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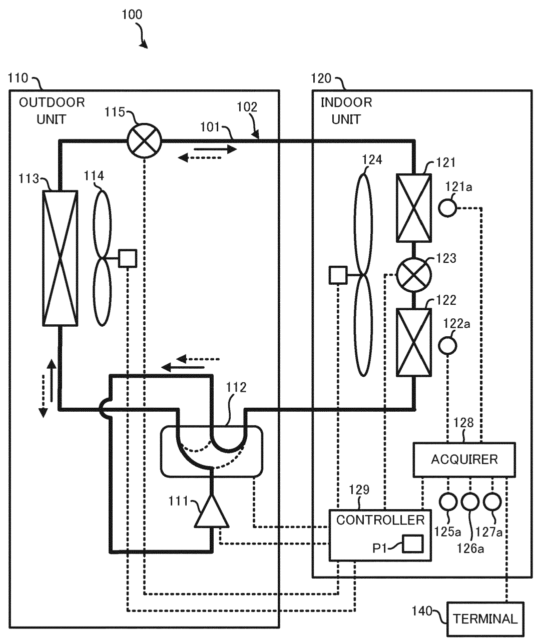
(54) AIR CONDITIONING DEVICE, AIR CONDITIONING METHOD, AND PROGRAM

(57) An air conditioning device (100) operates in an operating mode selected from a first cooling mode, a second cooling mode, and a dehumidifying mode. The air conditioning device (100) includes a refrigerant circuit (102) in which a refrigerant circulates through, in order, a compressor (111), an outdoor heat exchanger (113), a first expansion valve (115), a first indoor heat exchanger (121), a second expansion valve (123), and a second indoor heat exchanger (122). In the first cooling mode, the refrigerant evaporation temperature of the first indoor heat exchanger (121) is equal to the refrigerant evaporation temperature of the second indoor heat exchanger (122). In the second cooling mode, the refrigerant evaporation temperature of the first indoor heat exchanger (121) is higher than the refrigerant evaporation temperature of the second indoor heat exchanger (122) and lower than the temperature of the air in an indoor space to be air conditioned. In the dehumidification mode, the refrigerant evaporation temperature of the first indoor heat exchanger (121) is higher than the temperature of the air in the indoor space.

FIG.1



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Description

Technical Field

[0001] The present disclosure relates to an air conditioning device, an air conditioning method, and a program.

Background Art

[0002] An air conditioner performing a cooling operation usually exchanges heat between the inside of and the outside of a room by circulating refrigerant through a compressor, an outdoor heat exchanger, a decompressor and an indoor heat exchanger. The outdoor heat exchanger functions as a condenser and releases heat. The indoor heat exchanger functions as an evaporator and absorbs heat.

[0003] An air conditioner is known that performs not only the above cooling operation but also a so-called reheating-dehumidifying operation (refer to, for example, Patent Literature 1). The "reheating-dehumidifying operation" means an operation by which air is cooled to dew point temperature or less to be dehumidified and is heated at the same time.

[0004] The air conditioner disclosed in Patent Literature 1 is equipped with a first heat exchanger and a second heat exchanger that are used as an indoor heat exchanger, and an electronic expansion valve is arranged between the first heat exchanger and the second heat exchanger. Additionally, this air conditioner performs the reheating-dehumidifying operation by controlling a degree of throttling of the electronic expansion valve to make the first heat exchanger release heat as a reheater and to make the second heater absorb heat as an evaporator.

Citation List

Patent Literature

[0005] Patent Literature 1: Unexamined Japanese Patent Application Kokai Publication No. H05-18630

Summary of Invention

Technical Problem

[0006] When the air conditioner disclosed in Patent Literature 1 performs the cooling operation, the refrigerant in the first heat exchanger is maintained at a temperature lower to some extent than an ambient temperature of a space to be air-conditioned. As a result, the first heat exchanger cools air. Also, when this air conditioner performs the reheating-dehumidifying operation, the refrigerant in the first heat exchanger is maintained at a temperature higher to some extent than the ambient temperature of the space. As a result, when the operation of this air conditioner changes from the cooling operation to the reheating-dehumidifying operation, the temperature of the refrigerant in the first heat exchanger discontinuously increases. Therefore, a capability of this air conditioner in processing sensible heat load also discontinuously changes and thus there is risk that user comfort may be impaired.

[0007] In consideration of the aforementioned circumstances, an objective of the present disclosure is to improve user's comfort.

Solution to Problem

[0008] In order to attain the aforementioned objective, an air conditioning device according to the present disclosure for operation in an operation mode selected from a first cooling mode, a second cooling mode, and a dehumidification mode, the air conditioning device including: a refrigerant circuit configured to circulate refrigerant by passing the refrigerant through, in an order of, a compressor, an outdoor heat exchanger, a first expansion valve, a first indoor heat exchanger, a second expansion valve, and a second indoor heat exchanger, a degree of opening of the first expansion valve and a degree of opening of the second expansion valve being adjustable; acquisition means for acquiring temperature information indicating a temperature of air in an indoor space to be air-conditioned; and indoor ventilation means for sending air that is heat-exchanged by the first indoor heat exchanger and the second indoor heat exchanger to the indoor space. In the first cooling mode, when the degree of opening of the first expansion valve and the degree of opening of the second expansion valve are adjusted to a predetermined degree of opening, a refrigerant evaporation temperature of the first indoor heat exchanger becomes equal to a refrigerant evaporation temperature of the second indoor heat exchanger. In the second cooling mode, when (i) the degree of opening of the first expansion valve is adjusted to be greater than or equal to the degree of opening in the first cooling mode and (ii) the degree of opening of the second expansion valve is adjusted to be less than or equal to the degree of opening in the first cooling mode, the refrigerant evaporation temperature of the first indoor heat exchanger becomes higher than the refrigerant evaporation temperature of the second indoor heat exchanger and becomes lower than the temperature indicated by the temperature information. In the dehumidification mode, when (i) the degree of opening of the first expansion valve is adjusted to be greater than or equal to the degree of opening in the second cooling mode and (ii) the degree of opening of the second expansion valve is adjusted to be less than or equal to the degree of opening in the second cooling mode, the refrigerant evaporation temperature of the first indoor heat exchanger becomes higher than the temperature indicated by the temperature information.

Advantageous Effects of Invention

[0009] According to the present disclosure, the air conditioning device operates in the second cooling mode in which refrigerant temperature in the first indoor heat exchanger is higher than refrigerant temperature in the second indoor heat exchanger and is lower than an ambient temperature. As a result, the performance of the air conditioning device can be continuously adjusted between the first cooling mode and the dehumidification mode, and thus user comfort can be improved.

Brief Description of Drawings

[0010]

FIG. 1 is a view illustrating a configuration of an air conditioning device according to Embodiment 1;
FIG. 2 is a graph illustrating the relationship between sensible heat load and a degree of opening of an expansion valve;
FIG. 3 is a graph illustrating the relationship between sensible heat load and refrigerant evaporation temperature;
FIG. 4 is a flow chart illustrating an air conditioning process;
FIG. 5 is a graph illustrating examples of transitions of ambient temperature, room temperature and degrees of opening of the expansion valves;
FIG. 6 is a graph illustrating the relationship between sensible heat capacity and latent heat capacity in Embodiment 1;
FIG. 7 is a graph illustrating examples of transitions of ambient temperature, room temperature and an amount of air blown by an outdoor blower in Embodiment 2;
FIG. 8 is a view illustrating a configuration of an air conditioning device according to Embodiment 3;
FIG. 9 is a view illustrating a configuration of an air conditioning device according to Embodiment 4; and
FIG. 10 is a graph illustrating the relationship between sensible heat capacity and latent heat capacity in Embodiment 5.

Description of Embodiments

[0011] Embodiments of the present disclosure are described below in detail with reference to drawings.

Embodiment 1

[0012] FIG. 1 illustrates a configuration of an air conditioning device 100 according to Embodiment 1. The air conditioning device 100 is a room air conditioner for conditioning air in an indoor space to be air-conditioned by a vapor compression heat pump. The indoor space is a specific room of a house, an office, a factory or the like. The air conditioning device 100 performs a cooling operation by which an ambient temperature of the indoor space is reduced to a preset temperature, a dehumidifying operation in which a so-called reheating-dehumidifying operation is executed to decrease humidity of the indoor space, and a heating operation by which the ambient temperature of the indoor space is increased to a preset temperature, and thus air in the indoor space is conditioned by the execution of these operations. Also, the air conditioning device 100 smoothly changes a temperature of the air to be conditioned when the air conditioning device 100 changes one of the cooling operation and the dehumidifying operation to the other, and thus comfort of a user who is present in the indoor space is improved.

[0013] As illustrated in FIG. 1, the air conditioning device 100 includes an outdoor unit 110 and an indoor unit 120 connected to each other via a refrigerant line 101. In FIG. 1, the refrigerant line 101 is represented by a thick solid line.

[0014] The refrigerant line 101 includes a copper pipe for circulating the refrigerant between the outdoor unit 110 and the indoor unit 120 and a protective member for preventing corrosion of the copper pipe and absorption-desorption of heat of the refrigerant. The refrigerant line 101 includes a tube and a pipe. The refrigerant is, for example, R410A or R32 that is a hydrofluorocarbon (HFC) refrigerant. However, materials for the refrigerant line and types of the refrigerant are not limited to the above material and the above refrigerant, and any material for the refrigerant line and any type of the refrigerant may be used.

[0015] The outdoor unit 110 is placed outside, for example, on a wall surface of a building having an indoor space inside or on the roof of the building. The outdoor unit 110 includes a compressor 111 for compressing the refrigerant, a four-way valve 112 for changing a flow channel of the refrigerant, an outdoor heat exchanger 113 for exchanging heat between ambient air and the refrigerant, an outdoor blower 114 for blowing air to the outdoor heat exchanger 113, and a first expansion valve 115 that can change a degree of opening of the valve 115. The compressor 111, the four-way valve 112, the outdoor heat exchanger 113 and the first expansion valve 115 are connected to one another via the refrigerant line 101.

[0016] The compressor 111 is, for example, a scroll compressor, a rotary compressor or an apparatus compressing the refrigerant by another method. The compressor 111 compresses refrigerant vapor flowing from the four-way valve 112 via the refrigerant line 101 into an inlet and then discharges the high-temperature and high-pressure refrigerant vapor from an outlet. The refrigerant vapor discharged by the compressor 111 is sent to the four-way valve 112 via the refrigerant line 101. The compressor 111 operates in accordance with a control signal transmitted from a controller 129 of the indoor unit 120, and an operating frequency for the compressor 111 is determined by this control signal.

[0017] The four-way valve 112 is connected to the inlet of and the outlet of the compressor 111 via the refrigerant line 101. Also, the four-way valve 112 is connected to the outdoor heat exchanger 113 and a second indoor heat exchanger 122 of the indoor unit 120 via the refrigerant line 101. The four-way valve 112 changes a flow channel of the refrigerant in accordance with the control signal transmitted from the controller 129. That is, the four-way valve 112 sends, to the outdoor heat exchanger 113 or the second indoor heat exchanger 122, the refrigerant discharged from the outlet of the compressor 111. Also, the four-way valve 112 sends, to the inlet of the compressor 111, the refrigerant discharged from the outdoor heat exchanger 113 or the second indoor heat exchanger 122. The change of the flow channels by the four-ways valve 112 forms either a refrigerant circuit 102 for the cooling operation and the dehumidifying operation, or a refrigerant circuit 102 for the heating operation. The details of the refrigerant circuit 102 are described below.

[0018] The outdoor heat exchanger 113 is connected to the four-way valve 112 and the first expansion valve 115 via the refrigerant line 101 and sends the refrigerant flowing from one of the four-way valve 112 and the first expansion valve 115 into the outdoor heat exchanger 113 to the other of the four-way valve 112 and the first expansion valve 115. The outdoor heat exchanger 113 exchanges heat between the ambient air and the refrigerant to condense or evaporate the refrigerant flowing into the outdoor heat exchanger 113 and then discharges the liquefied refrigerant or the refrigerant vapor. For example, the outdoor heat exchanger 113 functions as a condenser to make the refrigerant release heat during the cooling operation or the dehumidifying operation. Also, the outdoor heat exchanger 113 functions as an evaporator to make the refrigerant absorb heat during the heating operation.

[0019] The outdoor blower 114 includes a fan and an electric motor for rotating the fan and is arranged near the outdoor heat exchanger 113. The outdoor blower 114 generates an air flow passing from the outside of the outdoor unit 110 into the outdoor unit 110 through the outdoor heat exchanger 113 by rotating the fan in accordance with the control signal transmitted from the controller 129. Air is made to exchange heat by the outside heat exchanger 113 to be heated or cooled and then is discharged to the outside of the outdoor unit 110. An amount of air supplied by the outdoor blower 114 is determined by the control signal from the controller 129.

[0020] The first expansion valve 115 is a decompressor including a built-in pulse motor by which a degree of opening of the valve 115 can be continuously changed. The first expansion valve 115 is connected to the outdoor heat exchanger 113 and a first indoor heat exchanger 121 of the indoor unit 120 via the refrigerant line 101 and sends the refrigerant flowing from one of the outdoor heat exchanger 113 and the first indoor heat exchanger 121 into the valve 115 to the other of the outdoor heat exchanger 113 and the first indoor heat exchanger 121. The first expansion valve 115 reduces pressure on the refrigerant having flowed into the valve 115 to expand the refrigerant and then discharge the refrigerant having a temperature lower and pressure lower than those of the inflowing refrigerant. The temperature and pressure of the refrigerant discharged from the first expansion valve 115 vary depending on the degree of opening of the first expansion valve 115. However, when the first expansion valve 115 is fully opened, the refrigerant is not decompressed and passes through the first expansion valve 115 almost without expansion of the refrigerant. The degree of opening of the first expansion valve 115 is determined by the number of pulses of the control signal transmitted from the controller 129. The degree of opening corresponds to a degree of throttling, and the degree of opening when fully opened corresponds to the case in which the degree of throttling is zero.

[0021] The indoor unit 120 is arranged, for example, on a wall of the indoor space, on a ceiling of the indoor space or the like and blows cold air or hot air to condition air in the indoor space. The indoor unit 120 includes first and second indoor heat exchangers 121 and 122 for exchanging heat between air in the indoor space and the refrigerant, a variably-openable second expansion valve 123 arranged on the refrigerant line 101 between the first indoor heat exchanger 121 and the second indoor heat exchanger 122, an indoor blower 124 for blowing, to the indoor space, air made to exchange heat by the first indoor heat exchanger 121 and the second indoor heat exchanger 122, a sensor 121a for measuring a refrigerant evaporation temperature of the first indoor heat exchanger 121, a sensor 122a for measuring a refrigerant evaporation temperature of the second indoor heat exchanger 122, a sensor 125a for measuring a temperature of the air in the indoor space, a sensor 126a for measuring humidity of the air in the indoor space, a sensor 127a for receiving infrared light, an acquirer 128 for acquiring information indicating a measurement result from each of the sensors, and the controller 129 for controlling each of the components of the air conditioning device 100. The first indoor heat exchanger 121, the second expansive valve 123 and the second indoor heat exchanger 122 are connected via the refrigerant line 101 in that order. In FIG. 1, the dashed line connected to the acquirer 128 and the dashed line connected to the controller 129 represent signal lines.

[0022] The first indoor heat exchanger 121 is connected to the first expansion valve 115 and the second expansion valve 123 via the refrigerant line 101 and sends the refrigerant flowing in from one to the other of the first expansion valve 115 and the second expansion valve 123. The second indoor heat exchanger 122 is connected to the second expansion valve 123 and the four-way valve 112 via the refrigerant line 101 and sends the refrigerant flowing in from one to the other of the second expansion valve 123 and the four-way valve 112.

[0023] The first indoor heat exchanger 121 and the second indoor heat exchanger 122 exchange heat between the air in the indoor space and the refrigerant to evaporate or condense the inflowing refrigerant and then discharge refrigerant vapor, liquefied refrigerant or two-phase refrigerant. The "two-phase refrigerant" means a mixture of refrigerant vapor and liquefied refrigerant. For example, during the cooling operation, the first indoor heat exchanger 121 and the second indoor heat exchanger 122 function as an evaporator to make the refrigerant absorb heat, thereby cooling the air in the indoor space. Also, during the heating operation, the first indoor heat exchanger 121 and the second indoor heat exchanger 122 function as a condenser to make the refrigerant release heat, and thus the air in the indoor space is heated. However, during the dehumidifying operation, the first indoor heat exchanger 121 functions as a condenser to heat the air and the second indoor heat exchanger 122 functions as an evaporator to cool the air to a temperature equal to or lower than the dew point temperature, and thus the air is dehumidified.

[0024] The second expansion valve 123 is a decompressor having a structure similar to that of the first expansion valve 115. However, the sizes, shapes and material of components of the second expansion valve 123 may be different from those of the first expansion valve 115. The second expansion valve 123 is connected to the first indoor heat exchanger 121 and the second indoor heat exchanger 122 via the refrigerant line 101, decompresses the refrigerant flowing in from one of the first indoor heat exchanger 121 and the second indoor heat exchanger 122 and sends the decompressed refrigerant to the other of the first indoor heat exchanger 121 and the second indoor heat exchanger 122. A degree of opening of the first expansion valve 115 is specified by the control signal transmitted from the controller 129.

[0025] The indoor blower 124 has a structure similar to that of the outdoor blower 114 and is arranged near the first indoor heat exchanger 121 and the second indoor heat exchanger 122. A fan of the indoor blower 124 is, for example, a cross flow fan or a propeller fan. The indoor blower 124 generates air flow flowing from the indoor space into the inside of indoor unit 120 and passing through the first indoor heat exchanger 121 and the second indoor heat exchanger 122, by rotating the fan in accordance with the control signal transmitted from the controller 129. The air made to exchange heat by the first indoor heat exchanger 121 and the second indoor heat exchanger 122 is cooled or heated to be sent from the outlet of the indoor unit 120 to the indoor space. A direction of a flow of and an amount of air blown by the indoor blower 124 are specified by the control signal transmitted by the controller 129.

[0026] Although, for the sake of convenience, a blower including a fan having one rotation shaft and a motor is illustrated as the indoor blower 124 in FIG. 1, the indoor blower 124 is not limited to the blower illustrated in FIG. 1. The indoor blower 124 may include (i) a fan and a motor used for blowing air to the first indoor heat exchanger 121 and (ii) a fan and a motor used for blowing air to the second indoor heat exchanger 122. Also, although FIG. 1 illustrates a configuration in which air flow passing through the first indoor heat exchanger 121 and air flow passing through the second indoor heat exchanger 122 are generated separately from each other, the present disclosure is not limited to this configuration. The indoor blower 124 may generate air flow passing through both the first indoor heat exchanger 121 and the second indoor heat exchanger 122 in that order or in the reverse order.

[0027] The sensor 121a is arranged on the central portion of the first indoor heat exchanger 121. The sensor 121a measures, as a refrigerant evaporation temperature in the first indoor heat exchanger 121, a temperature of pipes included in the first indoor heat exchanger 121 and transmits temperature information indicating the measurement result to the acquirer 128. Alternatively, the sensor 121a may measure, as the refrigerant evaporation temperature in the first indoor heat exchanger 121, a temperature of a portion of the refrigerant line 101 near the inlet of or the outlet of the first indoor heat exchanger 121.

[0028] The sensor 122a is arranged on the central portion of the second indoor heat exchanger 122. The sensor 122a measures, as a refrigerant evaporation temperature in the second indoor heat exchanger 122, a temperature of pipes included in the second indoor heat exchanger 122 and transmits temperature information indicating the measurement result to the acquirer 128. Alternatively, the sensor 122a may measure, as the refrigerant evaporation temperature in the second indoor heat exchanger 121, a temperature of a portion of the refrigerant line 101 near the inlet of or the outlet of the first indoor heat exchanger 122.

[0029] Although the sensors 121a and 122a preferably directly measure actual refrigerant evaporation temperatures, the present disclosure is not limited to such direct measurement by the sensors 121a and 122a. The temperatures measured by the sensors 121a and 122a are sufficient if the controller 129 is able to a certain extent infer the refrigerant evaporation temperature based on the measurement results.

[0030] The sensors 125a and 126a are arranged near the air inlet of the indoor unit 120. The sensors 125a and 126a respectively measure a temperature and humidity of air absorbed in the indoor unit 120 as a temperature and humidity of air in the indoor space and respectively transmit temperature information and humidity information indicating the measurement results to the acquirer 128.

[0031] The sensor 127a includes an element for detecting infrared light, such as a thermopile or a bolometer. The sensor 127a is used for measuring a temperature distribution of the indoor space.

[0032] The acquirer 128 includes an interface circuit for acquiring information about a measurement result from each of the sensors and the like. The acquirer 128

(i) acquires, from the sensors 121a and 122a, temperature information indicating the refrigerant evaporation temperatures of the first indoor heat exchanger 121 and the second indoor heat exchanger 122, (ii) acquires, from the sensors 125a and 126a, temperature information and humidity information respectively indicating a temperature and humidity of air in the indoor space, and (iii) acquires data transmitted from a terminal 140. The acquirer 128 transmits the acquired information to the controller 129.

[0033] The controller 129 includes a microprocessor, a random access memory (RAM) and an electrically erasable programmable read-only memory (EEPROM). The microprocessor included in the controller 129 executes a program P1 stored in the EEPROM to make the controller 129 perform various functions. That is, the controller 129 appropriately controls, on the basis of the information received from the acquirer 128, the operating frequency for the compressor 111, the flow channel of the four-way valve 112, the amount of air blown by the outdoor blower 114, the degree of opening of the first expansion valve 115, the degree of opening of the second expansion valve 123 and the amount of air blown by the indoor blower 124. The cooling operation, the dehumidifying operation and the heating operation of the air conditioning device 100 are performed by the controller 129 controlling each component of the air conditioning device 100.

[0034] The terminal 140 is a remote control terminal used for a user to operate the air conditioning device 100. The terminal 140 may be a smartphone or a wearable terminal. The terminal 140 acquires data indicating an operation mode and a preset temperature that are inputted by the user and transmits, to the air conditioning device 100, infrared light or a radio signal that represents this data, the radio signal being typically used for a wireless local area network (wireless LAN) .

[0035] When the cooling operation and the dehumidifying operation are performed in the air conditioning device 100 having the above configuration, as in FIG. 1, the refrigerant is circulated in the refrigerant circuit 102 such that the refrigerant passes through the compressor 111, the four-way valve 112, the outdoor heat exchanger 113, the first expansion valve 115, the first indoor heat exchanger 121, the second expansion valve 123, the second indoor heat exchanger 122, and the four-way valve 112 in that order. A direction of the refrigerant flowing in the refrigerant circuit 102 is represented by a solid-line arrow in FIG. 1. Also, when the heating operation is performed, the refrigerant is circulated in the refrigerant circuit 102 such that the refrigerant passes through the compressor 111, the four-way valve 112, the second indoor heat exchanger 122, the second expansion valve 123, the first indoor heat exchanger 121, the first expansion valve 115, the outdoor heat exchanger 113, and the four-way valve 112 in that order. A direction of the refrigerant flowing in the refrigerant circuit 102 is represented by a dashed-line arrow in FIG. 1.

[0036] Next, each of the operation modes of the air conditioning device 100 is described. Operation modes according to the present embodiment include a first cooling mode, a second cooling mode, a third cooling mode, a dehumidification mode and a heating mode. The first cooling mode, the second cooling mode and the third cooling mode correspond to the cooling operation of the air conditioning device 100, the dehumidification mode corresponds to the dehumidifying operation of the air conditioning device 100, and the heating mode corresponds to the heating operation of the air conditioning device 100. The air conditioning device 100 selects one operation mode from these operation modes and operates in the selected operation mode to blow conditioned air into the indoor space.

[0037] The "operation mode" means a specific state in which the air conditioning device 100 continuously operates. The air conditioning device 100 usually continues to operate in one operation mode unless information acquired by the acquirer 128 is changed. The phrase, "the air conditioning device 100 continuously operates in one operation mode", means that the operation mode is not changed at least for one minute.

[0038] In the present embodiment, the controller 129 controls the degree of opening of the first expansion valve 115 and the degree of opening of the second expansion valve 123 in accordance with the sensible heat load to change an operation mode on the basis of predetermined conditions. The sensible heat load means energy necessary for changing a temperature of the indoor space to the preset temperature. Also, when an indoor space is to be cooled that has a high sensible heat load, the controller 129 changes the operation modes such that the initial operation mode is the first cooling mode, followed by the second cooling mode, the third cooling mode and the dehumidification mode. The description below is mainly centered on a case in which a change of the operation modes is made in the order described above.

[0039] FIG. 2 illustrates the relationship between sensible heat load and degrees of opening of the first and second expansion valves 115 and 123 that are controlled by the controller 129. In FIG. 2, a line L1 represents a degree of opening of the first expansion valve and a line L2 represents a degree of opening of the second expansion valve.

[0040] As a result of control of the degrees of opening of the expansion valves as illustrated in FIG. 2, the refrigerant evaporation temperature of the first indoor heat exchanger 121 and the refrigerant evaporation temperature of the second indoor heat exchanger 122 change in accordance with the sensible heat load as illustrated in FIG. 3. In FIG. 3, a line L11 represents the refrigerant evaporation temperature of the first indoor heat exchanger 121 and a line L12 represents the refrigerant evaporation temperature of the second indoor heat exchanger 122. The first cooling mode, the second cooling mode, the third cooling mode and the dehumidification mode are determined, as described below, from the relationship between (i) the refrigerant evaporation temperatures and (ii) a present ambient temperature Tr indicated by the temperature information acquired by the acquirer 128.

[0041] The first cooling mode is an operation mode in which the refrigerant evaporation temperature of the first indoor heat exchanger 121 is equal to the refrigerant evaporation temperature of the second indoor heat exchanger 122. The first cooling mode is achieved by adjusting the degrees of opening of the first and second expansion valves 115 and 123 to predetermined degrees of opening via the controller 129. Specifically, as illustrated in FIG. 2, the controller 129 decreases the degree of opening of the first expansion valve 115 and increases the degree of opening of the second expansion valve 123 to fully open the second expansion valve 123 and thus the first cooling mode is executed. In the first cooling mode, low-temperature, low-pressure refrigerant discharged from the first expansion valve 115 is evaporated by the first indoor heat exchanger 121 and the second indoor heat exchanger 122, and the indoor unit 120 cools air to blow the cooled air into the indoor space.

[0042] The second cooling mode is an operation mode in which the refrigerant evaporation temperature of the first indoor heat exchanger 121 is equal to or higher than the refrigerant evaporation temperature of the second indoor heat exchanger 122 and is equal to or lower than the ambient temperature Tr. As illustrated in FIG. 2, the second cooling mode is achieved in such a manner that the controller 129 increases the degree of opening of the first expansion valve 115 such that the degree of opening of the valve 115 in the second cooling mode is greater than that in the first cooling mode and decreases the degree of opening of the second expansion valve 123 such that the degree of opening of the valve 123 is smaller than that in the first cooling mode. In the second cooling mode, medium-temperature, medium-pressure refrigerant decompressed by the first expansion valve 115 is evaporated by the first indoor heat exchanger 121 and is decompressed by the second expansion valve 123 again. The low-temperature, low-pressure refrigerant discharged from the second expansion valve 123 is evaporated by the second indoor heat exchanger 122. As a result, the indoor unit 120 blows, to the indoor space, air cooled more mildly than the air is cooled in the first cooling mode.

[0043] The third cooling mode is an operation mode in which the refrigerant evaporation temperature of the first indoor heat exchanger 121 is equal to the ambient temperature Tr. As illustrated in FIG. 2, the third cooling mode is achieved by adjusting the degrees of opening of the first and second expansion valves 115 and 123 via the controller 129. Specifically, the controller 129 adjusts the degree of opening of the first expansion valve 115 to the maximum degree thereof in the second cooling mode and adjusts the degree of opening of the second expansion valve 123 to the minimum degree thereof in the second cooling mode and thus the third cooling mode is performed. In the third cooling mode, the temperature of the refrigerant decompressed by the first expansion valve 115 is equal to the ambient temperature Tr, and thus the refrigerant decompressed by the valve 115 does not exchange heat through the first indoor heat exchanger 121. The refrigerant having passed through the first indoor heat exchanger 121 without condensing or evaporating the refrigerant is decompressed by the second expansion valve 123 again and the low-temperature, low-pressure refrigerant is evaporated by the second indoor heat exchanger 122. As a result, the indoor unit 120 blows, to the indoor space, air not cooled by the first indoor heat exchanger 121 but cooled only by the second indoor heat exchanger 122.

[0044] The third cooling mode is included in the second cooling mode. However, the second cooling mode may be an operation mode in which the refrigerant evaporation temperature of the first indoor heat exchanger 121 is higher than the refrigerant evaporation temperature of the second indoor heat exchanger 122 and is lower than the ambient temperature Tr, and thus the third cooling mode may be an operation mode that is different from the second cooling mode.

[0045] The dehumidification mode is an operation mode in which the refrigerant evaporation temperature of the first indoor heat exchanger 121 is higher than the ambient temperature Tr. As illustrated in FIG. 2, the dehumidification mode is achieved in such a manner that the controller 129 increases the degree of opening of the first expansion valve 115 such that the degree of opening of the valve 115 is greater than that in the third cooling mode and decreases the degree of opening of the second expansion valve 123 such that the degree of opening of the valve 123 is smaller than that in the third cooling mode. In the dehumidification mode, the refrigerant slightly decompressed by the first expansion valve 115 or having passed through the first expansion valve 115 without decompressing the refrigerant is condensed by the first indoor heat exchanger 121 and is decompressed by the second expansion valve 123. The low-temperature, low-pressure refrigerant discharged from the second expansion valve 123 is evaporated by the second indoor heat exchanger 122. As a result, the indoor unit 120 blows, to the indoor space, air heated by the first indoor heat exchanger 121 and cooled to a temperature equal to or lower than the dew point temperature by the second indoor heat exchanger 122 to be humidified.

[0046] Next, an air conditioning process performed by the air conditioning device 100 is described with reference to FIG. 4. The air conditioning process illustrated in FIG. 4 is started by turning on the air conditioning device 100.

[0047] Upon starting the air conditioning process, the acquirer 128 acquires information (Step S1). This information includes temperature information and humidity information indicating a measurement result by each sensor, and when the user operates the terminal, this information includes at least one of a preset temperature or an operation mode that are specified by the user.

[0048] Next, the controller 129 determines whether an operation mode is specified (Step S2). If the controller 129 determines that the operation mode is specified (Yes in Step S2), the controller 129 controls the degrees of opening of the first and second extension valves 115 and 123 as illustrated in FIG. 2 and operates in the specified operation mode (Step S3). Specifically, the controller 129 selects the specified operation mode and controls each of the components of the air conditioning device 100 including the expansion valves based on the selected operation mode to condition air in the indoor space. As a result, the indoor blower 124 blows the conditioned air into the indoor space.

[0049] In a case in which no preset temperature is set, the controller 129 may use a predetermined target value as a preset temperature. This target value is, for example, a value of 22°C previously stored in the EEPROM or a value determined in accordance with ambient temperature.

[0050] Also, although the controller 129 may control the degrees of opening of the expansion valves simply in accordance with the sensible heat load on the basis of the relationship illustrated in FIG. 2, manners of controlling the degrees of opening of the expansion valves are not limited to the manners illustrated in FIG. 2. The controller 129 may perform feedback control using measurement results from the sensors 121a and 122a to control the degrees of opening of the expansion valves to achieve the refrigerant evaporation temperatures determined in accordance with the sensible heat load as illustrated in FIG. 3.

[0051] In the case in which the above feedback control is performed, the controller 129 slightly closes the first expansion valve 115 when the measurement result from the sensor 121a is higher than the refrigerant expansion temperature illustrated as a target value in FIG. 3, and slightly opens the first expansion valve 115 when the measurement result is lower than the target value. Also, the controller 129 slightly opens the second expansion valve 123 when the measurement result from the sensor 122a is lower than the refrigerant expansion temperature illustrated as a target value in FIG. 3, and slightly closes the second expansion valve 123 when the measurement result is higher than the target value.

[0052] When such feedback control is performed, the controller 129 accurately controls the refrigerant evaporation temperatures and thus the sensible heat capacity of the air conditioning device 100 can be accurately achieved as intended. The sensible heat capacity is a collective term meaning both a cooling capacity in the cooling operation and a cooling capacity in the dehumidifying operation and means a capacity for sensible heat load processed by the air conditioning device 100. As a result, the temperature of the indoor space becomes stable, and thus comfort of the user is improved. Additionally, the refrigerant evaporation temperatures are adequately controlled, and thus it is possible to prevent the compressor 111 from breaking down due to suction of the liquefied refrigerant into the compressor 111.

[0053] The flow chat illustrated in FIG. 4 is further described. After executing the Step S3, the controller 129 makes a transition to Step S7 in the process.

[0054] However, if it is determined that no operation mode is specified (No in Step S2), the controller 129 determines whether a preset temperature is specified (Step S4). If the controller 129 determines that the preset temperature is specified (Yes in Step S4), the controller 129 make a transition to Step S6 in the process.

[0055] However, if it is determined that no preset temperature is specified (No in Step S4), the controller 129 sets a preset temperature to a predetermined target value as (Step S5).

[0056] Next, the controller 129 controls the degrees of opening of the first expansion valve 115 and the degree of opening of the second expansion valve 123 as illustrated in FIG. 2 to operate in an operation mode depending on the present sensible heat load (Step S6). As a result, the indoor blower 124 blows the conditioned air into the indoor space.

[0057] Next, the controller 129 acquires information from the acquirer 128 (Step S7). This information includes the temperature information and the humidity information indicating the measurement results from the sensors.

[0058] Next, the controller 129 determines whether a condition for change of the operation mode is satisfied (Step S8). Conditions for change of the operation mode vary depending on an operation mode presently performed and an operation mode performed after change of the operation mode. These conditions for change of the operation mode are predetermined and are stored in the EEPROM of the controller 129. The conditions for change of the operation mode are satisfied depending on a present ambient temperature indicated by the temperature information acquired by the acquirer 128, present humidity of the indoor space indicated by the humidity information acquired by the acquirer 128, an operating frequency for the compressor 111 and the duration of operation of the air conditioning device 100 in the present operation mode.

[0059] For example, a condition for changing from the first cooling mode to the second cooling mode is a condition that the present ambient temperature is smaller than a first threshold, the present humidity of the indoor space is greater than a second threshold, the operating frequency for the compressor 111 is smaller than a third threshold and an operation of the air conditioning device 100 in the first cooling mode continues for one minute or more. Also, a condition for changing from the second cooling mode including the third cooling mode to the dehumidification mode is a condition that the present ambient temperature is smaller than a fourth threshold, the present humidity of the indoor space is greater than a fifth threshold, the operating frequency for the compressor 111 is smaller than a sixth threshold and an operation of the air conditioning device 100 in the second cooling mode continues for one minute or more.

[0060] The first and fourth thresholds may be predetermined values indicating 26°C, 28°C or the like and stored in the EEPROM or values obtained by adding a predetermined margin to the preset temperature. The second and fifth thresholds are, for example, predetermined values stored in the EEPROM, the preset temperature or values determined depending on the preset temperature. The third and sixth thresholds are, for example, predetermined values stored in the EEPROM or values obtained by adding a predetermined margin to the minimum operating frequency in operation of the compressor 111. The first and fourth thresholds may be different from each other, the second and fifth thresholds may be different from each other, and the third and sixth thresholds may be different from each other.

[0061] The operation mode transitions to, in order or reverse order, the first cooling mode, the second cooling mode, the third cooling mode, and the dehumidification mode. That is, the controller 129 changes from one operation mode to another operation mode when a condition for change of the operation modes is satisfied. In this case, an operation mode made to transition from the first cooling mode is the second cooling mode, and the third cooling mode or the dehumidification mode are not made to transition to the first cooling mode. Also, an operation mode made to transition from the second cooling mode is the first cooling mode or the dehumidification mode. Particularly, when a specific condition is satisfied in the second cooling mode, the operation mode is made to transition to the third cooling mode. An operation mode made to transition from the third cooling mode is the second cooling mode or the dehumidification mode and the third cooling mode is not made to transition to the first cooling mode. Also, an operation mode made to transition from the dehumidification mode is the second cooling mode or the third cooling mode and the dehumidification mode is not made to transition to the first cooling mode.

[0062] If the controller 129 determines that no condition for change of the operation modes is satisfied (No in Step S8), the controller 129 makes a transition to Step S10 in the process. However, if the controller 129 determines that a condition for change of the operation modes is satisfied (Yes in Step S8), the controller 129 changes the operation mode on the basis of the satisfied condition for change of the operation modes (Step S9). Specifically, the controller 129 selects an operation mode different from the currently selected operation mode on the basis of the condition for change of the operation mode.

[0063] Next, the controller 129 controls the degrees of opening of the first expansion valve 115 and the second expansion valves 123 as illustrated in FIG. 2 and makes the air conditioning device operate in the currently-selected operation mode (Step S10). As a result, the indoor blower 124 blows the conditioned air to the indoor space. Afterward, the controller 129 repeatedly performs Step S7 and beyond.

[0064] Next, an example of change of the operation modes achieved by the above air conditioning process is described with reference to FIG. 5. FIG. 5 illustrates transitions of ambient temperature, room temperature and a degree of opening of the expansion valve on a common time axis in a case in which the cooling operations and the dehumidification operation are performed in a day in summer.

[0065] As illustrated in FIG. 5, since ambient temperature is high during midday and thus sensible heat load for a cooling operation is high, the air conditioning device 100 operates in the first cooling mode to cool the indoor space. As the ambient temperature gradually drops during a time period between noon and evening, the sensible heat load also gradually decreases. When the ambient temperature drops up to a temperature close to the preset temperature, the controller 129 reduces the operating frequency of the compressor 111 to reduce its cooling capacity. However, since the compressor 111 must be operated at an operating frequency equal to or greater than the minimum operating frequency, the ambient temperature is made to drop to a temperature equal to or lower than the preset temperature even though the compressor 111 operates at this minimum operating frequency.

[0066] When a condition for changing of the operating mode from the first cooling mode to the second cooling mode is satisfied at this time, the controller 129 changes the operation mode to the second cooling mode. Since the cooling capacity of the air conditioning device 100 in the second cooling mode is smaller than that in the first cooling mode, the change to the second cooling mode causes a slight rise in the ambient temperature. As a result, the ambient temperature can be maintained at a temperature close to the preset temperature. Also, the air conditioning device 100 can perform dehumidification due to an increase in the sensible heat capacity of the air conditioning device 100. The sensible heat capacity corresponds to dehumidification performance and means a capacity for sensible heat load of the indoor space processed by the air conditioning device 100.

[0067] As the ambient temperature drops during a time period between evening and night, the sensible heat load also gradually decreases. When the ambient temperature drops to a temperature close to the preset temperature, the controller 129 reduces the operating frequency of the compressor 111, and the ambient temperature drops to a temperature equal to or lower than the preset temperature again. When a condition for changing the operation mode to the third cooping mode is satisfied at this time, the controller 129 changes the operation mode to the third cooling mode. Changing the operation mode to the third cooling mode causes a decrease in the sensible heat capacity of the air conditioning device 100, and thus the ambient temperature slightly rises. As a result, the ambient temperature can be maintained at a temperature close to the preset temperature. Also, the air conditioning device 100 can perform dehumidification due to an increase in the sensible heat capacity of the air conditioning device 100.

[0068] As the night grows late and thus the ambient temperature further drops, the sensible heat load also further decreases. When the ambient temperature drops to a temperature close to the preset temperature, the controller 129 reduces the operating frequency of the compressor 111, and thus the ambient temperature drops to a temperature equal to or lower than the preset temperature. When a condition for changing the operation mode from the second cooling mode to the dehumidification mode is satisfied at this time, the controller 129 changes the operation mode to the dehumidification mode. Since the sensible heat capacity of the air conditioning device 100 in the dehumidification mode is smaller than that in the second cooling mode, changing the operation mode to the dehumidification mode causes a slight rise in the ambient temperature. As a result, the ambient temperature can be maintained at a temperature close to the preset temperature. Also, the air conditioning device 100 can perform dehumidification due to an increase in the sensible heat capacity of the air conditioning device 100.

[0069] As described above, the air conditioning device 100 according to the present embodiment executes a cooling operation in the second cooling mode after executing a cooling operation in the first cooling mode, and then the air conditioning device 100 executes a dehumidifying operation in the dehumidification mode after executing a cooling operation in the second cooling mode.

[0070] In a generally known method, a compressor is stopped when the ambient temperature is lower than the preset temperature and the compressor is run when the ambient temperature is higher than the preset temperature, thereby maintaining an ambient temperature at a temperature close to a preset temperature. However, the repeated frequent stopping and running of the compressor cause the ambient temperature and an air amount to remarkably fluctuate in a short time, or makes it difficult to perform dehumidification, and thus comfort of the user is impaired. Also, an increase in frequencies of starting and stopping of the compressor might cause a decrease in the lifetime of the compressor.

[0071] In contrast, in the present embodiment, the restriction on the minimum operating frequency of the compressor 111 makes it possible to maintain the ambient temperature at the preset temperature by reducing the sensible heat capacity without stopping the compressor 111 even though there is need to raise the ambient temperature in the cooling operation. That is, comfort of the user and the product reliability can be improved without frequently starting and stopping of the compressor 111.

[0072] FIG. 6 illustrates the relationship between the sensible hear capacity and the latent heat capacity of the air conditioning device 100. In the first cooling mode illustrated in FIG. 6, the greater the operating frequency of the compressor 111 becomes, the greater the sensible heat capacity becomes. The boundary between the first cooling mode and the second cooling mode corresponds to a state in which the compressor 111 is run at the minimum operating frequency. In the present embodiment, as illustrated in FIG. 6, the sensible heat capacity and the latent heat capacity can be continuously adjusted by changing the operation mode, in order or reverse order, to the first cooling mode, the second cooling mode, the third cooling mode, and the dehumidification mode. Therefore, fine adjustments of the ambient temperature and the room humidity can be made when heat load is low, for example, during night in summer or in intermediate seasons such as spring, the rainy season and fall in Japan, and thus comfort of the user can be improved.

[0073] Also, in the present embodiment, the operation mode transitions to, in order or reverse order, the first cooling mode, followed by the second cooling mode, the third cooling mode and the dehumidification mode. Changing the operation mode in such a manner enables the air conditioning device 100 to continuously control its sensible heat capacity and the latent heat capacity, and thus rapid fluctuations in the temperature and the humidity in the indoor space can be suppressed. Also, since the operation modes transition in the above described manner, the degrees of opening of the expansion valves gradually and continuously change, as illustrated in FIG. 2. As a result, occurrence of refrigerant-induced noise can be suppressed as much as possible.

[0074] Also, the conditions for change of the operation modes include a condition that the operating frequency of the compressor 111 is equal to or smaller than the threshold. When the operating frequency of the compressor 111 is small, a flow volume of the refrigerant becomes small, and thus the occurrence of refrigerant-induced noise in a change of the operation modes can be suppressed.

[0075] Also, the conditions for a change of the operation modes in the present embodiment include conditions regarding results of measurement of the temperature and the humidity of the indoor space, the operating frequency of the compressor 111 and the duration of an operation of the air conditioning device in one operation mode. As a result, the controller 129 changes the operation modes in light of the sensible heat load, the latent load and the total heat load of the indoor space and fluctuation in the load. Accordingly, even though the sensible heat load and the latent heat load change due to an environmental change from afternoon to night or a change in weather from sunny weather to rainy weather, the temperature and the humidity of the indoor space are kept approximately constant, and thus comfort of the user is improved.

Embodiment 2

[0076] Next, Embodiment 2 is described with a focus on matters different from those of Embodiment 1 described above. Components that are the same as or equivalent to those used in Embodiment 1 are assigned the same reference signs, and descriptions of such components are omitted or brief descriptions of such components are provided. Embodiment 2 is different from Embodiment 1 in that Embodiment 2 uses a first dehumidification mode and a second dehumidification mode in which an amount of air blown by the outdoor blower 114 is smaller than that in the first dehumidification mode.

[0077] Since an amount of air blown by the outdoor blower 114 in the second dehumidification mode is smaller than that in the first dehumidification mode, the refrigerant evaporation temperatures of the outdoor heat exchanger 113 and the first indoor heat exchanger 121 rise. As a result, the temperature of air passing through the first indoor heat exchanger 121 is higher than that in the first dehumidification mode. Therefore, the sensible heat capacity in the second dehumidification mode is closer to zero than that in the first dehumidification mode.

[0078] The operation mode in Embodiment 2 transitions to, in order or reverse order, the first cooling mode, followed by the second cooling mode, the third cooling mode, the first dehumidification mode and the second dehumidification mode. That is, an operation mode to which the second cooling mode is changed is the first cooling mode or the first dehumidification mode and the second cooling mode is not changed to the second dehumidification mode. Also, an operation mode made to transition from the third cooling mode is the second cooling mode or the first dehumidification mode and the third cooling mode is not made to transition to the second dehumidification mode. Also, an operation mode made to transition from the first dehumidification mode is the second cooling mode, third cooling mode or the second dehumidification mode and the first dehumidification mode is not changed to the first cooling mode. Also, an operation mode made to transition from the second dehumidification mode is the first dehumidification mode and the second dehumidification mode is not made to transition to the first cooling mode, the second cooling mode or the third cooling mode.

[0079] FIG. 7 illustrates transitions of ambient temperature, room temperature and an amount of air blown by the outdoor blower 114 on a common time axis in a case in which the cooling operations and the dehumidification operation are performed in a day in summer. As illustrated in FIG. 7, as the ambient temperature drops to become equal to or lower than the ambient temperature with the transition from midnight to early morning, the cooling load becomes zero or a heating load occurs. However, even though the air conditioning device continues to operate in the first dehumidification mode, the restriction on the operating frequency of the compressor 111 causes the ambient temperature to drop to a temperature equal to or lower than the preset temperature.

[0080] When a specific condition is satisfied at this time, the controller 129 changes from the first dehumidification mode to the second dehumidification mode to reduce an amount of air blown by the outdoor blower 114. This condition is a condition that a value of the ambient temperature acquired by the acquirer 128 is equal to or smaller than a threshold, a value of the humidity of the indoor space acquired by the acquirer 128 is equal to or greater than a threshold, the operating frequency of the compressor is equal to or smaller than a threshold, and an operation of the air conditioning device in the first dehumidification mode continues for one minute or more. The thresholds for determining whether the above condition is satisfied may be predetermined values or values determined depending on the preset temperature.

[0081] The sensible heat capacity of the air conditioning device 100 in the second humidification mode is smaller than that in the first dehumidification mode, and thus changing the operation mode to the second dehumidification mode causes a slight rise in the ambient temperature. As a result, the ambient temperature can be maintained at a temperature close to the preset temperature. Also, the air conditioning device 100 can perform dehumidification since the latent heat capacity of the air conditioning device is maintained despite the change of the operation mode.

[0082] As described above, the air conditioning device 100 is made to operate in the second dehumidification mode in which the sensible heat capacity is smaller than that in the first dehumidification mode. As a result, the temperature and the humidity of the indoor space can be adjusted when it is hot and humid despite low ambient temperature, for example, in the rainy season in Japan. Also, since the sensible heat capacity in the second dehumidification mode is close to zero to some extent, the operation modes can be continuously changed from the dehumidification mode to the heating mode and thus comfort of the user is improved.

Embodiment 3

[0083] Next, Embodiment 3 is described with a focus on matters different from those of Embodiment 1 described above. Components that are the same as or equivalent to those used in Embodiment 1 are assigned the same reference signs, and descriptions of such components are omitted or brief descriptions of such components are provided. Embodiment 3 is different from Embodiment 1 in that conditions for a change of the operation modes in Embodiment 3 are satisfied in accordance with a temperature of a building including the indoor space, a temperature and humidity of the ambient air and a body temperature of the user.

[0084] As illustrated in FIG. 8, the air conditioning device 100 according to the present embodiment is built into the outdoor unit and includes sensors 116a and 117a to respectively measure a temperature and humidity of the ambient air, a sensor 150a to measure a temperature of the building, and a body temperature detector 140a that is built into the terminal 140 and is a sensor to measure a body temperature of the user. The acquirer 128 acquires the temperature information and the humidity information indicating measurement results from the respective sensors and notifies the controller 129 of the temperature information and the humidity information. The controller 129 changes the operation mode in accordance with the measurement results indicated by the temperature information and the humidity information.

[0085] As described above, changing the operation modes in accordance with the temperature of the building, the temperature and the humidity of the ambient air and the body temperature of the user can contribute to energy saving and thus comfort of the user is improved.

[0086] For example, when the temperature of the ambient air rapidly drops and the humidity of the ambient air rapidly increases while the user are sleeping, the controller 129 can rapidly change the operation mode by presuming that the weather changes from sunny weather to rainy weather. Also, if the temperature and the humidity of the ambient air do not change even though the indoor temperature and the indoor humidity change, the controller 129 can determine, by determining that a temporary disturbance has occurred, that the operation modes should not be changed. As a result, the controller 129 stably executes the control, and thus the temperature and the humidity of the indoor space are kept constant and comfort of the user is improved.

[0087] The air conditioning device 100 is configured to have a structure from which the sensors 116a and 117a are omitted, and the acquirer 128 may acquire, from a server apparatus on the Internet, weather information including the temperature and humidity of the ambient air, solar insolation and weather.

[0088] Also, the air conditioning device 100 may have a structure in which the sensor 150a is omitted, and the controller 129 may estimate a mean radiant temperature or an amount of solar insolation from a surface temperature of a building frame of the indoor space, where the surface temperature of the building frame is measured as a building temperature by the sensor 127a. Additionally, the controller 129 may estimate a ratio of the sensible heat load to the latent heat load from a result of the estimation of the mean radiant temperature or the like, and may increase an amount of air blown by the indoor blower 124 when the sensible heat load is high.

[0089] The increase in the amount of air blown by the indoor blower 124 causes an increase in the sensible heat capacity and thus a decrease in the latent heat capacity. As a result, the heat load becomes equal to the cooling capacity of the air conditioning device 100. Accordingly, the ambient temperature and relative humidity can be controlled such that the ambient temperature and the relative humidity are within a comfortable range. Also, since pressure on the low-pressure side of the refrigerant circuit 102 increases, and thus a pressure difference caused by the compressor 111 is decreased, power consumption can be reduced.

Embodiment 4

[0090] Next, Embodiment 4 is described with a focus on matters different from those of Embodiment 1 described above. Components that are the same as or equivalent to those used in Embodiment 1 are assigned the same reference signs, and descriptions of such components are omitted or brief descriptions of such components are provided. The present embodiment is different from Embodiment 1 in that, as illustrated in FIG. 9, the indoor unit 120 includes in the air conditioning device 100 according to the present embodiment an estimating unit 129b to estimate user attributes.

[0091] The estimating unit 129b of the present embodiment creates data representing a heat distribution of the indoor space from a distribution of infrared intensity measured by the sensor 127a. The estimating unit 129b estimates the attributes of the user including the age of the user, the gender of the user, the sensory temperature of the user, temperatures of user's legs and arms, and whether the user is cold-sensitive or heat-sensitive, on the basis of the created heat distribution, and then the estimating unit 129b transmits estimation results to the controller 129. The controller 129 determines whether or not a condition for a change of the operation modes is satisfied, in accordance with the estimation results from the estimating unit 129b.

[0092] As described above, in the present embodiment, the conditions for a change of the operation modes are satisfied in accordance with the user's attributes. In this case, even though the user's thermal sensation is at a moderate level, the user may feel cold due to user's toes getting cold. In a case in which the estimating unit 129b estimates that the user's toes get cold, the controller 129 resets the first threshold to a high value, and resets the second threshold to a low value, where the first threshold and the second threshold are respectively used for the condition regarding the ambient temperature and the condition regarding humidity among the conditions for a change of the operation modes, and then the controller 129 changes the operation modes. As a result, both the thermal sensation in the whole body of the user and the thermal sensation in a local portion of the user's body such as toes or a hand can be kept comfortable.

[0093] Also, in a case in which both a hot-natured user and a cold-natured user are present in the same indoor space, the controller 129 may reset the first temperature and the second humidity so that the air conditioning state is suited for the cold-sensitive user, and air flow may be supplied to the heat-sensitive user. Also, in a case in which users different from one another in gender and age are present in the same indoor space, the controller 129 may reset the first threshold and the second threshold so that the air conditioning state is suited for a user having high priority, and air flow may be controlled such that the air flow is suited for the users other than the user having high priority. As a result, comfort of all of the users can be improved.

[0094] The body temperature of the user may be estimated by the estimating unit 129b instead of the body temperature being measured by the body temperature detector 140a used in Embodiment 3. That is, in Embodiment 3, the air conditioning device 100 is configured to have a structure in which the body temperature detector 140a is omitted from the terminal 140, and the body temperature of the user may be detected by the estimating unit 129b of the present embodiment.

Embodiment 5

[0095] Next, Embodiment 5 is described with a focus on matters different from those of Embodiment 1 described above. Components that are the same as or equivalent to those used in Embodiment 1 are assigned the same reference signs, and descriptions of such components are omitted or brief descriptions of such components are provided. The present embodiment is different from Embodiment 1 in that, when a specific condition is satisfied, the controller 129 of the present embodiment controls an amount of air blown by the indoor blower 124.

[0096] FIG. 10 illustrates the relationship between the sensible heat capability and the latent heat capability of the air conditioning device 100 according to the present embodiment. As illustrated via an outlined-type arrow in FIG. 10, when the controller 129 reduces an amount of air blown by the indoor blower 124, the latent heat capability increases.

[0097] In a case in which the compressor 111 operates at a relatively low operating frequency in the first cooling mode and the second cooling mode in this case, the latent heat capacity is small, and thus it is considered that an increase in the humidity in the indoor space can easily occur. Therefore, when the condition is satisfied that the temperature in the indoor space is equal to or lower than a threshold and the humidity in the indoor space is higher than a threshold, the controller 129 can increase the latent heat capacity by reducing the amount of air blown by the indoor blower 124. As a result, the sensible heat capacity and the latent heat capacity can be widely controlled. That is, not only values of one point in the graph in which the sensible heat capacity and the latent heat capacity correspond one-to-one with each other can be achieved by the above control but also the latent heat capacity can be increased with the sensible heat capacity kept constant. Therefore, fluctuations in the temperature and the humidity in the indoor space can be suppressed.

[0098] Although the embodiments of the present disclosure are described above, the present disclosure is not limited to the above embodiments.

[0099] For example, the first expansion valve 115 and the second expansion valve 123 may have a capability of reducing the sizes of air bubbles and liquid droplets of two-phase refrigerant flowing into the valves to deaden sound.

[0100] Also, the sensors 125a and 126a may be placed outside the indoor unit, for example, in the terminal 140.

[0101] Also, the controller 129 may be configured as two controllers that are an outdoor controller and an indoor controller such that the outdoor unit 110 includes the outdoor controller to control each component of the outdoor unit 110 and the indoor unit 120 includes the indoor controller to control each component of the indoor unit 120.

[0102] Also, even though the second expansion valve 123 is fully opened in the first cooling mode, the degree of opening of the second expansion valve 123 is insufficient and thus the refrigerant might be decompressed. Accordingly, a bypass circuit bypassing the second expansion valve 123 is added to the refrigerant circuit 102, and a solenoid valve may be provided, such that the solenoid valve is connected in parallel to the second expansion valve 123. In the case in which the solenoid valve is provided, the solenoid valve is fully opened in the first cooling mode. As a result, pressure loss of the refrigerant can be prevented, and the refrigerant circuit 102 can be efficiently operated.

[0103] Also, a device performing the above processes can be configured by storing the program P1 stored in the EEPROM of the controller 129 in a computer-readable recording medium such as a flexible disc, a compact disk read-only memory (CD-ROM), a digital versatile disk (DVD), a magneto-optional disc (MO) and the like, distributing the computer-readable recording medium, and installing the program P1 on a computer.

[0104] Also, the program P1 may be stored in a disk device included in a server device on a communication network typified by the Internet, and, for example, the program P1 may be downloaded to a computer by superimposing the program P1 on a carrier wave.

[0105] Also, the above processes can be achieved by starting and running the program P1 while transferring the program P1 via the network typified by the Internet.

[0106] Also, the above processes can be achieved by running the whole of or a portion of the program P1 on the server device and running the program P1 by the computer while the computer is receiving and transmitting information about the processes via the communication network.

[0107] When the above-described functions are, for example, achieved partly by an operating system (OS) or cooperatively with the OS and the application, the program other than the OS may be stored on the above recording medium for distribution or may be downloaded to the computer.

[0108] Also, means for achieving the functions of the air conditioning device 100 is not limited to software, and a portion of or the whole of the functions may be achieved by dedicated hardware. For example, when the acquirer 128, the controller 129 and the estimating unit 129b are made using circuits typified by a field programmable gate array (FPGA) or an application specific integrated circuit (ASIC), power saving can be achieved on the air conditioning device 100.

[0109] The foregoing describes some example embodiments for explanatory purposes. Although the foregoing discussion has presented specific embodiments, persons skilled in the art will recognize that changes may be made in form and detail without departing from the broader spirit and scope of the invention. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense. This detailed description, therefore, is not to be taken in a limiting sense, and the scope of the invention is defined only by the included claims, along with the full range of equivalents to which such claims are entitled.

[0110] Furthermore, additional examples, for instance to which features disclosed above can be added and/or introduced in replacement and/or appropriately combined, are set out herein below in a numbered form for the sake of conciseness.

1. An example of air conditioning device for operation in an operation mode selected from a first cooling mode, a second cooling mode, and a dehumidification mode, the air conditioning device comprising:

a refrigerant circuit configured to circulate refrigerant by passing the refrigerant through, in an order of, a compressor, an outdoor heat exchanger, a first expansion valve, a first indoor heat exchanger, a second expansion valve, and a second indoor heat exchanger, a degree of opening of the first expansion valve and a degree of opening of the second expansion valve being adjustable;
acquisition means for acquiring temperature information indicating a temperature of air in an indoor space to be air-conditioned; and
indoor ventilation means for sending air that is heat-exchanged by the first indoor heat exchanger and the second indoor heat exchanger to the indoor space,
wherein
in the first cooling mode, when the degree of opening of the first expansion valve and the degree of opening of the second expansion valve are adjusted to a predetermined degree of opening, a refrigerant evaporation temperature of the first indoor heat exchanger becomes equal to a refrigerant evaporation temperature of the second indoor heat exchanger,
in the second cooling mode, when (i) the degree of opening of the first expansion valve is adjusted to be greater than or equal to the degree of opening in the first cooling mode and (ii) the degree of opening of the second expansion valve is adjusted to be less than or equal to the degree of opening in the first cooling mode, the refrigerant evaporation temperature of the first indoor heat exchanger becomes higher than the refrigerant evaporation temperature of the second indoor heat exchanger and becomes lower than the temperature indicated by the temperature information, and
in the dehumidification mode, when (i) the degree of opening of the first expansion valve is adjusted to be greater than or equal to the degree of opening in the second cooling mode and (ii) the degree of opening of the second expansion valve is adjusted to be less than or equal to the degree of opening in the second cooling mode, the refrigerant evaporation temperature of the first indoor heat exchanger becomes higher than the temperature indicated by the temperature information.

2. The air conditioning device according to example 1, further comprising:

outdoor ventilation means for blowing air to the outdoor heat exchanger, wherein
the dehumidification mode includes

a first dehumidification mode, and
a second dehumidification mode in which an amount of air blown by the outdoor ventilation means is smaller than an amount of air blown by the outdoor ventilation means in the first dehumidification mode.

3. The air conditioning device according to example 1 or 2, wherein

when a predetermined condition is satisfied, the operation mode transitions from one to another among the first cooling mode, the second cooling mode and the dehumidification mode,
the operation mode to be made to transition from the first cooling mode is the second cooling mode,
the operation mode to be made to transition from the second cooling mode is the first cooling mode or the dehumidification mode, and
the operation mode to be made to transition from the dehumidification mode is the second cooling mode.

4. The air conditioning device according to example 3, wherein

the acquisition means acquires humidification information indicating humidity of air in the indoor space, and
the condition is satisfied in accordance with at least one of the temperature indicated by the temperature information, the humidity indicated by the humidification information, or an operating frequency of the compressor.

5. The air conditioning device according to example

4, wherein

when the operation mode is the first cooling mode, the condition is satisfied and the operation mode is made to transition to the second cooling mode upon (i) the temperature indicated by the temperature information being lower than a first threshold, (ii) the humidity indicated by the humidity information being higher than a second threshold, and (iii) the operating frequency of the compressor being less than a third threshold, and

when the operation mode is the second cooling mode, the condition is satisfied and the operation mode is made to transition to the dehumidification mode upon (i) the temperature indicated by the temperature information being lower than a fourth threshold, (ii) the humidity indicated by the humidification information being higher than a fifth threshold, and (iii) the operating frequency of the compressor being less than a sixth threshold.

6. The air conditioning device according to any one of examples 3 to 5, wherein the condition is satisfied in accordance with duration of an operation in one operation mode.

7. The air conditioning device according to any one of examples 3 to 6, wherein

the temperature information indicates (i) a temperature within a building including the indoor space and (ii) an outdoor temperature, and

the condition is satisfied in accordance with at least one of (i) the temperature within the building and the outdoor temperature that are indicated by the temperature information, or (ii) a body temperature of a user present in the indoor space, the body temperature being detected by body temperature detection means.

8. The air conditioning device according to any one of examples 3 to 7, further comprising:

estimation means for estimating attributes of the user present in the indoor space, wherein

the condition is satisfied in accordance with a result of estimation by the estimation means, and

the attributes include at least one of a gender or an age of the user.

9. An example of air conditioning method for sending conditioned air to an indoor space in an operation mode selected from a first cooling mode, a second cooling mode, and a dehumidification mode,

wherein

a refrigerant circuit is configured to circulate refrigerant by passing the refrigerant through, in an order of, a compressor, an outdoor heat exchanger, a first expansion valve, a first indoor heat exchanger, a second expansion valve, and a second indoor heat exchanger, a degree of opening of the first expansion valve and a degree of opening of the second expansion valve being adjustable,

in the first cooling mode, the degree of opening of the first expansion valve and the degree of opening of the second expansion valve are adjusted to a predetermined degree of opening, thereby making a refrigerant evaporation temperature of the first indoor heat exchanger equal to a refrigerant evaporation temperature of the second indoor heat exchanger,

in the second cooling mode, the degree of opening of the first expansion valve and the degree of opening of the second expansion valve are adjusted such that the degree of opening of the first expansion valve is greater than or equal to the degree of opening in the first cooling mode and the degree of opening of the second expansion valve is less than or equal to the degree of opening in the first cooling mode, thereby making the refrigerant evaporation temperature of the first indoor heat exchanger higher than the refrigerant evaporation temperature of the second indoor heat exchanger and lower than a temperature of air in the indoor space, and

in the dehumidification mode, the degree of opening of the first expansion valve and the degree of opening of the second expansion valve are adjusted such that the degree of opening of the first expansion valve is greater than or equal to the degree of opening in the second cooling mode and the degree of opening of the second expansion valve is less than or equal to the degree of opening in the second cooling mode, thereby making the refrigerant evaporation temperature of the first indoor heat exchanger higher than the temperature of the air in the indoor space.

10. An example of program causing a computer for controlling an air conditioning device to function as:

acquisition means for acquiring temperature information indicating a temperature of air in an indoor space to be air-conditioned; and

control means for controlling an operation mode of the air conditioning device and selecting the operation mode from a first cooling mode, a second cooling mode, and a dehumidification mode,

wherein

a refrigerant circuit is configured to circulate refrigerant by passing the refrigerant through, in an order of, a compressor, an outdoor heat exchanger, a first expansion valve, a first indoor heat exchanger, a second expansion valve, and a second indoor heat exchanger that are included in the air conditioning device, a degree of opening of the first expansion valve and a degree of opening of the second expansion valve being adjustable,

in the first cooling mode, when the degree of opening of the first expansion valve and the degree of opening of the second expansion valve are adjusted to a predetermined degree of opening, a refrigerant evaporation temperature of the first indoor heat exchanger becomes equal to a refrigerant evaporation temperature of the second indoor heat exchanger,

in the second cooling mode, when (i) the degree of opening of the first expansion valve is adjusted to be greater than or equal to the degree of opening in the first cooling mode and (ii) the degree of opening of the second expansion valve is adjusted to be less than or equal to the degree of opening in the first cooling mode, the refrigerant evaporation temperature of the first indoor heat exchanger becomes higher than the refrigerant evaporation temperature of the second indoor heat exchanger and becomes lower than the temperature indicated by the temperature information, and

in the dehumidification mode, when (i) the degree of opening of the first expansion valve is adjusted to be greater than or equal to the degree of opening in the second cooling mode and (ii) the degree of opening of the second expansion valve is adjusted to be less than or equal to the degree of opening in the second cooling mode, the refrigerant evaporation temperature of the first indoor heat exchanger becomes higher than the temperature indicated by the temperature information.

[0111] The above numbered examples, possibly in combination with any of the features disclosed in this description, may be a basis for the claims. As well, the above numbered examples, possibly in combination with any of the features disclosed in the description, may support the claims.

Industrial Applicability

[0112] The present disclosure is suitable for technologies for conditioning air in an indoor space.

Reference Signs List

[0113]

100 Air conditioning device
101 Refrigerant line
102 Refrigerant circuit
110 Outdoor unit
111 Compressor
112 Four-way valve
113 Outdoor heat exchanger
114 Indoor blower
115 First expansion valve
116a, 117a, 121a, 122a, 125a, 126a, 127a, 150a Sensor
120 Indoor unit
121 First indoor heat exchange
122 Second indoor heat exchanger
123 Second expansion valve
124 Indoor blower
128 Acquirer
129 Controller
129b Estimating unit
140 Terminal
140a Body temperature detector
L1, L2, L11, L12 Line
P1 Program

Claims

1. An air conditioning device (100) for operation in an operation mode selected from a first cooling mode, a second cooling mode, and a dehumidification mode, the air conditioning device (100) comprising:

a refrigerant circuit (102) configured to circulate refrigerant by passing the refrigerant through, in an order of, a compressor (111), an outdoor heat exchanger (113), a first expansion valve (115), a first indoor heat exchanger (121), a second expansion valve (123), and a second indoor heat exchanger (122), a degree of opening of the first expansion valve (115) and a degree of opening of the second expansion valve (123) being adjustable;

a first sensor (121a) configured to measure a refrigerant evaporation temperature of the first indoor heat exchanger (121);

a second sensor (122a) configured to measure a refrigerant evaporation temperature of the second indoor heat exchanger (122);

acquisition means (128) configured to acquire first temperature information, from the first sensor (121a) and from the second sensor (122a), indicating the refrigerant evaporation temperatures of the first indoor heat exchanger (121) and the second indoor heat exchanger (122), and second temperature information indicating a temperature of air in an indoor space to be air-conditioned;

indoor ventilation means (124) configured to send air that is heat-exchanged by the first indoor heat exchanger (121) and the second indoor heat exchanger (122) to the indoor space; and

outdoor ventilation means (114) configured to send air to the outdoor heat exchanger (113), wherein

in the first cooling mode, the air conditioning device (100) is configured to adjust the degree of opening of the first expansion valve (115) and the degree of opening of the second expansion valve (123) to a predetermined degree so that the refrigerant evaporation temperature of the first indoor heat exchanger (121) indicated by the first temperature information becomes equal to the refrigerant evaporation temperature of the second indoor heat exchanger (122) indicated by the first temperature information,

in the second cooling mode, the air conditioning device (100) is configured to adjust the degree of opening of the first expansion valve (115) to be greater than or equal to the degree of opening in the first cooling mode and adjust the degree of opening of the second expansion valve (123) to be less than or equal to the degree of opening in the first cooling mode so that the refrigerant evaporation temperature of the first indoor heat exchanger (121) indicated by the first temperature information becomes higher than the refrigerant evaporation temperature of the second indoor heat exchanger (122) indicated by the first temperature information and becomes lower than the temperature indicated by the second temperature information,

in the dehumidification mode, the air conditioning device (100) is configured to adjust the degree of opening of the first expansion valve (115) to be greater than or equal to the degree of opening in the second cooling mode and adjust the degree of opening of the second expansion valve (123) to be less than or equal to the degree of opening in the second cooling mode so that the refrigerant evaporation temperature of the first indoor heat exchanger (121) indicated by the first temperature information becomes higher than the temperature indicated by the second temperature information, and

the dehumidification mode includes a first dehumidification mode, and a second dehumidification mode in which an amount of air blown by the outdoor ventilation means (114) is smaller than an amount of air blown by the outdoor ventilation means (114) in the first dehumidification mode.

2. The air conditioning device (100) according to claim 1, wherein

when a predetermined condition is satisfied, the operation mode transitions from one to another among the first cooling mode, the second cooling mode and the dehumidification mode,

the operation mode to be made to transition from the first cooling mode is the second cooling mode,

the operation mode to be made to transition from the second cooling mode is the first cooling mode or the dehumidification mode, and

the operation mode to be made to transition from the dehumidification mode is the second cooling mode.

3. The air conditioning device (100) according to claim 2, wherein

the acquisition means (128) acquires humidification information indicating humidity of air in the indoor space, and

the condition is satisfied in accordance with at least one of the temperature indicated by the second temperature information, the humidity indicated by the humidification information, or an operating frequency of the compressor (111).

4. The air conditioning device (100) according to claim 3, wherein

when the operation mode is the first cooling mode, the condition is satisfied and the operation mode is made to transition to the second cooling mode upon (i) the temperature indicated by the second temperature information being lower than a first threshold, (ii) the humidity indicated by the humidity information being higher than a second threshold, and (iii) the operating frequency of the compressor (111) being less than a third threshold, and

when the operation mode is the second cooling mode, the condition is satisfied and the operation mode is made to transition to the dehumidification mode upon (i) the temperature indicated by the second temperature information being lower than a fourth threshold, (ii) the humidity indicated by the humidification information being higher than a fifth threshold, and (iii) the operating frequency of the compressor (111) being less than a sixth threshold.

5. The air conditioning device (100) according to any one of claims 2 to 4, wherein the condition is satisfied in accordance with duration of an operation in one operation mode.

6. The air conditioning device (100) according to any one of claims 2 to 5, wherein

the second temperature information indicates (i) a temperature within a building including the indoor space and (ii) an outdoor temperature, and the condition is satisfied in accordance with at least one of (i) the temperature within the building and the outdoor temperature that are indicated by the second temperature information, or (ii) a body temperature of a user present in the indoor space, the body temperature being detected by body temperature detection means (140a).

7. The air conditioning device (100) according to any one of claims 2 to 6, further comprising:

estimation means (129b) for estimating attributes of the user present in the indoor space, wherein
the condition is satisfied in accordance with a result of estimation by the estimation means (129b), and
the attributes include at least one of a gender of the user, an age of the user, sensory temperature of the user, temperatures of legs and arms of the user, or information about whether the user is cold-sensitive or heat-sensitive.

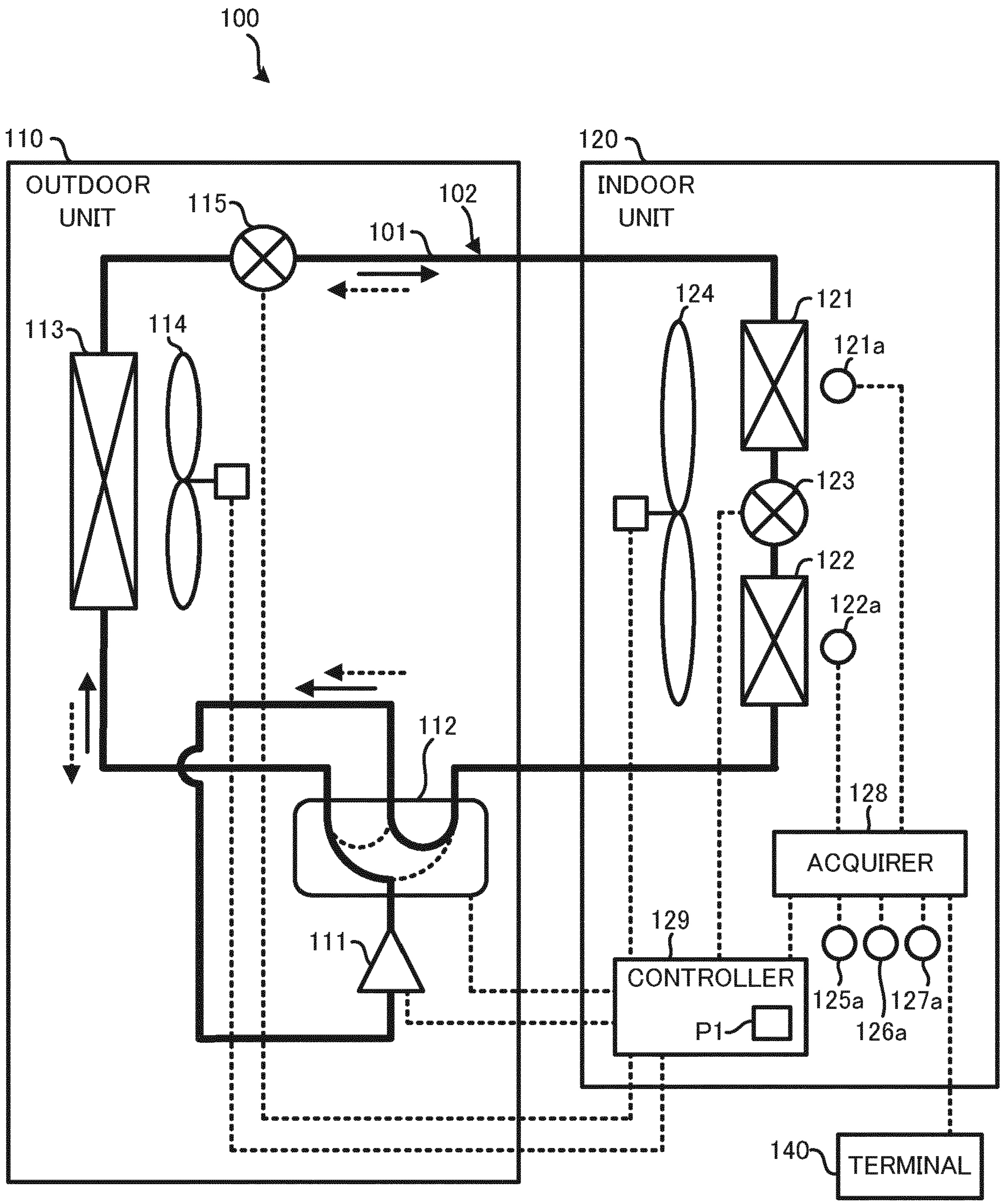
8. An air conditioning method for sending conditioned air to an indoor space in an operation mode selected from a first cooling mode, a second cooling mode, and a dehumidification mode, the air conditioning method comprising:

measuring by means of a first sensor (121a) a refrigerant evaporation temperature of a first indoor heat exchanger (121) of a refrigerant circuit (102) comprising a compressor (111), an outdoor heat exchanger (113), a first expansion valve (115), the first indoor heat exchanger (121), a second expansion valve (123), and a second indoor heat exchanger (122), in this order, refrigerant being circulated to pass through the refrigerant circuit (102), a degree of opening of the first expansion valve (115) and a degree of opening of the second expansion valve (123) being adjustable;
measuring by means of a second sensor (122a) a refrigerant evaporation temperature of the second indoor heat exchanger (122) by means of a second sensor (122a); and
acquiring (128) first temperature information, from the first sensor (121a) and from the second sensor (122a), indicating the refrigerant evaporation temperatures of the first indoor heat exchanger (121) and the second indoor heat exchanger (122), and second temperature information indicating a temperature of air in an indoor space to be air-conditioned,
wherein
in the first cooling mode, adjusting the degree of opening of the first expansion valve (115) and the degree of opening of the second expansion valve (123) to a predetermined degree so that the refrigerant evaporation temperature of the first indoor heat exchanger (121) indicated by the first temperature information becomes equal to the refrigerant evaporation temperature of the second indoor heat exchanger (122) indicated by the first temperature information,
in the second cooling mode, adjusting the degree of opening of the first expansion valve (115) to be greater than or equal to the degree of opening in the first cooling mode and adjusting the degree of opening of the second expansion valve (123) to be less than or equal to the degree of opening in the first cooling mode so that the refrigerant evaporation temperature of the first indoor heat exchanger (121) indicated by the first temperature information becomes higher than the refrigerant evaporation temperature of the second indoor heat exchanger (122) indicated by the first temperature information and becomes lower than the temperature indicated by the second temperature information,
in the dehumidification mode, adjusting the degree of opening of the first expansion valve (115) to be greater than or equal to the degree of opening in the second cooling mode and adjusting the degree of opening of the second expansion valve (123) to be less than or equal to the degree of opening in the second cooling mode so that the refrigerant evaporation temperature of the first indoor heat exchanger (121) indicated by the first temperature information becomes higher than the temperature indicated by the second temperature information, and
the dehumidification mode includes a first dehumidification mode, and a second dehumidification mode in which an amount of air blown by an outdoor ventilation means (114) for blowing air to the outdoor heat exchanger (113) is smaller than an amount of air blown by the outdoor ventilation means (114) in the first dehumidification mode.

9. A program causing a computer for controlling an air conditioning device (100) comprising a refrigerant circuit (102) configured to circulate refrigerant by passing the refrigerant through, in an order of, a compressor (111), an outdoor heat exchanger (113), a first expansion valve (115), a first indoor heat exchanger (121), a second expansion valve (123), and a second indoor heat exchanger (122), a degree of opening of the first expansion valve (115) and a degree of opening of the second expansion valve (123) being adjustable, the program being designed to function as:

acquisition means (128) configured to acquire, from a first sensor (121a) configured to measure a refrigerant evaporation temperature of the first indoor heat exchanger (121) and a second sensor (122a) configured to measure a refrigerant evaporation temperature of the second indoor heat exchanger (122), first temperature information indicating refrigerant evaporation temperatures of the first indoor heat exchanger (121) and the second indoor heat exchanger (122), and second temperature information indicating a temperature of air in an indoor space to be air-conditioned, and
wherein
in the first cooling mode, the air conditioning device (100) is configured to adjust the degree of opening of the first expansion valve (115) and the degree of opening of the second expansion valve (123) to a predetermined degree so that the refrigerant evaporation temperature of the first indoor heat exchanger (121) indicated by the first temperature information becomes equal to the refrigerant evaporation temperature of the second indoor heat exchanger (122) indicated by the first temperature information,
in the second cooling mode, the air conditioning device (100) is configured to adjust the degree of opening of the first expansion valve (115) to be greater than or equal to the degree of opening of in the first cooling mode and adjust the degree of opening of the second expansion valve (123) to be less than or equal to the degree of opening in the first cooling mode so that the refrigerant evaporation temperature of the first indoor heat exchanger (121) indicated by the first temperature information becomes higher than the refrigerant evaporation temperature of the second indoor heat exchanger (122) indicated by the first temperature information and becomes lower than the temperature indicated by the second temperature information,
in the dehumidification mode, the air conditioning device (100) is configured to adjust the degree of opening of the first expansion valve (115) to be greater than or equal to the degree of opening in the second cooling mode and adjust the degree of opening of the second expansion valve (123) to be less than or equal to the degree of opening in the second cooling mode so that the refrigerant evaporation temperature of the first indoor heat exchanger (121) indicated by the first temperature information becomes higher than the temperature indicated by the second temperature information, and
the dehumidification mode includes a first dehumidification mode, and a second dehumidification mode in which an amount of air blown by an outdoor ventilation means (114) for blowing air to the outdoor heat exchanger (113) is smaller than an amount of air blown by the outdoor ventilation means (114) in the first dehumidification mode.

FIG.1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INDOOR UNIT
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122a
112
128
ACQUIRER
111
129
CONTROLLER
P1
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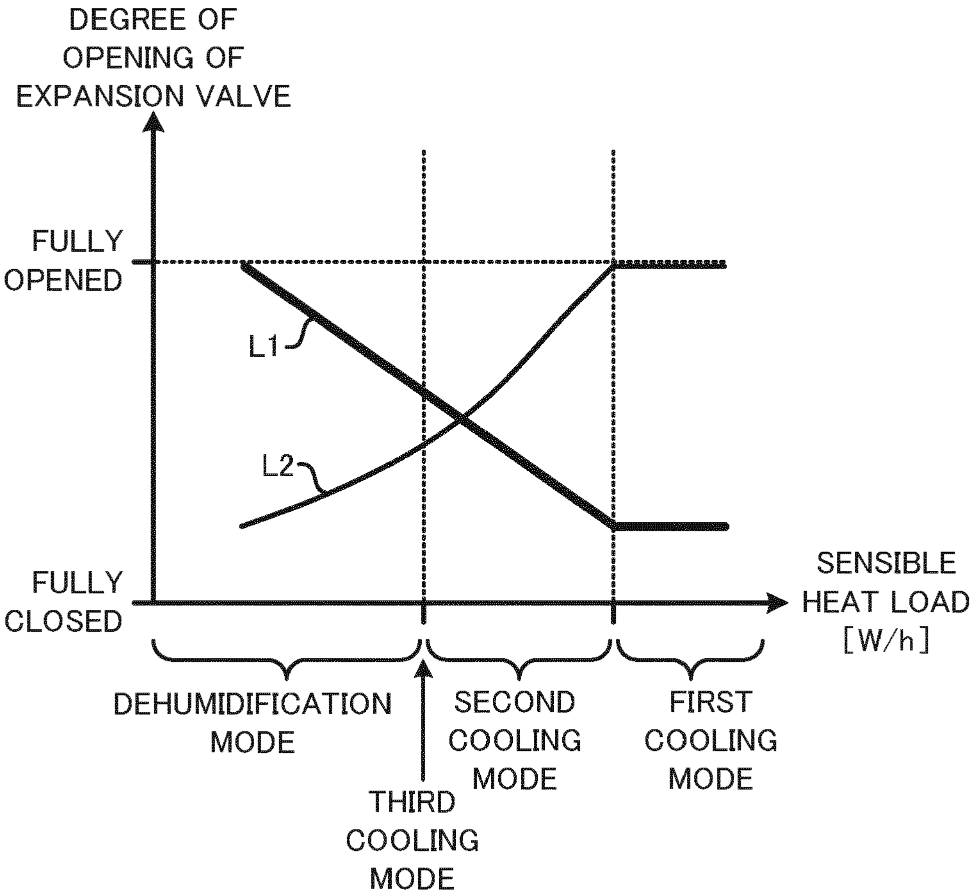
126a
127a
140
TERMINAL

FIG.2


DEGREE OF
OPENING OF
EXPANSION VALVE
FULLY
OPENED
L1
L2
FULLY
CLOSED
SENSIBLE
HEAT LOAD
[W/h]
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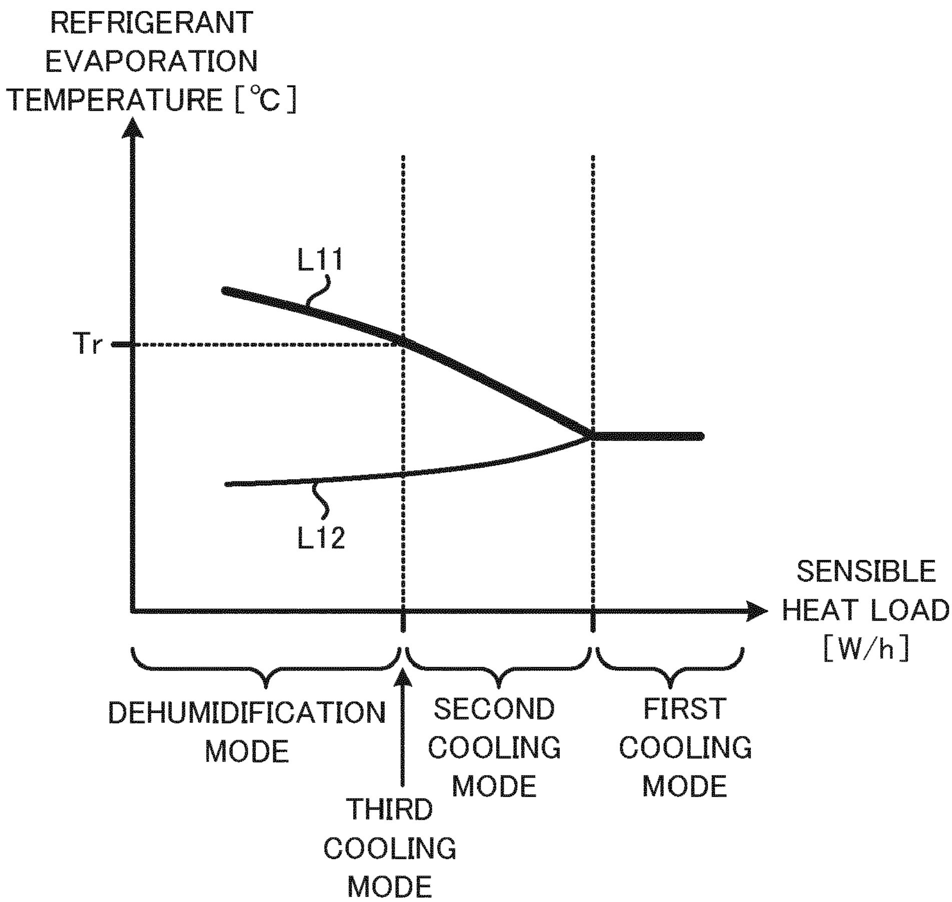
MODE
SECOND
COOLING
MODE
FIRST
COOLING
MODE
THIRD
COOLING
MODE

FIG.3


REFRIGERANT
EVAPORATION
TEMPERATURE [℃]
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Tr
L12
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HEAT LOAD
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MODE
SECOND
COOLING
MODE
FIRST
COOLING
MODE
THIRD
COOLING
MODE

FIG.4

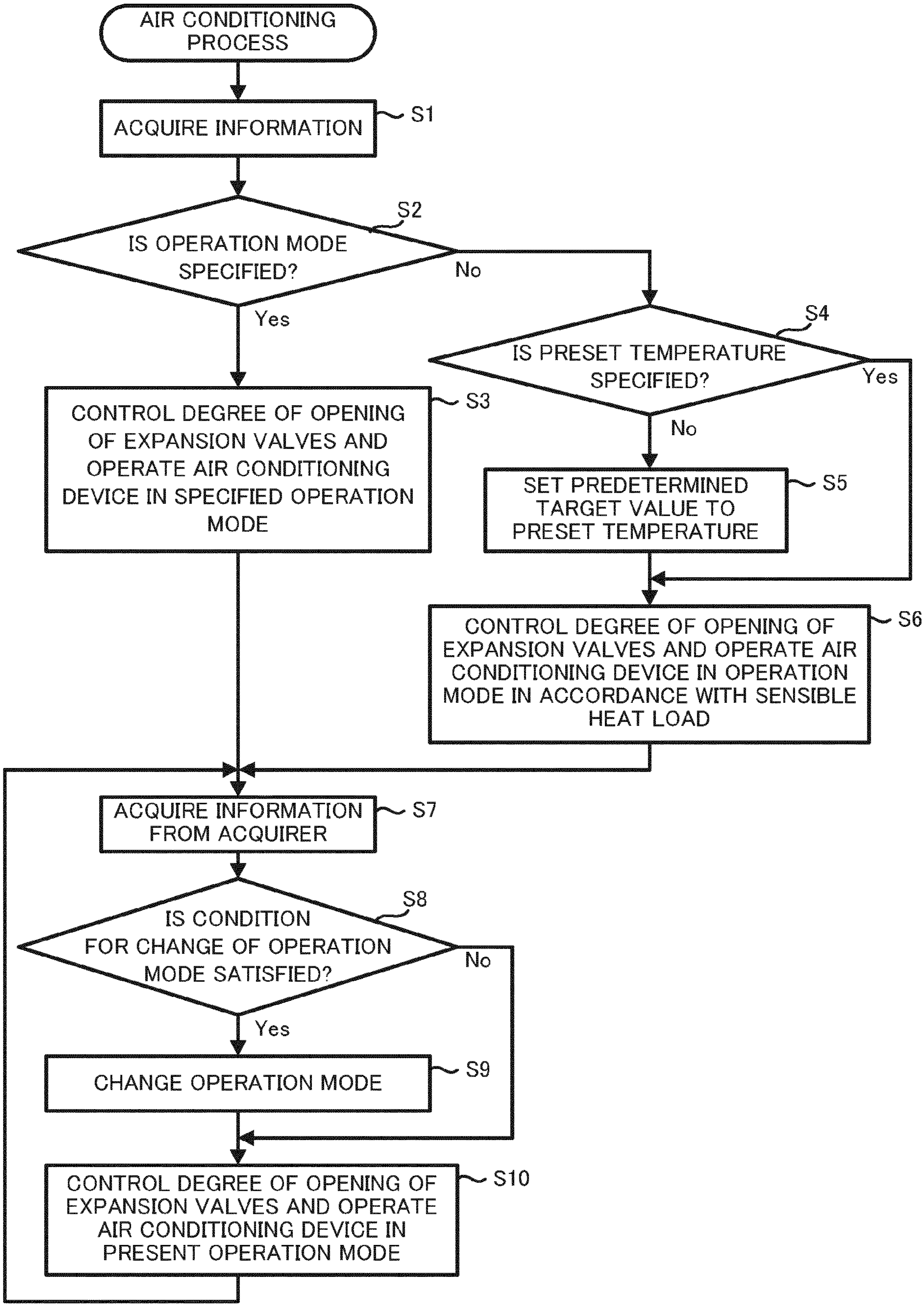
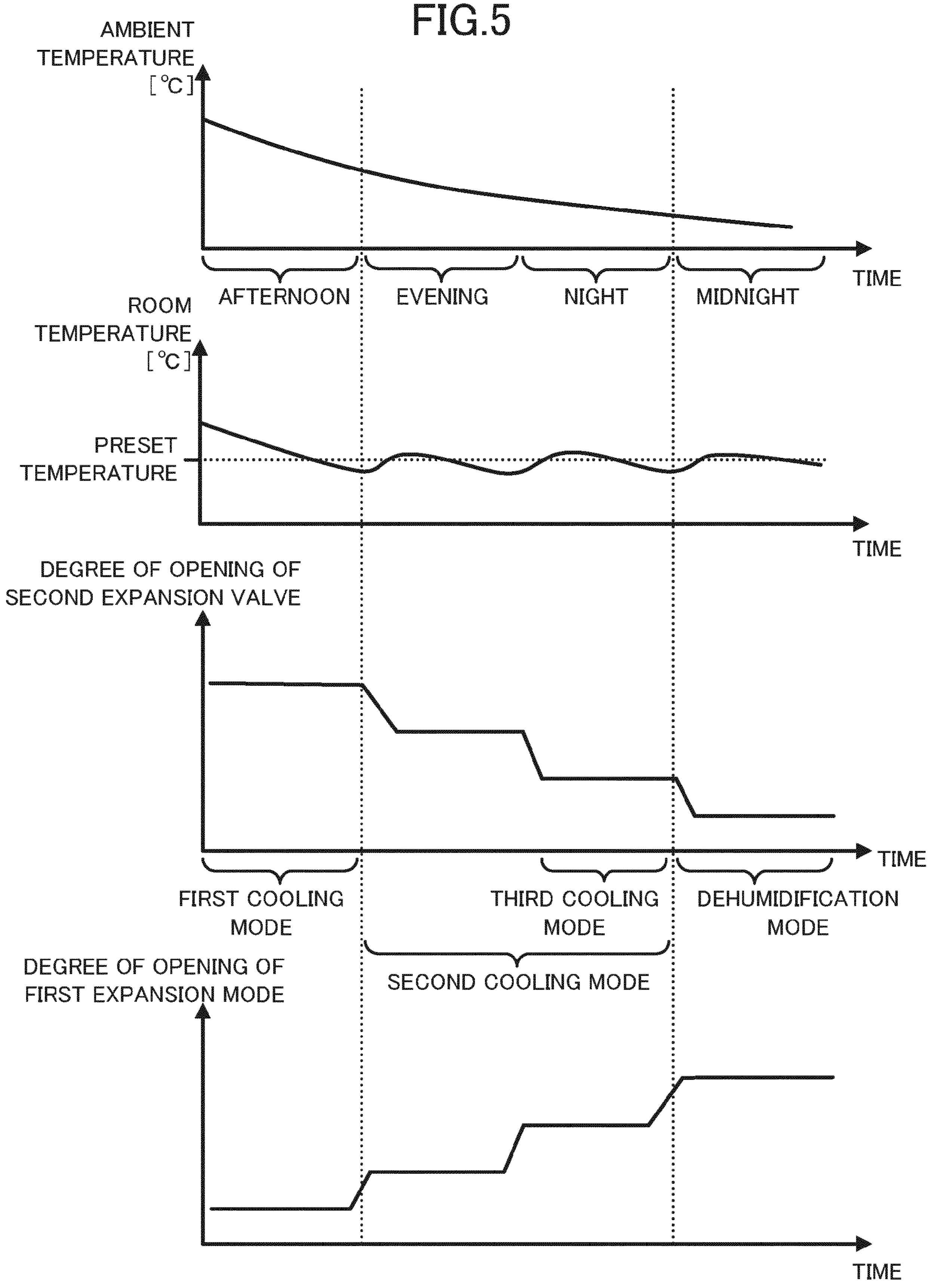

AIR CONDITIONING PROCESS
ACQUIRE INFORMATION
S1
IS OPERATION MODE SPECIFIED?
S2
No
Yes
IS PRESET TEMPERATURE SPECIFIED?
S4
Yes
No
CONTROL DEGREE OF OPENING OF EXPANSION VALVES AND OPERATE AIR CONDITIONING DEVICE IN SPECIFIED OPERATION MODE
S3
SET PREDETERMINED TARGET VALUE TO PRESET TEMPERATURE
S5
CONTROL DEGREE OF OPENING OF EXPANSION VALVES AND OPERATE AIR CONDITIONING DEVICE IN OPERATION MODE IN ACCORDANCE WITH SENSIBLE HEAT LOAD
S6
ACQUIRE INFORMATION FROM ACQUIRER
S7
IS CONDITION FOR CHANGE OF OPERATION MODE SATISFIED?
S8
No
Yes
CHANGE OPERATION MODE
S9
CONTROL DEGREE OF OPENING OF EXPANSION VALVES AND OPERATE AIR CONDITIONING DEVICE IN PRESENT OPERATION MODE
S10

FIG.5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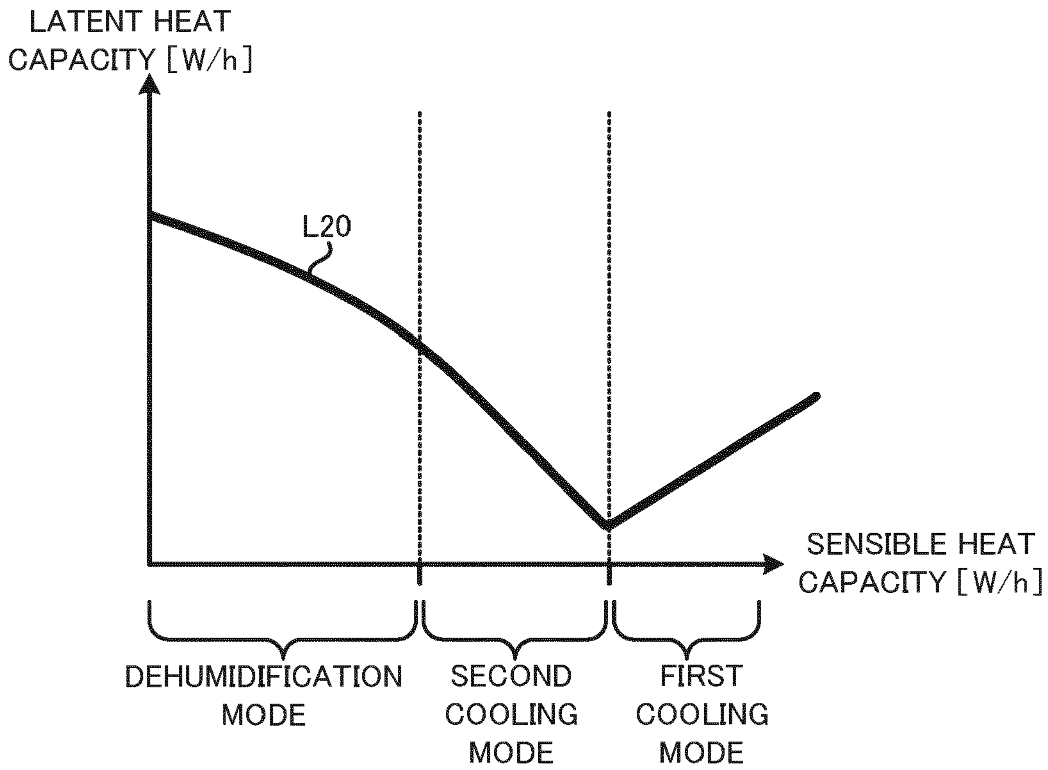
TIME
AFTERNOON
EVENING
NIGHT
MIDNIGHT
ROOM TEMPERATURE [℃]
PRESET TEMPERATURE
TIME
DEGREE OF OPENING OF SECOND EXPANSION VALVE
TIME
FIRST COOLING MODE
THIRD COOLING MODE
DEHUMIDIFICATION MODE
SECOND COOLING MODE
DEGREE OF OPENING OF FIRST EXPANSION MODE
TIME

FIG.6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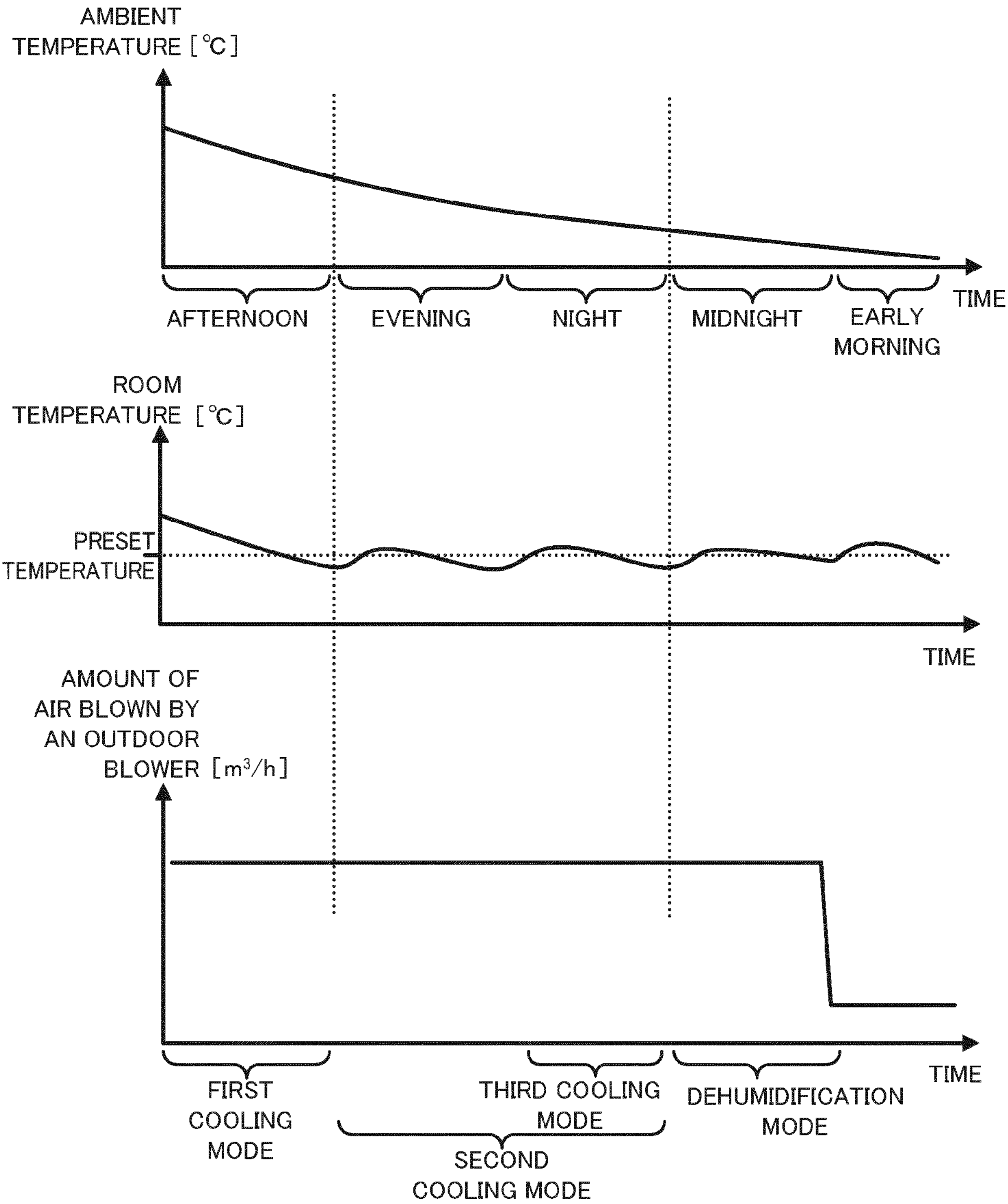
CAPACITY [W/h]
L20
SENSIBLE HEAT
CAPACITY [W/h]
DEHUMIDIFICATION
MODE
SECOND
COOLING
MODE
FIRST
COOLING
MODE

FIG.7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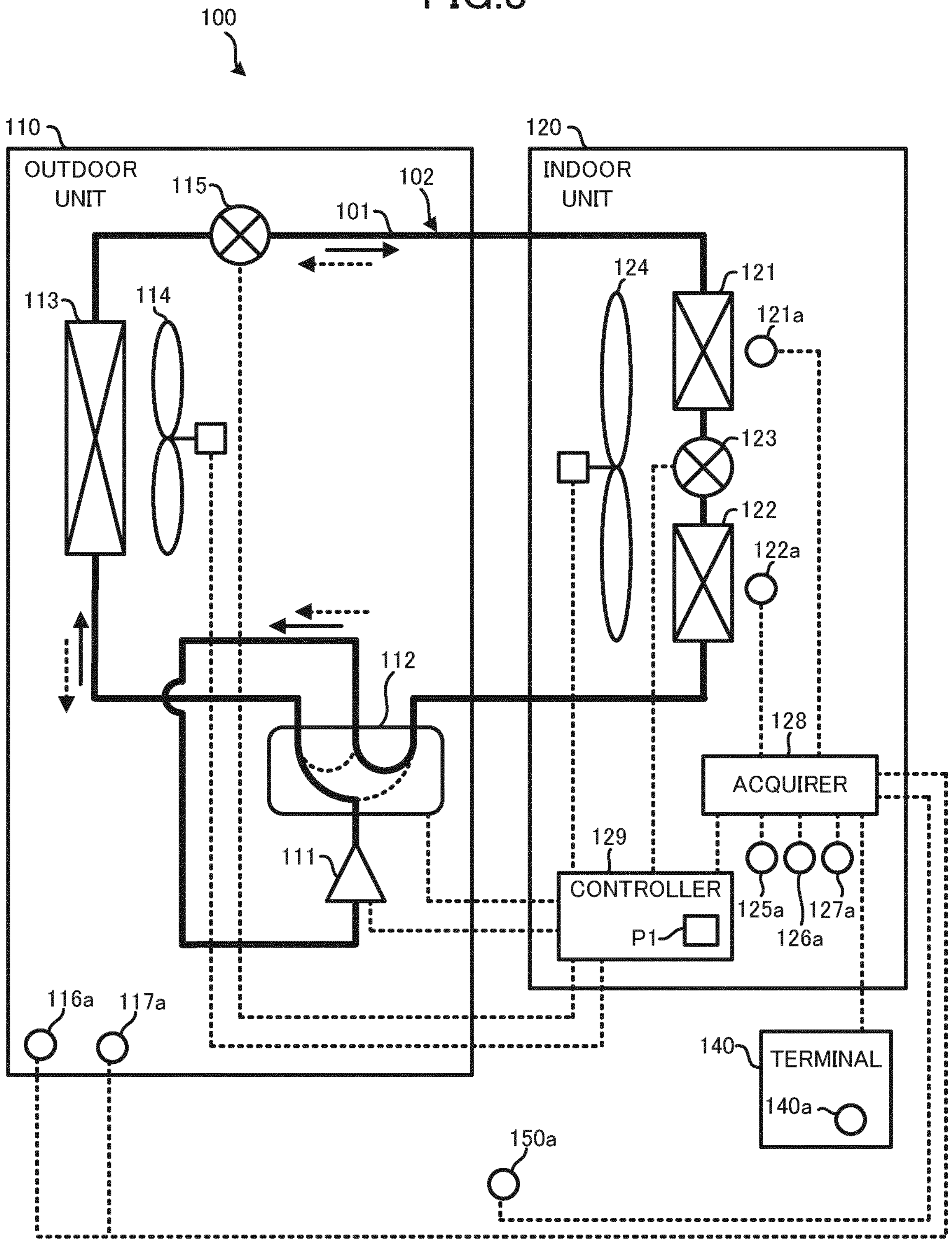
TIME
AFTERNOON
EVENING
NIGHT
MIDNIGHT
EARLY MORNING
ROOM
TEMPERATURE [℃]
PRESET
TEMPERATURE
TIME
AMOUNT OF
AIR BLOWN BY
AN OUTDOOR
BLOWER [m³/h]
TIME
FIRST
COOLING
MODE
THIRD COOLING
MODE
SECOND
COOLING MODE
DEHUMIDIFICATION
MODE

FIG.8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112
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ACQUIRER
129
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CONTROLLER
P1
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TERMINAL
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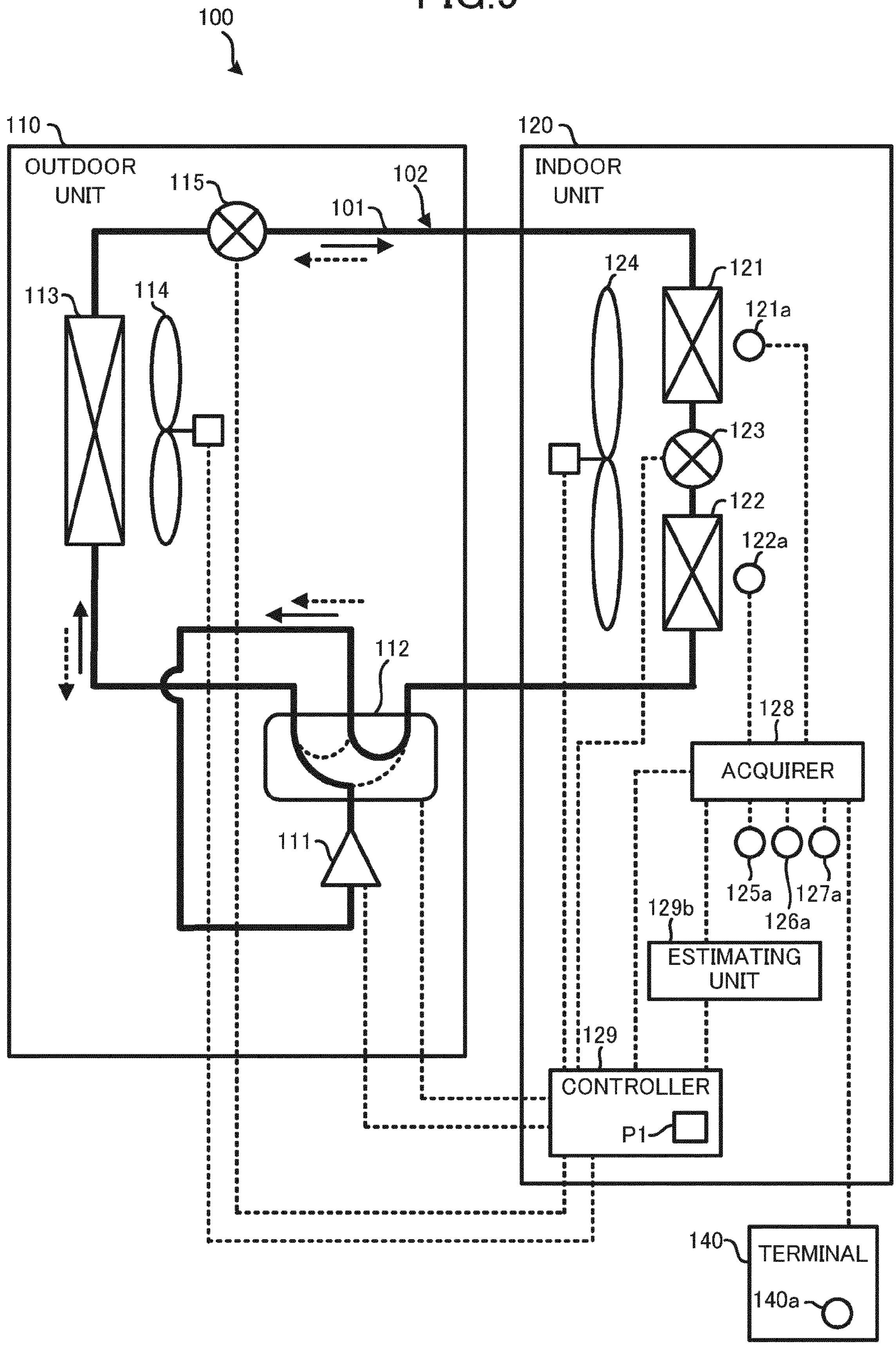
FIG.9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122a
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ACQUIRER
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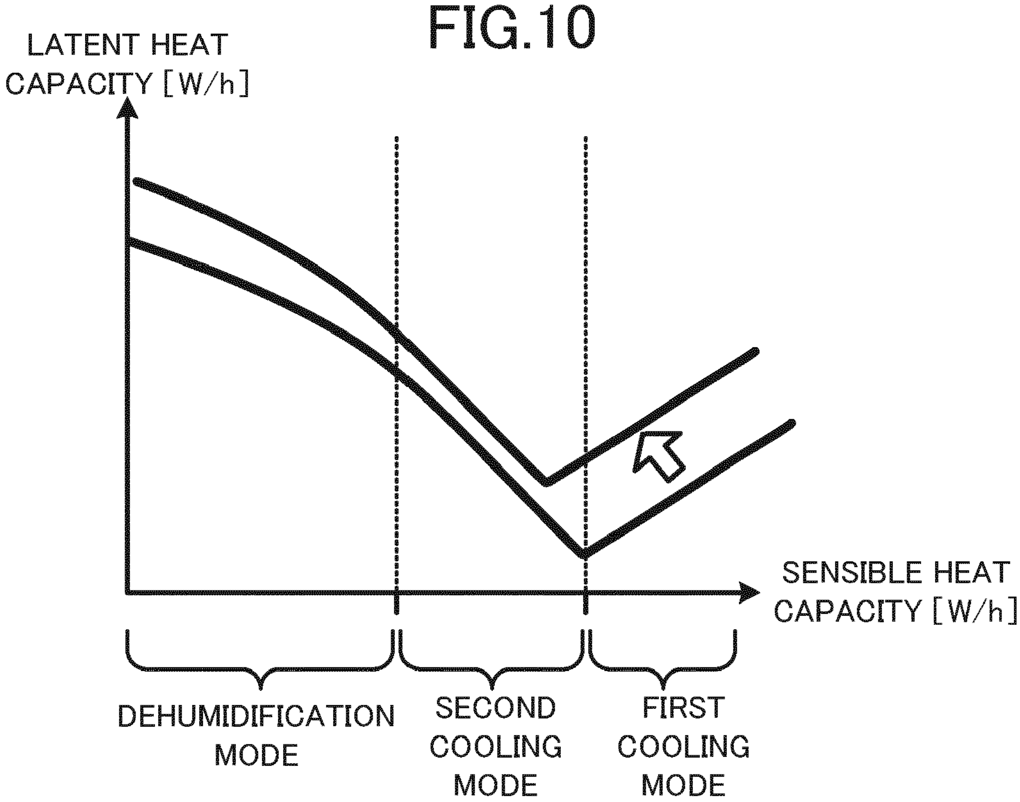
127a
129b
ESTIMATING UNIT
129
CONTROLLER
P1
140
TERMINAL
140a

FIG.10


LATENT HEAT CAPACITY [W/h]
SENSIBLE HEAT CAPACITY [W/h]
DEHUMIDIFICATION MODE
SECOND COOLING MODE
FIRST COOLING MODE

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European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 21 20 6751

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1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 February 2022	Blot, Pierre-Edouard

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons

& : member of the same patent family, corresponding document

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21-02-2022

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