flow rate control units 109d.

[0074] The above-mentioned use-side heat exchangers 105d and the first flow rate control units 109d constitute part of the refrigerant circuit.

[0075] Fig. 2 illustrates a modeled connection relationship between the second flow rate control device 122, the third flow rate control device 123, and the third flow rate control unit 115 of the relay unit B according to Embodiment 1 of the present invention. As illustrated in Fig. 2, the second flow rate control device 122 is provided between the relay unit B and the compressor 101. Furthermore, the third flow rate control device 123 and the fourth flow rate control valve 124 are provided between the relay unit B and the heat-source-unit-side heat exchanger 103. The third flow rate control device 123 and the fourth flow rate control valve 124 are connected in parallel to each other, and the third flow rate control device 123 and the second flow rate control device 122 are connected in parallel to each other. Accordingly, the second flow rate control device 122, the third flow rate control device 123, and the fourth flow rate control valve 124 are connected in parallel to one another and are connected in series to the relay unit B.

[0076] As described above, the relay unit B includes the third flow rate control unit 115, and adjusts the amount of refrigerant to the heat source unit A side.

[0077] Therefore, the third flow rate control unit 115 determines the amount of refrigerant flowing in the second flow rate control device 122, the third flow rate control device 123, and the fourth flow rate control valve 124.

[0078] The controller 141 adjusts the opening degree of the second flow rate control device 122, the third flow rate control device 123, and the fourth flow rate control valve 124. The controller 151 adjusts the opening degree of the third flow rate control unit 115. The controller 141 and the controller 151 transmit and receive various signals to supply control contents to each other.

[0079] Fig. 3 is a diagram illustrating an example of the configuration of the air-conditioning apparatus 1 for explaining a cooling main operation state in the cooling and heating simultaneous operation according to Embodiment 1 of the present invention.

[0080] As a prerequisite, it is assumed that the cooling operation and the heating operation are set for the indoor unit C and the indoor unit D, respectively, and the operation of the air-conditioning apparatus 1 is performed based on a cooling main operation.

[0081] The solenoid valves 108a on the indoor unit C side are opened, and the solenoid valves 108a on the indoor unit D side are closed. The solenoid valves 108b on the indoor unit C side are closed, and the solenoid valves 108b on the indoor unit D side are opened.

[0082] The opening degree of the second flow rate control unit 113 is controlled so that the pressure difference between the pressure detection means 127a and the pressure detection means 127b has an appropriate value.

[0083] The flow of the refrigerant will be explained. As expressed by thick solid arrows, a high-temperature and high-pressure gas refrigerant which has been compressed by and discharged from the compressor 101 passes through the four-way valve 102 and flows into the heat-source-unit-side heat exchanger 103.

[0084] The heat-source-unit-side heat exchanger 103 exchanges heat with a heat source medium such as air or water. The high-temperature and high-pressure gas refrigerant which has been subjected to heat exchange turns into a two-phase gas-liquid, high-temperature and high-pressure refrigerant. Next, the two-phase gas-liquid, high-temperature and high-pressure refrigerant passes through the fourth flow rate control valve 124, the check valve 118, and the second connection pipe 107, and is supplied to the gas/liquid separator 112 of the relay unit B.

[0085] The gas/liquid separator 112 separates the two-phase gas-liquid, high-temperature and high-pressure refrigerant into a gas-state refrigerant and a liquid-state refrigerant.

[0086] The separated gas-state refrigerant flows into the first branch part 110. The gas-state refrigerant which has flowed into the first branch part 110 passes through the opened solenoid valves 108b and the first connection pipes 106d, and is supplied to the indoor unit D, for which the heating operation is set.

[0087] In the indoor unit D, the use-side heat exchangers 105d exchange heat with a use-side medium such as air, and condense and liquefy the supplied gas-state refrigerant.

[0088] Furthermore, the use-side heat exchangers 105d are controlled by the first flow rate control units 109d on the basis of the degree of subcooling at the outlet of the use-side heat exchangers 105d.

[0089] The first flow rate control units 109d decompress a liquid refrigerant, which has been condensed and liquefied by the use-side heat exchangers 105d, into the refrigerant having an intermediate pressure, which is between a high pressure and a low pressure.

[0090] The refrigerant, which has the intermediate pressure, is caused to flow into the second branch part 111.

[0091] At this time, the first connection pipe 106 has a low pressure, and the second connection pipe 107 has a high pressure. Therefore, due to the pressure difference between the first connection pipe 106 and the second connection pipe 107, the refrigerant flows to the check valve 118 and the check valve 119, while the refrigerant does not flow to the check valve 120 or the check valve 121.

[0092] Meanwhile, the liquid-state refrigerant which has been separated by the gas/liquid separator 112 passes through the second flow rate control unit 113, which controls the pressure difference between the high pressure and the intermediate pressure to be maintained constant, and flows into the second branch part 111.

[0093] Next, in the second branch part 111, the supplied liquid-state refrigerant passes through the check valves 108d which are connected to the indoor unit C side, and flows into the indoor unit C.

[0094] Next, the liquid-state refrigerant which has flowed into the indoor unit C is decompressed into a low pressure using the first flow rate control units 109c which are controlled in accordance with the degree of superheat at the outlet of the use-side heat exchangers 105c of the indoor unit C, and is supplied to the use-side heat exchangers 105c.

[0095] In the use-side heat exchangers 105c, the supplied liquid-state refrigerant evaporates and gasifies by heat exchange with a use-side medium such as air.

[0096] The refrigerant, which has been gasified into a gas refrigerant, passes through the first connection pipes 106c and flows into the first branch part 110. In the first branch part 110, the solenoid valves 108a on a side that is connected to the indoor unit C are opened. Thus, the gas refrigerant which has flowed into the first branch part 110 passes through the solenoid valves 108a on a side that is connected to the indoor unit C, and flows into the first connection pipe 106.

[0097] Next, the gas refrigerant flows into the check valve 119 side at a lower pressure than the check valve 121, passes through the four-way valve 102 and the accumulator 104, and is sucked into the compressor 101.

[0098] By the above operation, a refrigeration cycle is formed, and a cooling main operation is performed.

[0099] Some of the liquid-state refrigerant which has been separated by the gas/liquid separator 112 and has flowed into the second branch part 111 does not flow into the indoor unit C. Such a liquid-state refrigerant passes through the second flow rate control unit 113 and the second heat exchanger 117, and flows not into the second branch part 111 but into the third flow rate control unit 115. The third flow rate control unit 115 decompresses the liquid-state refrigerant which has flowed into the third flow rate control unit 115 into a low pressure to lower the evaporating temperature of the refrigerant. In the course of passage through the bypass pipe 114, the liquid-state refrigerant whose evaporating temperature has been lowered turns into a two-phase gas-liquid refrigerant by heat exchange at the second heat exchanger 117 mainly with a liquid refrigerant supplied from the second flow rate control unit 113, turns into a gas refrigerant by heat exchange at the first heat exchanger 116 with a high-temperature and high-pressure liquid refrigerant supplied from the gas/liquid separator 112, and flows into the first connection pipe 106.

[0100] Fig. 4 is a diagram illustrating an example of the configuration of the air-conditioning apparatus 1 for explaining a heating main operation state in the cooling and heating simultaneous operation according to Embodiment 1 of the present invention.

[0101] As a prerequisite, it is assumed that the heating operation and the cooling operation are set for the indoor unit C and the indoor unit D, respectively, and the operation of the air-conditioning apparatus 1 is performed based on a heating main operation.

[0102] The solenoid valves 108a on the indoor unit C side are closed, and the solenoid valves 108a on the indoor unit D side are opened. The solenoid valves 108b on the indoor unit C side are opened, and the solenoid valves 108b on the indoor unit D side are closed.

[0103] The opening degree of the second flow rate control unit 113 is controlled so that the pressure difference between the pressure detection means 127a and the pressure detection means 127b has an appropriate value.

[0104] The flow of the refrigerant will be explained. As expressed by thick solid arrows, a high-temperature and high-pressure gas refrigerant which has been compressed by and discharged from the compressor 101 passes through the four-way valve 102, the check valve 120, and the second connection pipe 107, and flows into the gas/liquid separator 112 of the relay unit B.

[0105] The gas/liquid separator 112 supplies the high-temperature and high-pressure gas refrigerant to the first branch part 110. The gas refrigerant which has been supplied to the first branch part 110 passes through the opened solenoid valves 108b and the first connection pipes 106c, and is supplied to the indoor unit C, for which the heating operation is set.

[0106] In the indoor unit C, the use-side heat exchangers 105c exchange heat with a use-side medium such as air, and condense and liquefy the supplied gas refrigerant.

[0107] Furthermore, the use-side heat exchangers 105c are controlled by the first flow rate control units 109c on the basis of the degree of subcooling at the outlet of the use-side heat exchangers 105c.

[0108] The first flow rate control units 109c decompress a liquid refrigerant, which has been condensed and liquefied by the use-side heat exchangers 105c, into a liquid refrigerant having an intermediate pressure, which is between a high pressure and a low pressure.

[0109] The liquid refrigerant, which has the intermediate pressure, is caused to flow into the second branch part 111.

[0110] The liquid refrigerant which has flowed into the second branch part 111 merges at the junction part 137a_all. The liquid refrigerant which has been merged at the junction part 137a_all passes through the second heat exchanger 117. At this time, part of the liquid refrigerant which has passed through the second heat exchanger 117 earlier passes through the third flow rate control unit 115, and the refrigerant in the decompressed state flows into the second heat exchanger 117 via the bypass pipe 114. At the second heat exchanger 117, heat exchange is performed between the intermediate-pressure liquid refrigerant and the low-pressure liquid refrigerant. The low-pressure liquid refrigerant has a low evaporating temperature, and is therefore turns into a gas refrigerant. The gas refrigerant passes through the bypass pipe 114 and flows into the first connection pipe 106. Meanwhile, the intermediate-pressure liquid refrigerant reaches the junction part 137b_all, passes through the check valves 137b which are connected to the indoor unit D, passes through the second connection pipes 107d, and flows into the indoor unit D.

[0111] Next, the liquid-state refrigerant which has flowed into the indoor unit D is decompressed into a low pressure using the first flow rate control units 109d which are controlled in accordance with the degree of superheat at the outlet of the use-side heat exchangers 105d of the indoor unit D. The liquid refrigerant, which has a low evaporating temperature, is supplied to the use-side heat exchangers 105d.

[0112] In the use-side heat exchangers 105d, the supplied liquid refrigerant having the low evaporating temperature evaporates and gasifies by heat exchange with a use-side medium such as air.

[0113] The refrigerant, which has been gasified into a gas refrigerant, passes through the first connection pipes 106d and flows into the first branch part 110. In the first branch part 110, the solenoid valves 108a on a side that is connected to the indoor unit D are opened. Thus, the gas refrigerant which has flowed into the first branch part 110 passes through the solenoid valves 108a on a side that is connected to the indoor unit D, and flows into the first connection pipe 106.

[0114] Next, the gas refrigerant flows into the check valve 121 side having a lower pressure than the check valve 119, flows into the fourth flow rate control valve 124 and the heat-source-unit-side heat exchanger 103, and is evaporated and gasified into a gas state. Next, the refrigerant passes through the four-way valve 102 and the accumulator 104, and is sucked into the compressor 101.

[0115] By the above operation, a refrigeration cycle is formed, and a heating main operation is performed.

[0116] At this time, the first connection pipe 106 has a low pressure, and the second connection pipe 107 has a high pressure. Therefore, due to the pressure difference between the first connection pipe 106 and the second connection pipe 107, the refrigerant flows to the check valve 120 and the check valve 121, while the refrigerant does not flow to the check valve 118 or the check valve 119.

[0117] A case where the outside air temperature decreases at the time of a heating main operation during the cooling and heating simultaneous operation with the above configuration is assumed.

[0118] The suction temperature of the heat source unit A decreases as the outside air temperature decreases. Consequently, the evaporating temperature of the heat-source-unit-side heat exchanger 103 provided in the heat source unit A, that is, a low-pressure pressure, also decreases. Due to such a phenomenon, the liquid pipe temperatures detected by the liquid pipe temperature detection means 126 of the indoor unit D that is performing the cooling operation decrease. Consequently, the indoor unit D repeats start and stop. Therefore, the air-conditioning apparatus 1 cannot continue the cooling operation, which makes a user of the air-conditioning apparatus 1 feel uncomfortable.

[0119] In order to prevent start and stop of the indoor unit D, it is necessary to increase the liquid pipe temperatures detected by the liquid pipe temperature detection means 126 of the indoor unit D to a predetermined value or more. However, the liquid pipe temperatures detected by the liquid pipe temperature detection means 126 of the indoor unit D for the use-side heat exchangers 105d of the indoor unit D differ from one another. Therefore, in the case where processing for increasing the liquid pipe temperatures is performed, it is necessary to individually control the liquid pipe temperatures in accordance with the individual use-side heat exchangers 105d, and such control is complicated.

[0120] Accordingly, for simplified control, control may be performed using a single control parameter having a correlation with individual liquid pipe temperatures.

[0121] Such a control parameter is, for example, a relay unit temperature which will be explained with reference to Fig. 5.

[0122] Fig. 5 is a diagram illustrating an example of a temperature difference between an indoor unit temperature and a relay unit temperature at the time of cooling according to Embodiment 1 of the present invention. As illustrated in Fig. 5, the relay unit temperature detected by the temperature detection means 125 of the relay unit B and the indoor unit temperature detected by the liquid pipe temperature detection means 126d of the indoor unit D have a certain correlation with each other.

[0123] It is assumed that the horizontal axis represents the flow rate (kg/h) of the refrigerant. Furthermore, it is assumed that the vertical axis represents a temperature difference ΔT between the indoor unit temperature detected by the liquid pipe temperature detection means 126d of the indoor unit D that is performing the cooling operation and the relay unit temperature detected by the temperature detection means 125 of the relay unit B. It is assumed that a reference temperature difference is represented by α. Furthermore, it is assumed that $\sum Qjc$ represents a cooling-time total heat quantity and $\sum Qjh$ represents a heating-time total heat quantity. It is assumed that plotting is performed as illustrated in Fig. 5 such that a circle mark indicates that a division result obtained by dividing the cooling-time total heat quantity by the heating-time total heat quantity is small, a triangle mark indicates that the division result is large, and a square mark indicates that the division result is neither small or large.

[0124] Based on the above definition, a circle mark indicates that the heating-time total heat quantity is relatively large. This is equivalent to that a heating main operation is being performed. Based on the above definition, a triangle mark indicates that the cooling-time total heat quantity is relatively large. This is equivalent to that a cooling main operation is being performed. Furthermore, based on the above definition, a square mark is equivalent to that there is a relatively negligible amount of difference between the cooling operation and the heating operation.

[0125] Here, an attention is paid to a change in the case of a circle mark which indicates that the cooling/heating ratio is small, that is, the heating-time total heat quantity is relatively large. In the case where the cooling/hating ratio is small, that is, in the case where a heating main operation is being performed during the cooling and heating simultaneous operation, the pressure loss inside the relay unit B increases as the flow rate of the refrigerant increases. Therefore, the pressure loss increases, and the temperature detected by the temperature detection means 125 of the relay unit B increases.

[0126] For example, it is assumed that the liquid pipe temperature is 3 (degrees Centigrade). It is assumed that, at this time, in a heating main operation during the cooling and heating simultaneous operation, the relay unit temperature detected by the temperature detection means 125 of the relay unit B before the flow rate of the refrigerant increases is 2 (degrees Centigrade). In this case, the reference temperature difference is 1 (degree Centigrade). It is assumed that, after that, in a heating main operation during the cooling and heating simultaneous operation, the relay unit temperature detected by the temperature detection means 125 of the relay unit B after the flow rate of the refrigerant increases is 5 (degrees Centigrade). In this case, the current temperature difference is -2 (degrees Centigrade).

[0127] Therefore, when the flow rate of the refrigerant increases, the temperature difference changes from the reference temperature difference 1 (degree Centigrade) to the current temperature difference -2 (degrees Centigrade), and the current temperature difference may be smaller than the reference temperature difference by 3 (degrees Centigrade).

[0128] Consequently, the value corrected by 3 (degrees Centigrade) can be defined as a target control temperature of the relay unit temperature.

[0129] More specifically, in the above case, control may be performed using the value obtained by subtracting 3 (WB degrees Centigrade) from the temperature detected by the temperature detection means 125 of the relay unit B as the target control temperature of the third flow rate control unit 115. By this operation, the necessity to set a target control temperature for each of the indoor unit temperatures can be eliminated, and control can be performed based on a detection result of the temperature detection means 125 of the relay unit B.

[0130] Therefore, control may be simplified, and a stable cooling operation can be maintained.

[0131] Although the case where the flow rate of the refrigerant increases has been described above, similar processing may be performed for the case where the flow rate of the refrigerant decreases. For example, the pressure loss inside the relay unit B before the flow rate of the refrigerant decreases is larger than the pressure loss inside the relay unit B after the flow rate of the refrigerant decreases. Therefore, in the case where the flow rate of the refrigerant decreases, the temperature detected by the temperature detection means 125 of the relay unit B decreases. That is, processing opposite the above-described processing may be performed.

[0132] In short, an attention may be paid to variations in the flow rate of the refrigerant flowing inside the relay unit B. A method for detecting the flow rate of the refrigerant is not particularly limited. For example, a flow meter may be provided at a pipe through which the refrigerant flows. Furthermore, the flow rate may be obtained by conversion from variations of the discharge pressure of the compressor 101.

[0133] Here, if the outside air temperature is low at the time of a heating main operation during the cooling and heating simultaneous operation, the heat-source-unit-side heat exchanger 103, the second flow rate control device 122, and the third flow rate control device 123 correlate with one another.

[0134] More specifically, as the outside air temperature decreases, it becomes more difficult for the air-conditioning apparatus 1 to maintain a high-pressure pressure high and the heating capacity degrades. Furthermore, lowering the low-pressure pressure causes the indoor unit D which is currently performing the cooling operation not to continue the operation, and a problem thus occurs both in the cooling operation and the heating operation.

[0135] Fig. 6 is a diagram for explaining an example of the correlation between the outside air temperature and the heating capacity ratio in accordance with the opening degree of the second flow rate control device 122 according to Embodiment 1 of the present invention.

[0136] In Fig. 6, it is assumed that the reference temperature on the horizontal axis is represented by α, and the reference heating capacity ratio on the vertical axis is represented by β.

[0137] As illustrated in Fig. 6, in the case where the outside air temperature is at a certain value or below, the heating capacity ratio is low when the opening degree of the second flow rate control device 122 is small, while the heating capacity ratio increases when the opening degree of the second flow rate control device 122 increases.

[0138] In other words, in order to increase the heating capacity, by increasing the opening degree of the second flow rate control device 122, a high-pressure pressure can be maintained high.

[0139] More specifically, by increasing the flow rate from the second flow rate control device 122 into the compressor 101 through a bypass, that is, the amount of injection, the high-pressure pressure increases, and the heating capacity is thus increased. For example, at an outside air temperature of α-30 degrees Centigrade, when the amount of injection is increased by 30 percent to 40 percent, the heating capacity is increased by about 8 percent.

[0140] The opening degree of the third flow rate control device 123 will now be discussed. In the case where the opening degree of the third flow rate control device 123 is opened at a certain value or more, since the second flow rate control device 122 and the third flow rate control device 123 are connected in parallel to each other, the flow rate to the second flow rate control device 122 decreases.

[0141] When the above explanation is taken into consideration, in the case where the outside air temperature is decreased from a certain value at the time of a heating main operation during the cooling and heating simultaneous operation, a value obtained by the liquid pipe temperature detection means 126 in the indoor unit D becomes lower than or equal to a certain value, and therefore the cooling operation cannot be maintained. For the above reason, by reducing the opening degree of the third flow rate control device 123, the liquid pipe temperature of the indoor unit D is increased and the amount of injection to the compressor 101 is prioritized.

[0142] By this operation, a comfortable operation can be achieved both in the cooling operation and the heating operation.

[0143] By taking such correlation characteristics into consideration, the opening degree of the second flow rate control device 122 and the opening degree of third flow rate control device 123 will be described below.

[0144] Fig. 7 is a diagram for explaining an example of the correlation between the outside air temperature and the flow rate ratio in accordance with the opening degree of the second flow rate control device 122 and the opening degree of the third flow rate control device 123 according to Embodiment 1 of the present invention.

[0145] In Fig. 7, it is assumed that the reference temperature on the horizontal axis is represented by α, and the reference flow rate ratio on the vertical axis is represented by β.

[0146] As illustrated in Fig. 7, when the outside air temperature is α-20 degrees Centigrade, the flow rate of the third flow rate control device 123 is decreased, and the flow rate of the second flow rate control device 122 is increased.

[0147] By this operation, the heating capacity can be increased. At this time, a low-pressure pressure also decreases, and therefore the cooling capacity is not affected.

[0148] Next, the correlation with the relay unit B will be discussed.

[0149] Fig. 8 is a diagram for explaining an example of the correlation between the outside air temperature and the flow rate ratio in accordance with the opening degree of the second flow rate control device 122, the opening degree of the third flow rate control device 123, and the opening degree of the third flow rate control unit 115 according to Embodiment 1 of the present invention.

[0150] In Fig. 8, the third flow rate control unit 115 provided in the relay unit B for controlling the pressure difference between the high pressure and the intermediate pressure before and after the pressure detection means 127a and 127b to be maintained constant, decreases the opening degree thereof as the outside air temperature decreases, in a manner similar to the operation of the third flow rate control device 123.

[0151] By this operation, the pressure difference between the high pressure and the intermediate pressure is maintained constant, and at the same time, the liquid pipe temperature of the indoor unit D can be increased.

[0152] Consequently, the cooling operation can be maintained.

[0153] Fig. 9 is a diagram for explaining an example of the correlation between the outside air temperature and the heating capacity ratio in accordance with the case where the second flow rate control device 122 is properly controlled and the case where the second flow rate control device 122 is not properly controlled according to Embodiment 1 of the present invention.

[0154] As illustrated in Fig. 9, in the case where the outside air temperature has reached a certain value or more, by adjusting the proper opening degree of the second flow rate control device 122, it is possible to reduce the influence on the cooling capacity and thus maintain a stable cooling capacity.

[0155] Fig. 10 is a diagram for explaining an example of the correlation between the outside air temperature and the heating capacity ratio in accordance with the case where the fourth flow rate control valve 124 is properly controlled and the case where the fourth flow rate control valve 124 is not properly controlled according to Embodiment 1 of the present invention.

[0156] As illustrated in Fig. 9, by adjusting the opening degree of the fourth flow rate control valve 124, it is possible to reduce the influence on the cooling capacity and thus maintain a stable cooling capacity. For example, when the outside air temperature is lower than a certain value, the opening degree of the fourth flow rate control valve 124 is reduced. Meanwhile, when the outside air temperature is higher than the certain value, the opening degree of the fourth flow rate control valve 124 is increased.

[0157] By this operation, it is possible to reduce the influence on the cooling capacity and thus maintain a stable cooling capacity.

[0158] As described above, by properly controlling the opening degree of the second flow rate control device 122, the third flow rate control device 123, and the third flow rate control unit 115 of the relay unit B in accordance with the outside air temperature, it is possible to continue a stable cooling operation while maintaining the heating capacity.

[0159] Thus, a high-efficiency cooling and heating simultaneous operation can be achieved.

[0160] Although a cooling main operation and a heating main operation have been explained in Embodiment 1, the present invention is not particularly limited to this. For example, only the heating operation may be performed.

[0161] Furthermore, similar effects can be achieved in the case where some or all of the number of heat source units A, the number of relay units B, and the number of indoor units are different from those in Embodiment 1 described above.

[0162] Furthermore, similar effects can be achieved in the case where an ice thermal storage tank or a water thermal storage tank (including hot water) is installed in series or parallel to the heat-source-unit-side heat exchanger 103. Although a configuration including the heat source unit A, the relay unit B, and two connection pipes: the first connection pipe 106 and the second connection pipe 107, has been explained, similar effects can be achieved with a configuration in which the total number of connection pipes is three.

[0163] Next, an operation example will be explained with reference to Fig. 11, based on the assumption of the above explanation.

[0164] Fig. 11 is a flowchart for explaining an operation example of the controller 141 provided in the heat source unit A and an operation example of the controller 151 provided in the relay unit B according to Embodiment 1 of the present invention.

[0165] It is assumed that an affirmative result is obtained in processing of step S89 of the relay unit B before processing of step S55 of the heat source unit A. That is, a significant reduction in the opening degree of the third flow rate control unit 115 of the relay unit B is a prerequisite to proceed to step S55 of the heat source unit A.

(Processing on heat source unit side)

(Step S51)

[0166] The controller 141 of the heat source unit A determines whether or not the cooling and heating simultaneous operation is being performed. When it is determined that the cooling and heating simultaneous operation is being performed, the controller 141 of the heat source unit A proceeds to step S52. When it is determined that the cooling and heating simultaneous operation is not being performed, the controller 141 of the heat source unit A proceeds to step S56.

(Step S52)

[0167] The controller 141 of the heat source unit A acquires outside air temperature. The controller 141 of the heat source unit A acquires, for example, outside air temperature data detected by the outside air temperature detection means 131.

(Step S53)

[0168] The controller 141 of the heat source unit A determines whether or not the outside air temperature corresponds to a predetermined threshold.

[0169] For example, when the outside air temperature is lower than or equal to an injection start threshold (WB degrees Centigrade), the controller 141 of the heat source unit A proceeds to step S54. The injection start threshold (WB degrees Centigrade) corresponds to, for example, α-5 (WB degrees Centigrade) which is the start temperature at which the opening degree of the second flow rate control device 122 gradually increases, as illustrated in Fig. 8. It is assumed that α-5 (WB percent) is, for example, 0 degrees Centigrade.

[0170] Although an example in which α-5 (WB percent) is 0 degrees Centigrade has been explained above, the present invention is not particularly limited to this. A specific value of α-5 (WB percent) may be varied according to circumstances in accordance with ambient environment and the operation status of the air-conditioning apparatus 1.

[0171] For example, when the outside air temperature is not as described above (above the injection start threshold (WB percent)), the controller 141 of the heat source unit A proceeds to step S55.

(Step S54)

[0172] The controller 141 of the heat source unit A changes the opening degree of the second flow rate control device 122. For example, the controller 141 of the heat source unit A gradually changes the ratio at which the opening degree is reduced in accordance with the outside air temperature, as illustrated in Fig. 8.

(Step S55)

[0173] The controller 141 of the heat source unit A reduces the opening degree of the third flow rate control device 123. For example, as illustrated in Fig. 8, although the opening degree of the third flow rate control device 123 is fully opened when the outside air temperature is within a range from α (WB percent) to α-20 (WB percent), the third flow rate control device 123 is throttled and the opening degree thereof is reduced when the outside air temperature is at α-20 (WB percent) or below.

(Step S56)

[0174] The controller 141 of the heat source unit A determines whether or not a termination instruction exists. When a termination instruction exists, the controller 141 of the heat source unit A ends the process. When a termination instruction does not exist, the controller 141 of the heat source unit A returns to step S51, and repeats processing of steps S51 to S55.

(Processing on relay unit side)

(Step S81)

[0175] The controller 151 of the relay unit B determines whether or not the cooling and heating simultaneous operation is being performed. When it is determined that the cooling and heating simultaneous operation is being performed, the controller 151 of the relay unit B proceeds to step S82. When it is determined that the cooling and heating simultaneous operation is not being performed, the controller 151 of the relay unit B proceeds to step S92.

(Step S82)

[0176] The controller 151 of the relay unit B acquires a high-pressure-side pressure value. For example, the controller 151 of the relay unit B acquires a pressure value of a high-pressure side of the pressure detection means 127a or 127b. The determination as to which one of the pressure detection means 127a and 127b is on a high-pressure side is performed based on a correspondence table held by the controller 151 of the relay unit B in which information indicating which one of the pressure detection means 127a and 127b corresponds to a high pressure side is registered in advance in accordance with the operation state.

(Step S83)

[0177] The controller 151 of the relay unit B acquires an intermediate-pressure-side pressure value. For example, the controller 151 of the relay unit B acquires a pressure value of an intermediate-pressure side of the pressure detection means 127a or 127b. The determination as to which one of the pressure detection means 127a and 127b is on an intermediate pressure side is performed based on a correspondence table held by the controller 151 of the relay unit B in which information indicating which one of the pressure detection means 127a and 127b corresponds to an intermediate pressure side is registered in advance in accordance with the operation state.

(Step S84)

[0178] The controller 151 of the relay unit B obtains a pressure difference between the high-pressure-side pressure value and the intermediate-pressure-side pressure value.

(Step S85)

[0179] The controller 151 of the relay unit B determines whether or not the pressure difference is constant. When the pressure difference is constant, the controller 151 of the relay unit B proceeds to step S87. When the pressure difference is not constant, the controller 151 of the relay unit B proceeds to step S86.

(Step S86)

[0180] The controller 151 of the relay unit B makes the pressure difference constant by the third flow rate control unit 115 of the relay unit B.

(Step S87)

[0181] The controller 151 of the relay unit B acquires the temperature on the third flow rate control unit 115 side of the relay unit B. The controller 151 of the relay unit B acquires, for example, the relay unit temperature detected by the temperature detection means 125.

(Step S88)

[0182] The controller 151 of the relay unit B acquires the liquid pipe temperature of the indoor unit that is performing the cooling operation. The controller 151 of the relay unit B acquires, for example, the liquid pipe temperature detected by the liquid pipe temperature detection means 126d of the indoor unit D that is performing the cooling operation, as illustrated in Fig. 4.

[0183] For example, it is assumed that the liquid pipe temperature is detected by the liquid pipe temperature detection means 126d which is on the left side of Fig. 4.

(Step S89)

[0184] The controller 151 of the relay unit B acquires a temperature difference ΔT between the temperature on the third flow rate control unit 115 side and the liquid pipe temperature of the indoor unit D. For example, the controller 151 of the relay unit B obtains a temperature difference ΔT between the relay unit temperature detected by the temperature detection means 125 and the liquid pipe temperature detected by the liquid pipe temperature detection means 126d on the left side of Fig. 4.

(Step S90)

[0185] The controller 151 of the relay unit B determines, based on the temperature difference ΔT and the reference temperature difference, whether the temperature difference ΔT falls within a specific range. Here, the reference temperature difference represents a predetermined specific range based on the temperature difference between the liquid pipe temperature and the relay unit temperature, as described above.

(Step S91)

[0186] The controller 151 of the relay unit B determines whether or not the opening degree is significantly smaller than the previous time. When it is determined that the opening degree is significantly smaller than the previous adjustment time, the controller 151 of the relay unit B transmits to the heat source unit A information indicating that the opening degree is significantly smaller than the previous adjustment time, and at the same time, the process proceeds to step S55 of the heat source unit A side. When it is determined that the opening degree is not significantly smaller than the previous adjustment time, the controller 151 of the relay unit B proceeds to step S92.

(Step S92)

[0187] The controller 151 of the relay unit B determines whether or not a termination instruction exists. When a termination instruction exists, the controller 151 of the relay unit B ends the process. When a termination instruction does not exist, the controller 151 of the relay unit B returns to step S81, and repeats processing of steps S81 to S91.

[0188] As described above, by controlling the temperature detected by the temperature detection means 125 provided in the relay unit B, control for performing the cooling operation can be simplified even in the case where a plurality of use-side heat exchangers are performing the cooling operation during the cooling and heating simultaneous operation. Therefore, the cooling operation can continue to be performed with low cost.

[0189] As described above, in Embodiment 1, in the air-conditioning apparatus 1 that includes the heat-source-unit-side heat exchanger 103, the plurality of use-side heat exchangers 105, and the relay unit B which is provided between the heat-source-unit-side heat exchanger 103 and the plurality of use-side heat exchangers 105, which switches part of the plurality of use-side heat exchangers 105 to the cooling operation side, and which switches part of the plurality of use-side heat exchangers 105 to the heating operation side and that performs the cooling and heating simultaneous operation by switching each of the plurality of use-side heat exchangers 105 to the cooling operation side or the heating operation side in accordance with a control instruction, the relay unit B includes the third flow rate control unit 115 which adjusts the flow rate of the refrigerant to be distributed to the heat-source-unit-side heat exchanger 103 and a use-side heat exchanger 105 that is performing the cooling operation among the plurality of use-side heat exchangers 105, and the controller 151 which adjusts the third flow rate control unit 115, and the controller 151 obtains, based on a downstream-side temperature on a downstream side of the third flow rate control unit 115 and a liquid pipe temperature of the use-side heat exchanger 105 that is performing the cooling operation among the plurality of use-side heat exchangers 105, a target control temperature of the downstream-side temperature, and controls the liquid pipe temperature by adjusting the third flow rate control unit 115 in accordance with the target control temperature. Accordingly, even in the case where a plurality of use-side heat exchangers are performing the cooling operation during the cooling and heating simultaneous operation, it is possible to simplify control for performing the cooling operation. With this configuration, the cooling operation can continue to be performed with low cost. Reference Signs List

[0190] A: heat source unit, B: relay unit, C, D: indoor unit, 1: air-conditioning apparatus, 101: compressor, 102: four-way valve, 103: heat-source-unit-side heat exchanger, 104: accumulator, 105, 105c, 105d: use-side heat exchanger, 106, 106c, 106d: first connection pipe, 107, 107c, 107d: second connection pipe, 108, 108a, 108b: solenoid valve, 109, 109c, 109d: first flow rate control unit, 110: first branch part, 111: second branch part, 112: gas/liquid separator, 113: second flow rate control unit, 114: bypass pipe, 115: third flow rate control unit, 116: first heat exchanger, 117: second heat exchanger, 118 to 121, 137a, 137b: check valve, 122: second flow rate control device, 123: third flow rate control device, 124: fourth flow rate control valve, 125: temperature detection means, 126, 126c, 126d: liquid pipe temperature detection means, 127, 127a, 127b: pressure detection means, 131: outside air temperature detection means, 135: injection pipe, 137a_all, 137b_all: junction part, 141, 151: controller

Claims

1. An air-conditioning apparatus (1) comprising:

a heat-source-unit-side heat exchanger (103);
a plurality of use-side heat exchangers (105, 105c, 105d);
a plurality of first flow rate control units (109, 109c, 109d) for controlling flow rate in the use-side heat exchangers (105, 105c, 105d);
wherein the air-conditioning apparatus (1) performs a cooling and heating simultaneous operation by switching each of the plurality of use-side heat exchangers (105, 105c, 105d) to the cooling operation side or the heating operation side in accordance with a control instruction;
a relay unit (B) provided between the heat-source-unit-side heat exchanger (103) and the plurality of use-side heat exchangers (105,

105c, 105d), configured to switch part of the plurality of use-side heat exchangers (105, 105c, 105d) to a cooling operation side, and switch part of the plurality of use-side heat exchangers (105, 105c, 105d) to a heating operation side, **characterized in that** the relay unit (B) includes

a second flow rate control unit (115) configured to adjust a flow rate of a refrigerant to be distributed to the heat-source-unit-side heat exchanger (103) and a use-side heat exchanger (105, 105c, 105d) that is performing the cooling operation among the plurality of use-side heat exchangers (105, 105c, 105d),
a temperature detection device (125) configured to measure a downstream-side temperature on a downstream side of the second flow rate control unit (115),
a liquid pipe temperature detection device (126) configured to measure a liquid pipe temperature of the use side heat exchanger (105, 105c, 105d) that is performing the cooling operation,
a controller (151) configured to adjust the second flow rate control unit (115), and

wherein the controller (151)

obtains, based on the downstream-side temperature of the second flow rate control unit (115) and the liquid pipe temperature, a target control temperature of the downstream-side temperature, and
controls the liquid pipe temperature by adjusting the second flow rate control unit (115) in accordance with the target control temperature.

2. The air-conditioning apparatus (1) of claim 1, wherein the controller (151)
obtains a reference temperature difference between the downstream-side temperature and the liquid pipe temperature serving as a reference before a flow rate of the refrigerant flowing in the relay unit (B) varies,
obtains a current temperature difference between the downstream-side temperature and the liquid pipe temperature when the flow rate of the refrigerant flowing in the relay unit (B) varies,
obtains a correction amount of the downstream-side temperature, based on the reference temperature difference and the current temperature difference,
obtains the target control temperature, based on the downstream-side temperature and the correction amount, and
controls the liquid pipe temperature, based on the target control temperature.

3. The air-conditioning apparatus (1) of claim 2, wherein the controller (151)
decreases the target control temperature when the flow rate of the refrigerant flowing in the relay unit (B) increases, and
increases the target control temperature when the flow rate of the refrigerant flowing in the relay unit (B) decreases.

4. The air-conditioning apparatus (1) of claim 3, further comprising:

a compressor (101) configured to compress a refrigerant and discharge the compressed refrigerant;
an injection pipe (135) provided between the relay unit (B) and the heat-source-unit-side heat exchanger (103) and allowing the refrigerant that is to flow into the heat-source-unit-side heat exchanger (103) to be supplied to the compressor (101);
a compressor flow rate control device (122) provided at the injection pipe (135) and configured to adjust a flow rate of the refrigerant that is to flow into the compressor (101); and
a heat-source-unit-side heat exchanger flow rate control device (123) connected in parallel to the compressor flow rate control device (122) and configured to adjust a flow rate of the refrigerant to be distributed to the heat-source-unit-side heat exchanger (103),
wherein the flow rate control device, the compressor flow rate control device (122), and the heat-source-unit-side heat exchanger flow rate control device (123) are connected in series to one another.

5. The air-conditioning apparatus (1) of claim 4, wherein the controller (151)
adjusts an opening degree of the second flow rate control unit (115) to control the flow rate of the refrigerant to be supplied to the compressor flow rate control device (122) and the heat-source-unit-side heat exchanger flow rate control device (123).

Patentansprüche

1. Klimaanlagenvorrichtung (1), die Folgendes umfasst:

einen wärmequellenseitigen Wärmetauscher (103);
eine Vielzahl von nutzerseitigen Wärmetauschern (105, 105c, 105d);
eine Vielzahl von ersten Durchflusssteuereinheiten (109, 109c, 109d) zur Steuerung der Durchflussmenge in den nutzerseitigen Wärme-

tauschern (105, 105c, 105d);
wobei die Klimaanlagenvorrichtung (1) gleichzeitig einen Kühl- und Heizbetrieb durchführt, indem jede der Vielzahl von nutzerseitigen Wärmetauschern (105, 105c, 105d) in Übereinstimmung mit einem Steuerbefehl auf die Kühlbetriebsseite oder die Heizbetriebsseite umgeschaltet wird;
eine Relaiseinheit (B), die zwischen dem wärmequellenseitigen Wärmetauscher (103) und der Vielzahl von nutzerseitigen Wärmetauschern (105, 105c, 105d) bereitgestellt ist, die konfiguriert ist, um einen Teil der Vielzahl von nutzerseitigen Wärmetauschern (105, 105c, 105d) auf eine Kühlbetriebsseite umzuschalten und einen Teil der Vielzahl von nutzerseitigen Wärmetauschern (105, 105c, 105d) auf eine Heizbetriebsseite umzuschalten,
dadurch gekennzeichnet, dass
die Relaiseinheit (B) Folgendes umfasst:

eine zweite Durchflusssteuereinheit (115), die konfiguriert ist, um eine Durchflussmenge eines zu dem wärmequellenseitigen Wärmetauscher (103) und einem nutzerseitigen Wärmetauscher (105, 105c, 105d), der den Kühlvorgang unter der Vielzahl von nutzerseitigen Wärmetauschern (105, 105c, 105d) durchführt, hin zu verteilenden Kühlmittels einzustellen,
eine Temperaturdetektionsvorrichtung (125), die konfiguriert ist, um eine stromabwärtige Temperatur an einer stromabwärts liegenden Seite der zweiten Durchflussmengensteuereinheit (115) zu messen,
eine Temperaturdetektionsvorrichtung für Flüssigkeitsleitungen (126), die konfiguriert ist, um eine Flüssigkeitsleitungstemperatur des nutzerseitigen Wärmetauschers (105, 105c, 105d), der den Kühlvorgang durchführt, zu messen,
eine Steuerung (151), die konfiguriert ist, um die zweite Durchflussmengensteuereinheit (115) einzustellen und

wobei die Steuerung (151)

eine Ziel-Steuertemperatur der stromabwärtigen Temperatur erhält, die auf der stromabwärtigen Temperatur der zweiten Durchflussmengensteuereinheit (115) und der Flüssigkeitsleitungstemperatur basiert, und
die Flüssigkeitsleitungstemperatur steuert, indem die zweite Durchflussmengensteuereinheit (115) in Übereinstimmung mit der Ziel-Steuertemperatur eingestellt wird.

2. Klimaanlagenvorrichtung (1) nach Anspruch 1, wobei die Steuerung (151)
eine Referenztemperaturdifferenz zwischen der stromabwärtigen Temperatur und der Flüssigkeitsleitungstemperatur erhält, die als Referenz dient, bevor eine Durchflussmenge des in der Relaiseinheit (B) fließenden Kühlmittels variiert,
eine aktuelle Temperaturdifferenz zwischen der stromabwärtigen Temperatur und der Flüssigkeitsleitungstemperatur erhält, wenn die Durchflussmenge des in der Relaiseinheit (B) fließenden Kühlmittels variiert,
ein Korrekturausmaß der stromabwärtigen Temperatur, die auf der Referenztemperaturdifferenz und der aktuellen Temperaturdifferenz basiert, erhält,
die Ziel-Steuertemperatur, die auf der stromabwärtigen Temperatur und dem Korrekturausmaß basiert, erhält und
die Flüssigkeitsleitungstemperatur basierend auf der Ziel-Steuertemperatur steuert.

3. Klimaanlagenvorrichtung (1) nach Anspruch 2, wobei die Steuerung (151)
die Ziel-Steuertemperatur senkt, wenn die Durchflussmenge des in der Relaiseinheit (B) fließenden Kühlmittels steigt und
die Ziel-Steuertemperatur erhöht, wenn die Durchflussmenge des in der Relaiseinheit (B) fließenden Kühlmittels sinkt.

4. Klimaanlagenvorrichtung (1) nach Anspruch 3, die weiters Folgendes umfasst:

einen Kompressor (101), der konfiguriert ist, um ein Kühlmittel zu komprimieren und um das komprimierte Kühlmittel abzuführen;
eine Einspritzleitung (135), die zwischen der Relaiseinheit (B) und dem wärmequellenseitigen Wärmetauscher (103) bereitgestellt ist, die erlaubt, dass der Kompressor (101) mit dem Kühlmittel, das in den wärmequellenseitigen Wärmetauscher (103) fließen soll, versorgt wird;
eine Durchflussmengensteuerungsvorrichtung des Kompressors (122), die an der Einspritzleitung (135) bereitgestellt ist und konfiguriert ist, um eine Durchflussmenge des Kühlmittels, das in den Kompressor (101) fließen soll, einzustellen; und
eine Durchflussmengensteuerungsvorrichtung des wärmequellenseitigen Wärmetauschers (123), die mit der Durchflussmengensteuerungsvorrichtung des Kompressors (122) parallelgeschaltet ist und die konfiguriert ist, um die Durchflussmenge des Kühlmittels, das zu dem wärmequellenseitigen Wärmetauscher (103) hin verteilt werden soll, einzustellen,
wobei die Durchflussmengensteuerungsvorrichtung, die Durchflussmengensteuerungsvor-

richtung des Kompressors (122) und die Durchflussmengensteuerungsvorrichtung des wärmequellenseitigen Wärmetauschers (123) miteinander in Serie geschaltet sind.

5. Klimaanlagenvorrichtung (1) nach Anspruch 4, wobei die Steuerung (151) einen Öffnungsgrad der zweiten Durchflussmengensteuereinheit (115) einstellt, um die Durchflussmenge des Kühlmittels, mit dem die Durchflussmengensteuerungsvorrichtung des Kompressors (122) und die Durchflussmengensteuerungsvorrichtung des wärmequellenseitigen Wärmetauschers (123) versorgt werden soll, zu steuern.

Revendications

1. Appareil de climatisation (1) comprenant :

un échangeur de chaleur côté unité de source de chaleur (103) ;
une pluralité d'échangeurs de chaleur côté utilisation (105, 105c, 105d) ;
une pluralité de premières unités de commande de débit (109, 109c, 109d) pour commander le débit dans les échangeurs de chaleur côté utilisation (105, 105c, 105d) ;
dans lequel l'appareil de climatisation (1) effectue une opération simultanée de refroidissement et de chauffage en commutant chacun de la pluralité d'échangeurs de chaleur côté utilisation (105, 105c, 105d) vers le côté d'opération de refroidissement ou le côté d'opération de chauffage conformément à une instruction de commande ;
une unité relais (B) prévue entre l'échangeur de chaleur côté unité de source de chaleur (103) et la pluralité d'échangeurs de chaleur côté utilisation (105, 105c, 105d), configurée pour commuter une partie de la pluralité d'échangeurs de chaleur côté utilisation (105, 105c, 105d) vers un côté d'opération de refroidissement, et commuter une partie de la pluralité d'échangeurs de chaleur côté utilisation (105, 105c, 105d) vers un côté d'opération de chauffage,
caractérisé en ce que
l'unité relais (B) comprend
une deuxième unité de commande de débit (115) configurée pour ajuster un débit d'un fluide frigorigène à distribuer à l'échangeur de chaleur côté unité de source de chaleur (103) et l'échangeur de chaleur côté utilisation (105, 105c, 105d) qui effectue l'opération de refroidissement parmi la pluralité d'échangeurs de chaleur côté utilisation (105, 105c, 105d),
un dispositif de détection de température (125) configuré pour mesurer une température côté aval d'un côté aval de la deuxième unité de commande de débit (115),
un dispositif de détection de température de tuyau de liquide (126) configuré pour mesurer une température de tuyau de liquide de l'échangeur de chaleur côté utilisation (105, 105c, 105d) qui effectue l'opération de refroidissement,
un contrôleur (151) configuré pour ajuster la deuxième unité de commande de débit (115), et dans lequel le contrôleur (151)
obtient, sur la base de la température côté aval de la deuxième unité de commande de débit (115) et de la température de tuyau de liquide, une température de commande cible de la température côté aval, et
commande la température de tuyau de liquide en ajustant la deuxième unité de commande de débit (115) conformément à la température de commande cible.

2. Appareil de climatisation (1) selon la revendication 1, dans lequel le contrôleur (151)
obtient une différence de température de référence entre la température côté aval et la température de tuyau de liquide servant en tant que référence avant qu'un débit du fluide frigorigène s'écoulant dans l'unité relais (B) varie,
obtient une différence de température actuelle entre la température côté aval et la température de tuyau de liquide lorsque le débit du fluide frigorigène s'écoulant dans l'unité relais (B) varie,
obtient une quantité de correction de la température côté aval, sur la base de la différence de température de référence et de la différence de température actuelle,
obtient la température de commande cible, sur la base de la température côté aval et de la quantité de correction, et
commande la température de tuyau de liquide, sur la base de la température de commande cible.

3. Appareil de climatisation (1) selon la revendication 2, dans lequel le contrôleur (151)
diminue la température de commande cible lorsque le débit du fluide frigorigène s'écoulant dans l'unité relais (B) augmente, et
augmente la température de commande cible lorsque le débit du fluide frigorigène s'écoulant dans l'unité relais (B) diminue.

4. Appareil de climatisation (1) selon la revendication 3, comprenant en outre :

un compresseur (101) configuré pour comprimer un fluide frigorigène et décharger le fluide frigorigène comprimé ;
un tuyau d'injection (135) prévu entre l'unité re-

lais (B) et l'échangeur de chaleur côté unité de source de chaleur (103) et permettant que le fluide frigorigène qui doit s'écouler dans l'échangeur de chaleur côté unité de source de chaleur (103) soit fourni au compresseur (101) ;
un dispositif de commande de débit de compresseur (122) prévu au niveau du tuyau d'injection (135) et configuré pour ajuster un débit du fluide frigorigène qui doit s'écouler dans le compresseur (101) ; et
un dispositif de commande de débit d'échangeur de chaleur côté unité de source de chaleur (123) relié en parallèle au dispositif de commande de débit de compresseur (122) et configuré pour ajuster un débit du fluide frigorigène à distribuer à l'échangeur de chaleur côté unité de source de chaleur (103),
dans lequel le dispositif de commande de débit, le dispositif de commande de débit de compresseur (122), et le dispositif de commande de débit d'échangeur de chaleur côté unité de source de chaleur (123) sont reliés en série les uns aux autres

5. Appareil de climatisation (1) selon la revendication 4, dans lequel le contrôleur (151)
ajuste un degré d'ouverture de la deuxième unité de commande de débit (115) pour commander le débit du fluide frigorigène à fournir au dispositif de commande de débit de compresseur (122) et au dispositif de commande de débit d'échangeur de chaleur côté unité de source de chaleur (123).

F I G. 1

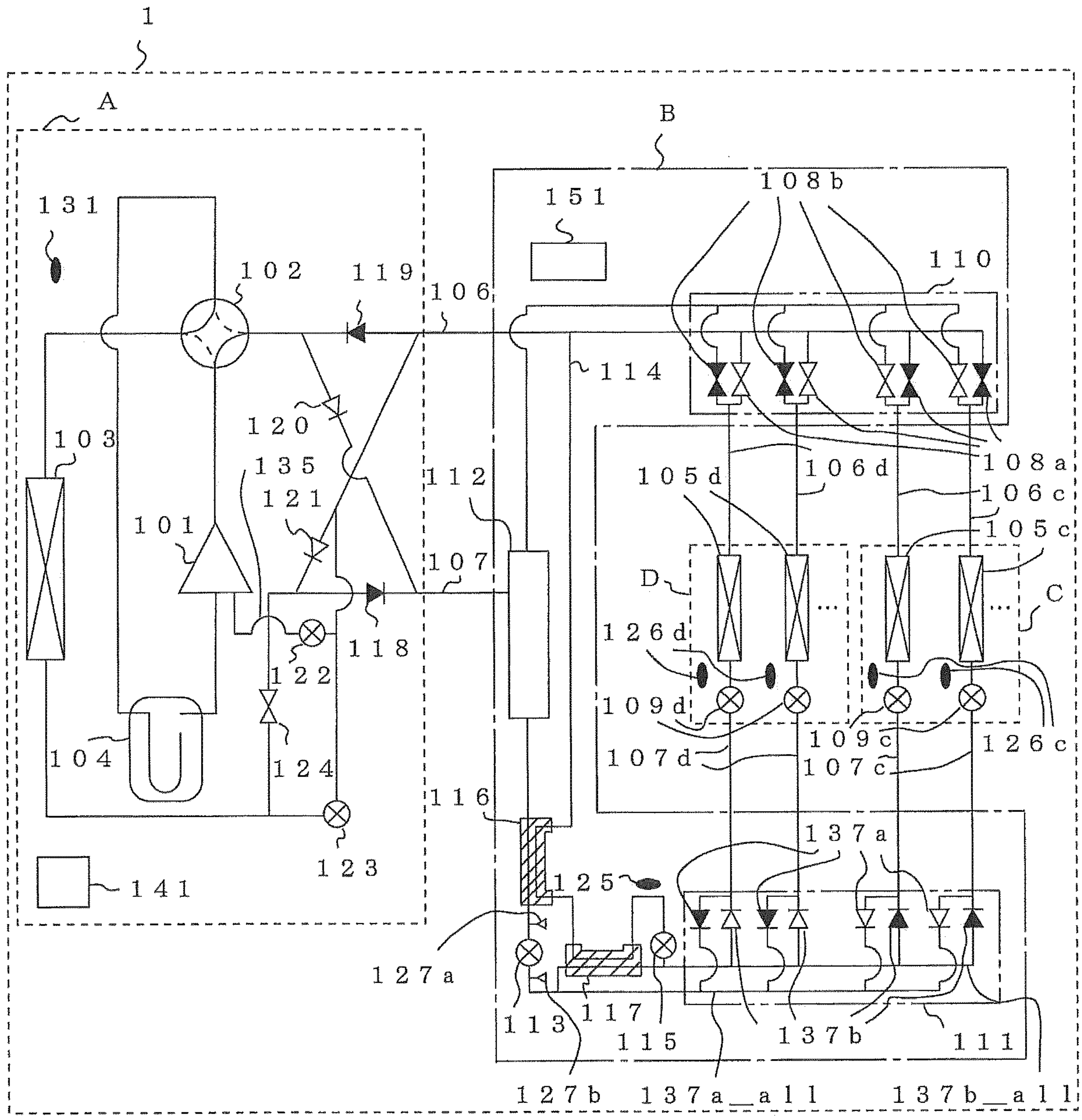

1
A
B
131
102
119
106
151
108b
110
114
103
120
135
121
101
112
107
118
122
124
104
123
141
116
105d
106d
108a
106c
105c
D
C
126d
109d
109c
126c
107d
107c
137a
125
127a
113
117
115
137b
111
127b
137a_all
137b_all

FIG. 2

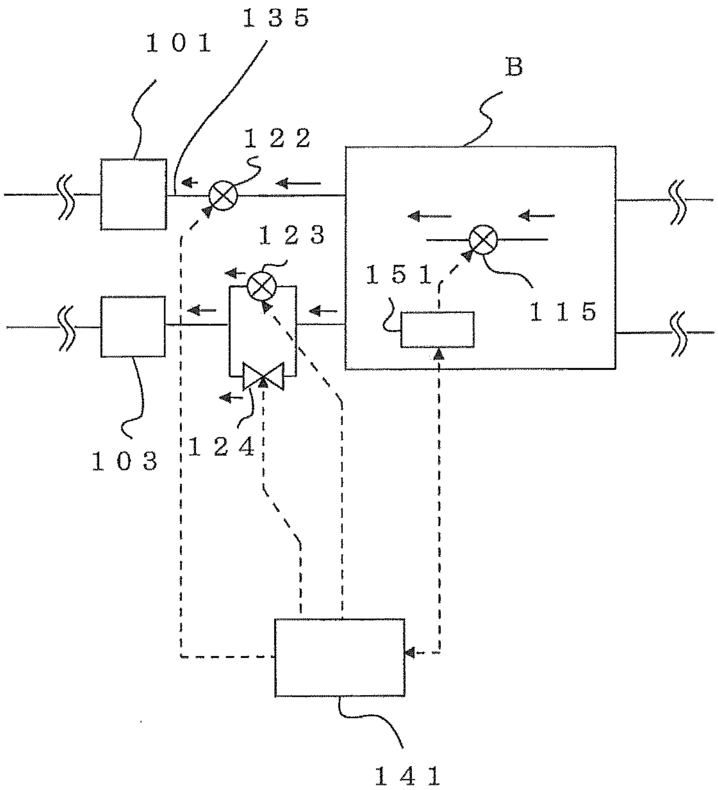


FIG. 3

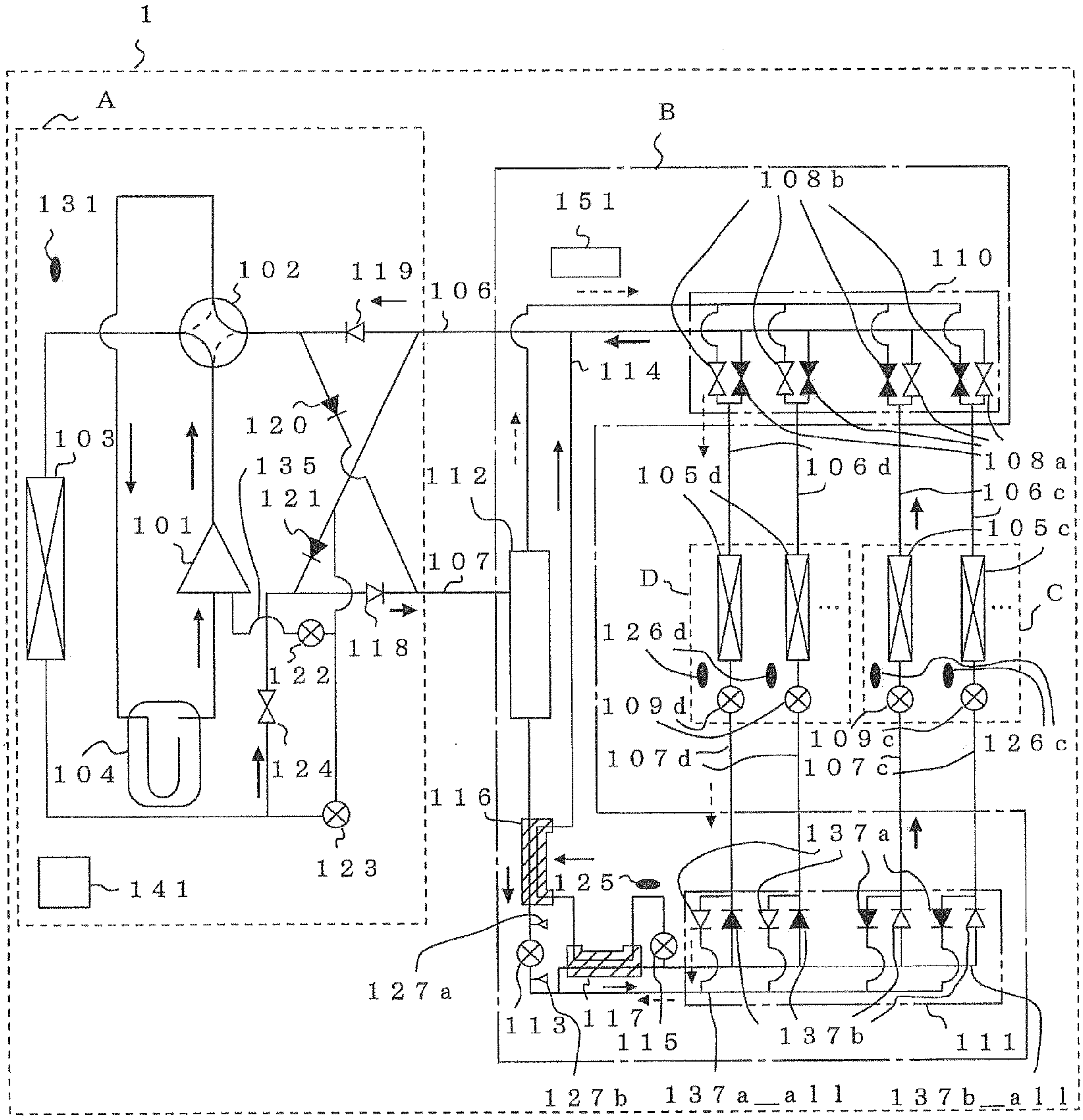

1
A
B
131
102
119
106
151
108b
110
114
103
120
135
121
101
112
107
118
122
124
104
123
141
116
125
113
117
115
127a
127b
105d
106d
108a
106c
105c
D
C
126d
109d
109c
126c
107d
107c
137a
137b
111
137a_all
137b_all

FIG. 4

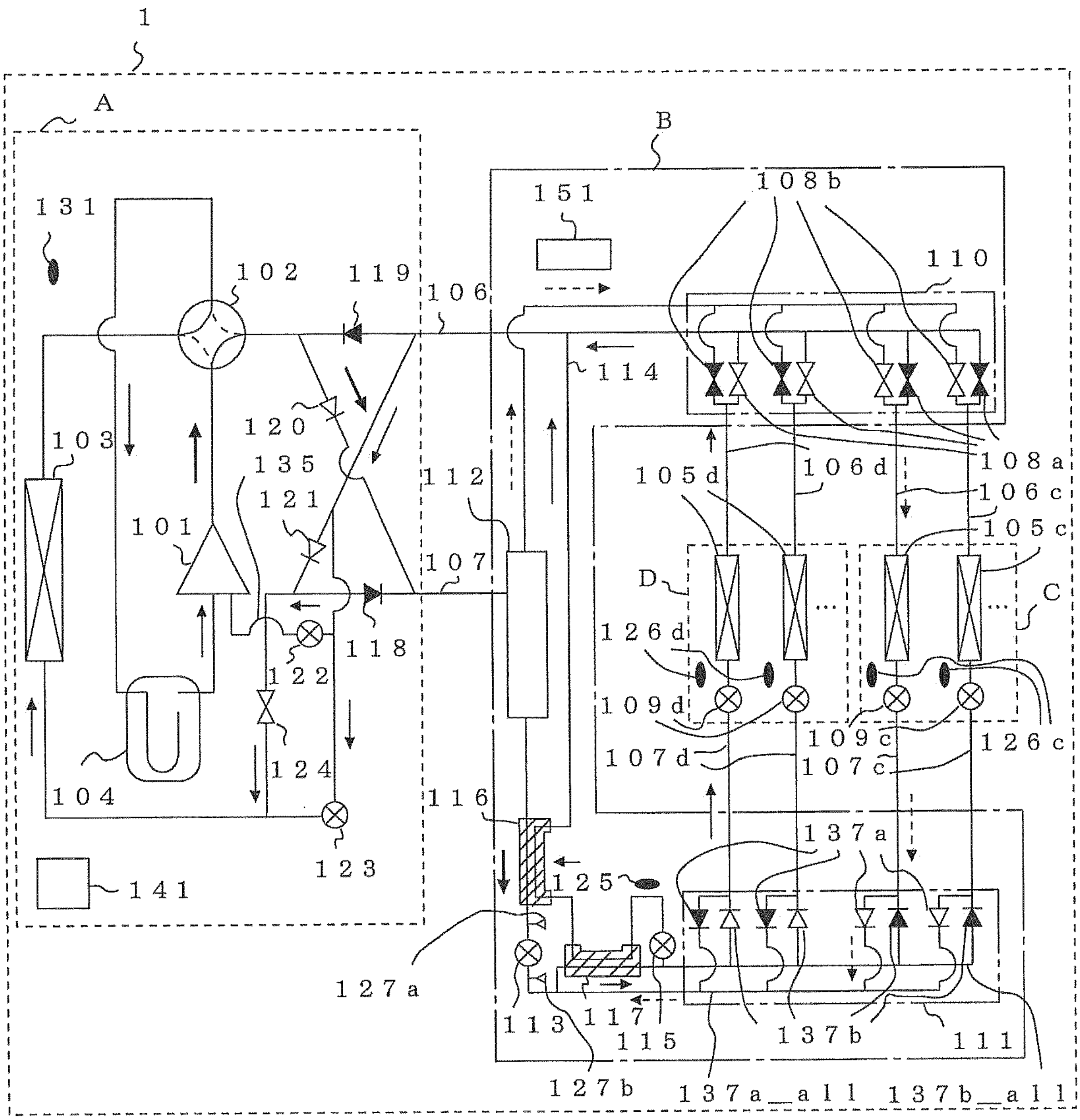
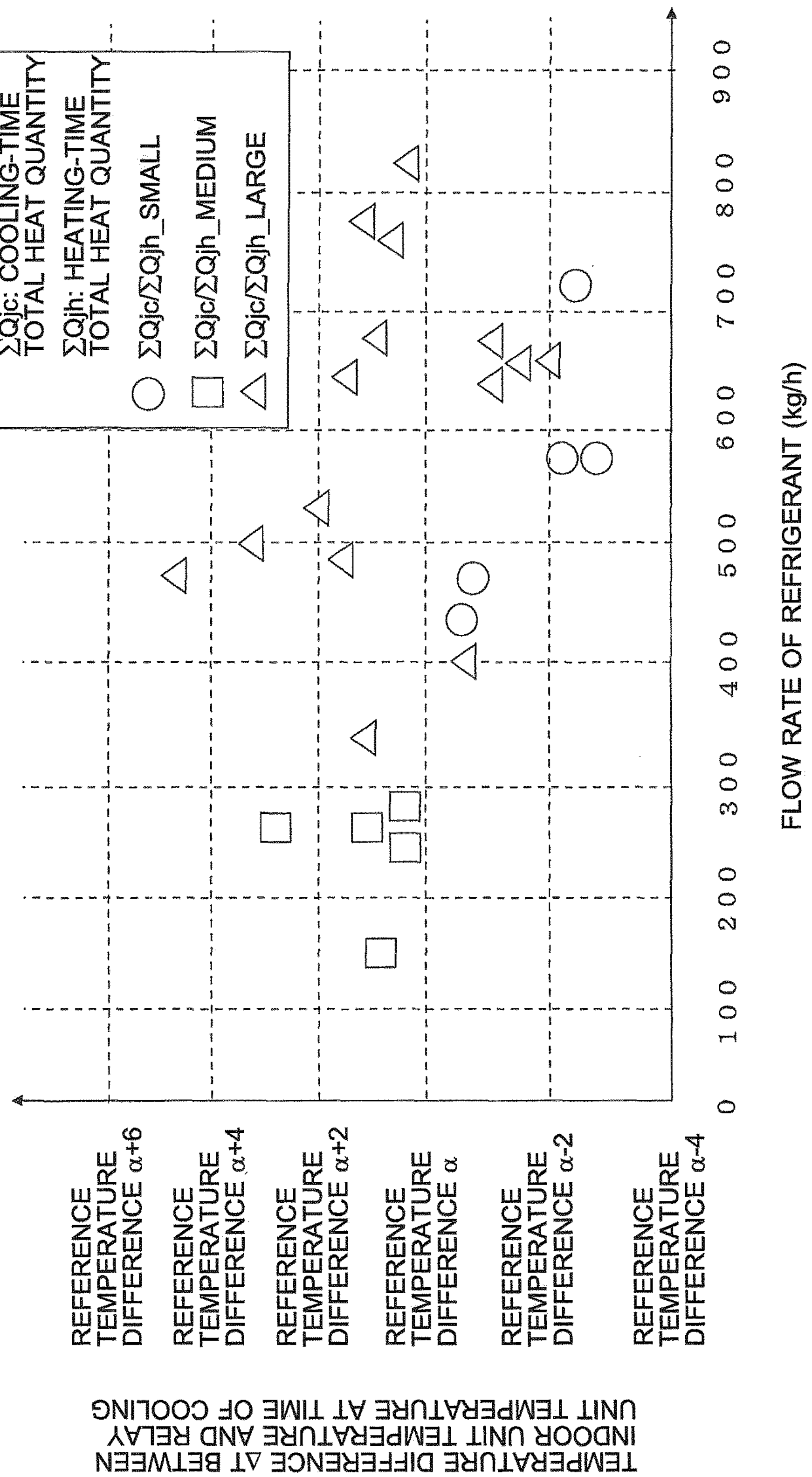
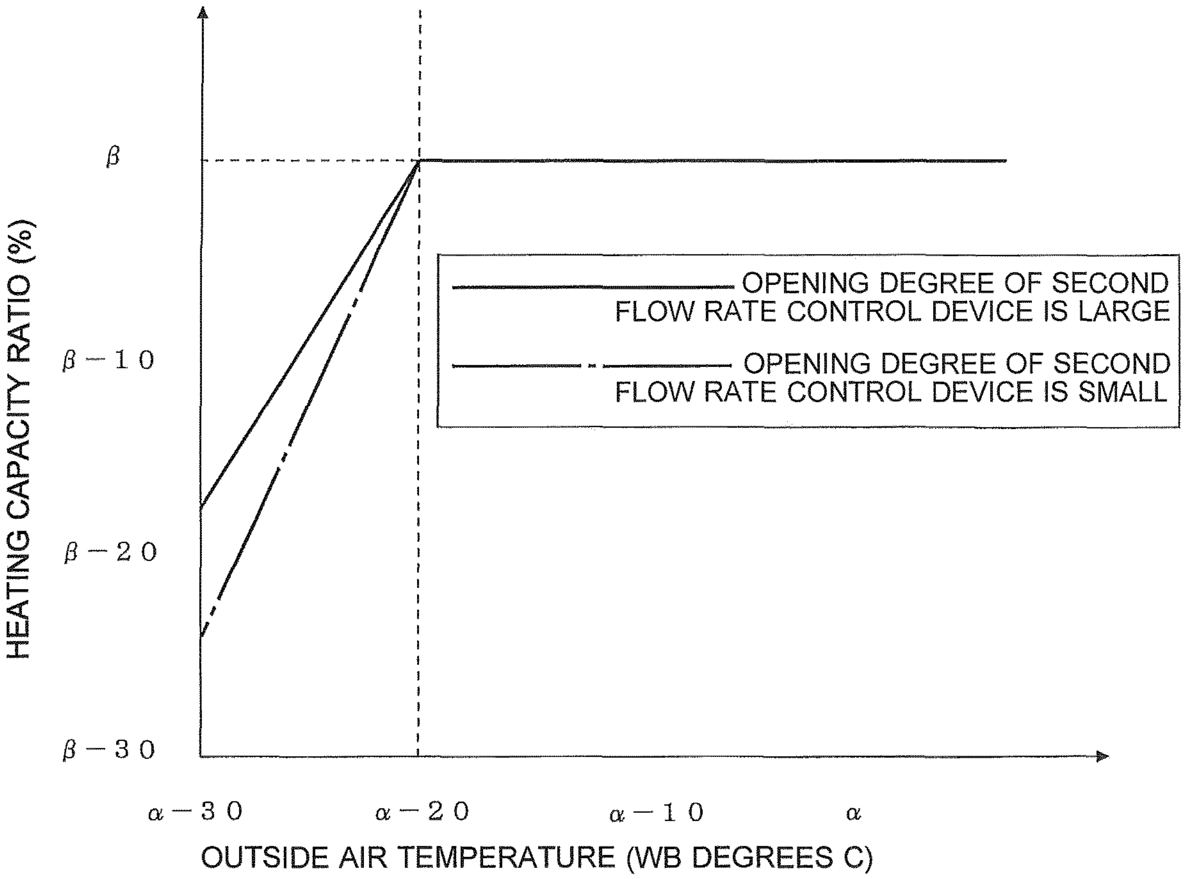

1
A
B
131
102
119
106
151
108b
110
114
103
120
135
101
121
112
107
118
122
124
104
123
141
116
125
127a
113
117
115
127b
105d
106d
108a
106c
105c
D
C
126d
109d
109c
126c
107d
107c
137a
137b
111
137a_all
137b_all

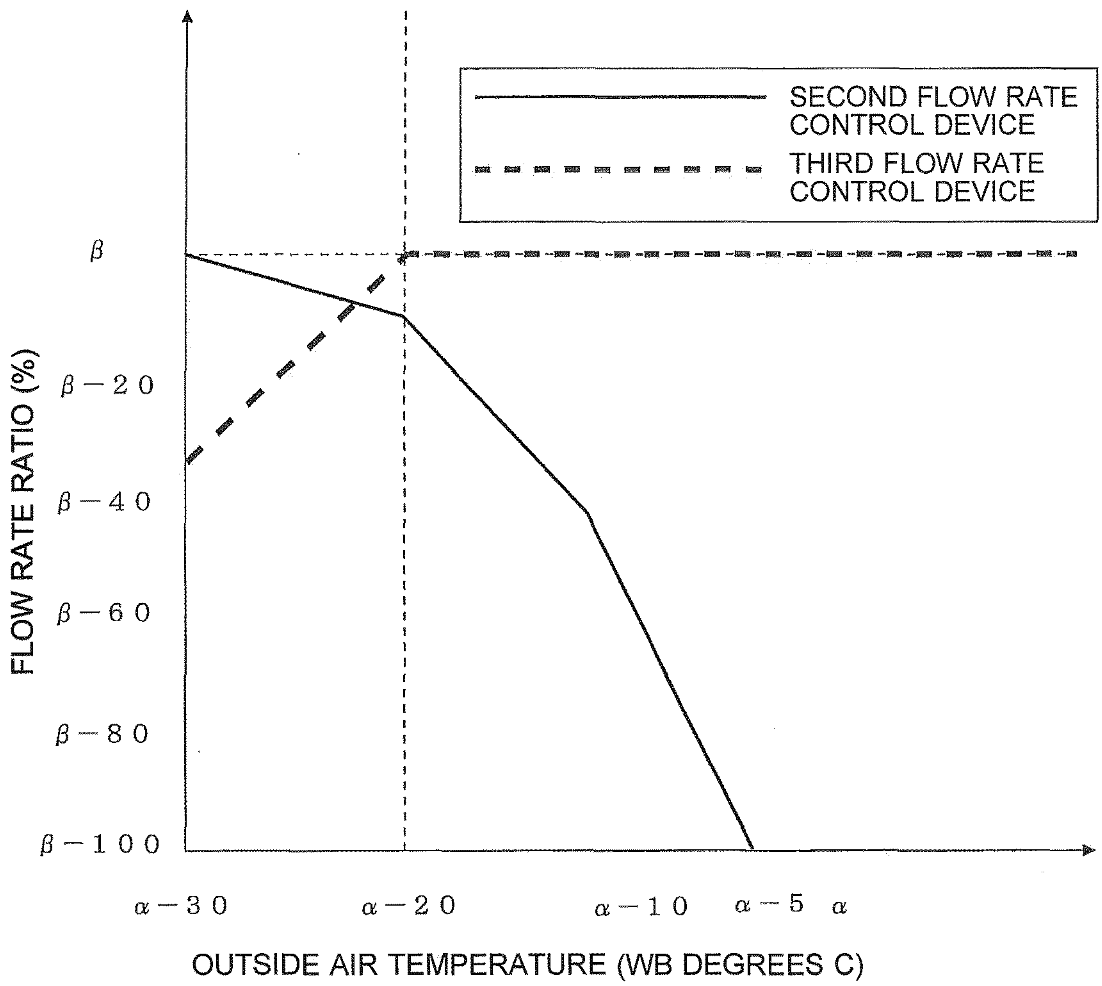
FIG. 5


ΣQjc: COOLING-TIME TOTAL HEAT QUANTITY
ΣQjh: HEATING-TIME TOTAL HEAT QUANTITY
ΣQjc/ΣQjh_SMALL
ΣQjc/ΣQjh_MEDIUM
ΣQjc/ΣQjh_LARGE
TEMPERATURE DIFFERENCE ΔT BETWEEN INDOOR UNIT TEMPERATURE AND RELAY UNIT TEMPERATURE AT TIME OF COOLING
REFERENCE TEMPERATURE DIFFERENCE α+6
REFERENCE TEMPERATURE DIFFERENCE α+4
REFERENCE TEMPERATURE DIFFERENCE α+2
REFERENCE TEMPERATURE DIFFERENCE α
REFERENCE TEMPERATURE DIFFERENCE α-2
REFERENCE TEMPERATURE DIFFERENCE α-4
0
100
200
300
400
500
600
700
800
900
FLOW RATE OF REFRIGERANT (kg/h)

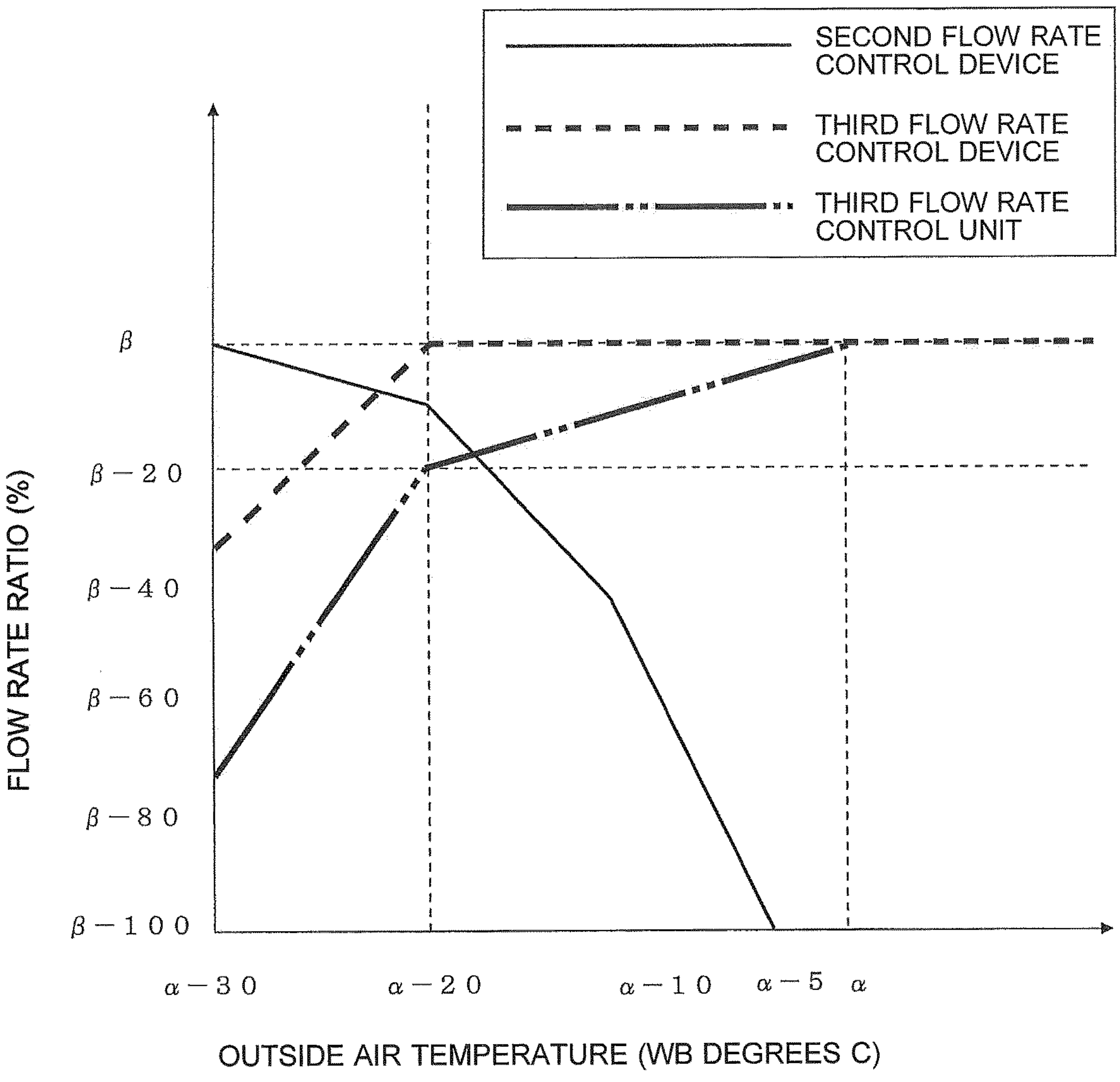
F I G. 6


HEATING CAPACITY RATIO (%)
β
β－10
β－20
β－30
OPENING DEGREE OF SECOND FLOW RATE CONTROL DEVICE IS LARGE
OPENING DEGREE OF SECOND FLOW RATE CONTROL DEVICE IS SMALL
α－30
α－20
α－10
α
OUTSIDE AIR TEMPERATURE (WB DEGREES C)

F I G. 7


SECOND FLOW RATE CONTROL DEVICE
THIRD FLOW RATE CONTROL DEVICE
FLOW RATE RATIO (%)
β
β−20
β−40
β−60
β−80
β−100
α−30
α−20
α−10
α−5
α
OUTSIDE AIR TEMPERATURE (WB DEGREES C)

F I G. 8


SECOND FLOW RATE CONTROL DEVICE
THIRD FLOW RATE CONTROL DEVICE
THIRD FLOW RATE CONTROL UNIT
FLOW RATE RATIO (%)
β
β－20
β－40
β－60
β－80
β－100
α－30
α－20
α－10
α－5
α
OUTSIDE AIR TEMPERATURE (WB DEGREES C)

F I G. 9

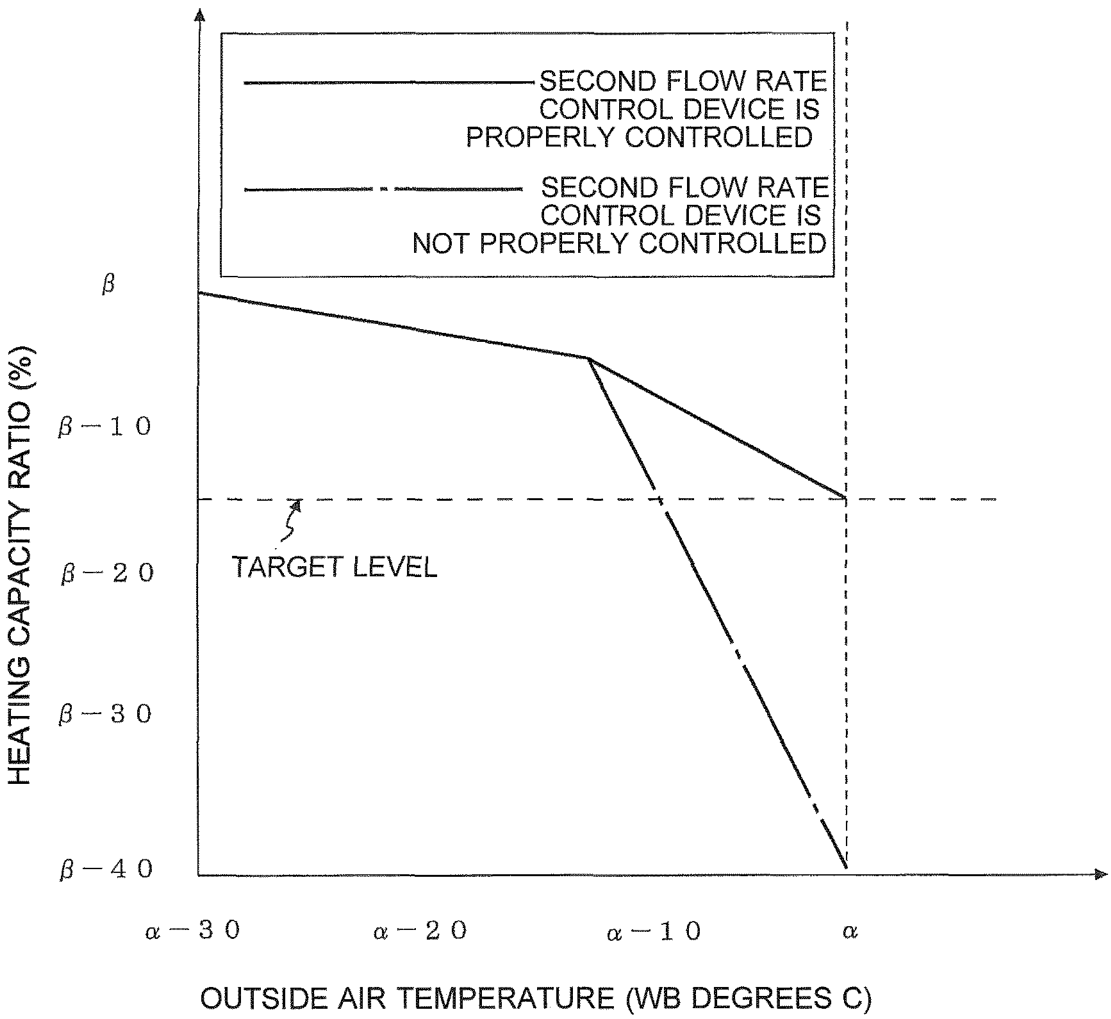

SECOND FLOW RATE CONTROL DEVICE IS PROPERLY CONTROLLED
SECOND FLOW RATE CONTROL DEVICE IS NOT PROPERLY CONTROLLED
β
β−10
β−20
β−30
β−40
HEATING CAPACITY RATIO (%)
TARGET LEVEL
α−30
α−20
α−10
α
OUTSIDE AIR TEMPERATURE (WB DEGREES C)

FIG. 10

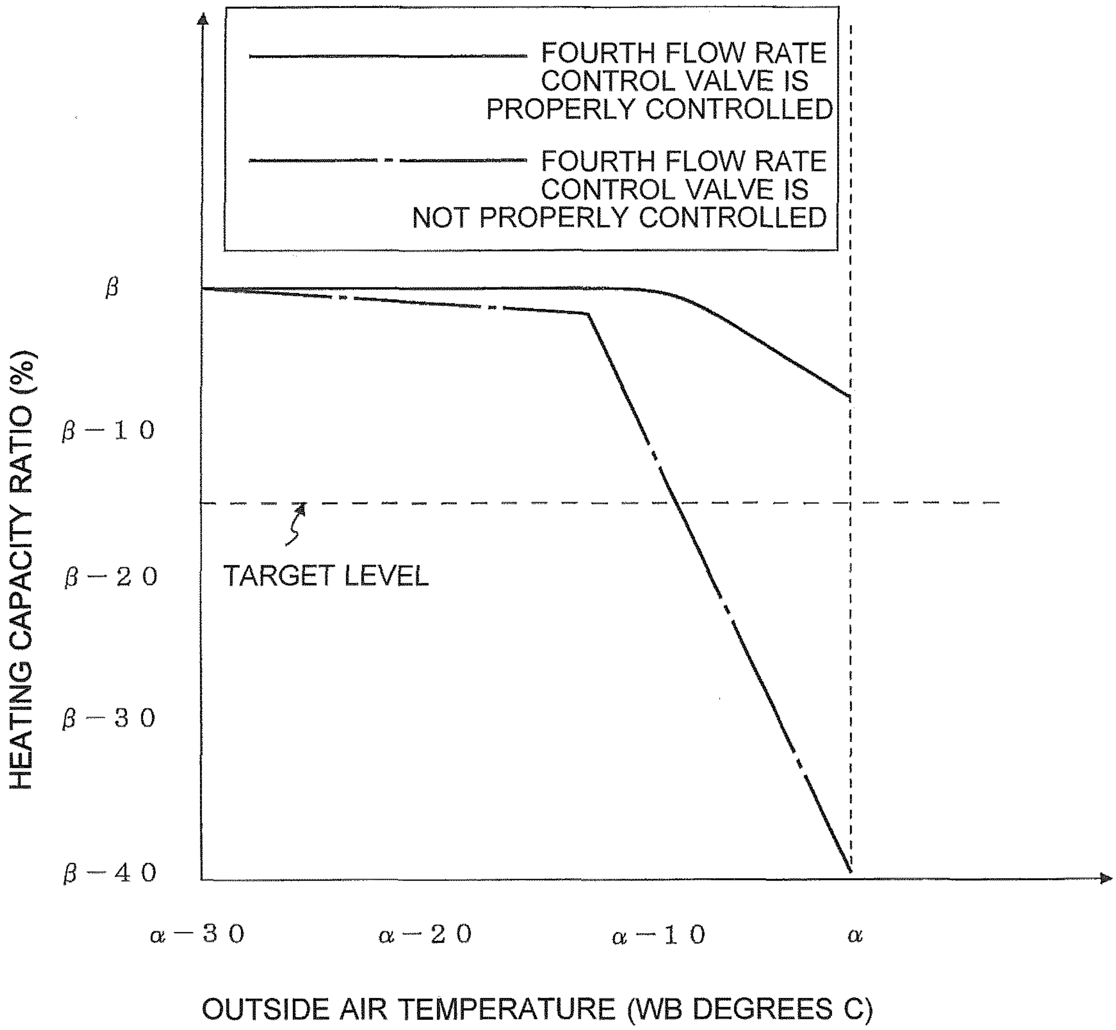
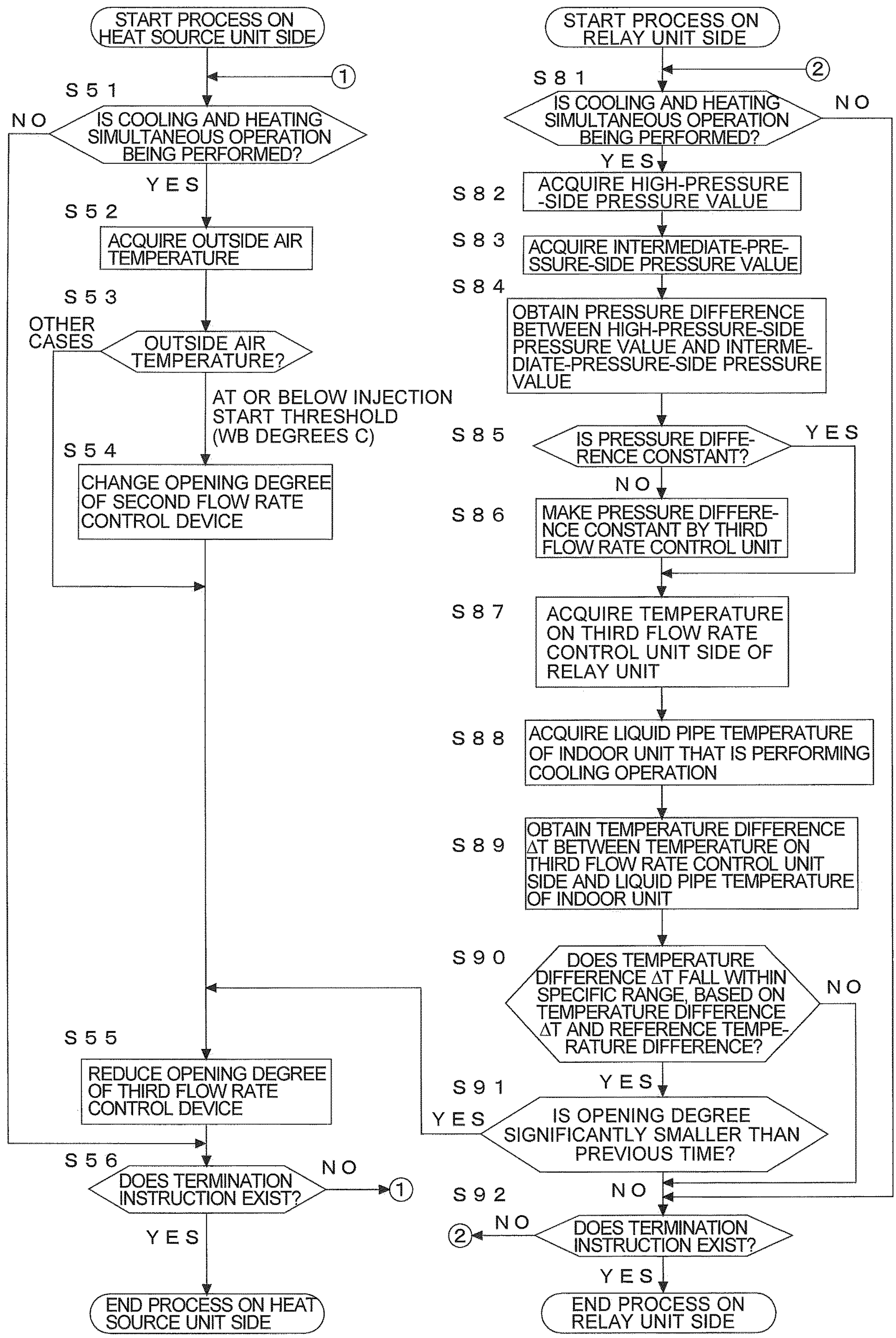

FOURTH FLOW RATE CONTROL VALVE IS PROPERLY CONTROLLED
FOURTH FLOW RATE CONTROL VALVE IS NOT PROPERLY CONTROLLED
β
β－10
β－20
β－30
β－40
HEATING CAPACITY RATIO (%)
TARGET LEVEL
α－30
α－20
α－10
α
OUTSIDE AIR TEMPERATURE (WB DEGREES C)

FIG. 11


START PROCESS ON HEAT SOURCE UNIT SIDE
S51
IS COOLING AND HEATING SIMULTANEOUS OPERATION BEING PERFORMED?
NO
YES
S52
ACQUIRE OUTSIDE AIR TEMPERATURE
S53
OUTSIDE AIR TEMPERATURE?
OTHER CASES
AT OR BELOW INJECTION START THRESHOLD (WB DEGREES C)
S54
CHANGE OPENING DEGREE OF SECOND FLOW RATE CONTROL DEVICE
S55
REDUCE OPENING DEGREE OF THIRD FLOW RATE CONTROL DEVICE
S56
DOES TERMINATION INSTRUCTION EXIST?
NO
YES
END PROCESS ON HEAT SOURCE UNIT SIDE
START PROCESS ON RELAY UNIT SIDE
S81
IS COOLING AND HEATING SIMULTANEOUS OPERATION BEING PERFORMED?
NO
YES
S82
ACQUIRE HIGH-PRESSURE -SIDE PRESSURE VALUE
S83
ACQUIRE INTERMEDIATE-PRE-SSURE-SIDE PRESSURE VALUE
S84
OBTAIN PRESSURE DIFFERENCE BETWEEN HIGH-PRESSURE-SIDE PRESSURE VALUE AND INTERME-DIATE-PRESSURE-SIDE PRESSURE VALUE
S85
IS PRESSURE DIFFE-RENCE CONSTANT?
YES
NO
S86
MAKE PRESSURE DIFFERE-NCE CONSTANT BY THIRD FLOW RATE CONTROL UNIT
S87
ACQUIRE TEMPERATURE ON THIRD FLOW RATE CONTROL UNIT SIDE OF RELAY UNIT
S88
ACQUIRE LIQUID PIPE TEMPERATURE OF INDOOR UNIT THAT IS PERFORMING COOLING OPERATION
S89
OBTAIN TEMPERATURE DIFFERENCE ΔT BETWEEN TEMPERATURE ON THIRD FLOW RATE CONTROL UNIT SIDE AND LIQUID PIPE TEMPERATURE OF INDOOR UNIT
S90
DOES TEMPERATURE DIFFERENCE ΔT FALL WITHIN SPECIFIC RANGE, BASED ON TEMPERATURE DIFFERENCE ΔT AND REFERENCE TEMPE-RATURE DIFFERENCE?
NO
YES
S91
IS OPENING DEGREE SIGNIFICANTLY SMALLER THAN PREVIOUS TIME?
YES
NO
S92
DOES TERMINATION INSTRUCTION EXIST?
NO
YES
END PROCESS ON RELAY UNIT SIDE

REFERENCES CITED IN THE DESCRIPTION

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- US 20090272135 A **[0005]**