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(71) Applicants:
- **Daikin Industries, Ltd.**
Osaka 530-8323 (JP)
- **Daikin Europe N.V.**
8400 Oostende (BE)

(72) Inventors:
- **HONDA, Masahiro**
Osaka-shi, Osaka 530-8323 (JP)
- **MATSUMOTO, Yoshihiro**
Osaka-shi, Osaka 530-8323 (JP)

(74) Representative: **Global IP Europe**
Patentanwaltskanzlei
Pfarrstraße 14
80538 München (DE)

(54) **AIR CONDITIONER**

(57) An air conditioning apparatus (1) comprises a refrigerant circuit (10) having a compressor (21), an outdoor heat exchanger (23), indoor heat exchangers (42a, 42b), and a heat storage heat exchanger (28) for performing heat exchange between a refrigerant and a heat storage medium, the air conditioning apparatus being capable of performing a heat storage operation and simultaneously performing a heat-storage-utilizing operation and an air-warming operation during a defrosting operation. During the defrosting operation accompanying the heat-storage-utilizing operation in the air conditioning apparatus (1), the defrosting capability of the outdoor heat exchanger (23) is altered based on the outdoor temperature of the external space where the outdoor heat exchanger (23) is located, and/or either an outdoor heat exchange outlet temperature, which is the temperature of the refrigerant in an outlet of the outdoor heat exchanger (23) at the end of the previous defrosting operation, or the time required for the previous defrosting operation.

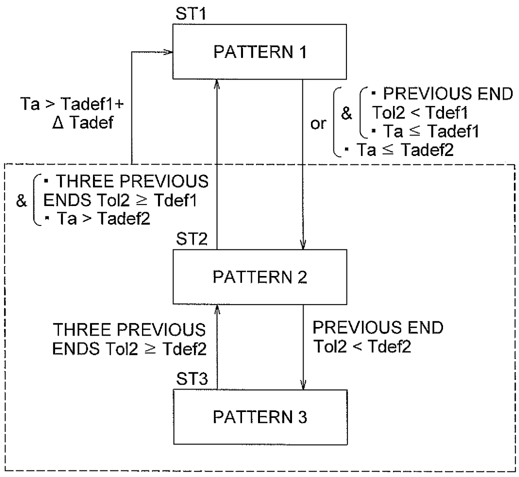

FIG. 9

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Description

TECHNICAL FIELD

[0001] The present invention relates to an air conditioning apparatus, and particularly to an air conditioning apparatus comprising a refrigerant circuit having a heat storage heat exchanger for performing heat exchange between a refrigerant and a heat storage medium, wherein a heat storage operation for storing heat in a heat storage medium can be performed by causing the heat storage heat exchanger to function as a heat radiator of the refrigerant, and an air-warming operation and a heat-storage-utilizing operation for radiating heat from the heat storage medium can be performed simultaneously by causing the heat storage heat exchanger to function as an evaporator of the refrigerant during a defrosting operation.

BACKGROUND ART

[0002] In the past, there have been air conditioning apparatuses that comprise a refrigerant circuit having a compressor, an outdoor heat exchanger, an indoor heat exchanger, and a heat storage heat exchanger for performing heat exchange between a refrigerant and a heat storage medium, wherein a heat storage operation is performed, and a heat-storage-utilizing operation and an air-warming operation can be performed simultaneously during a defrosting operation, as shown in Patent Literature 1 (Japanese Laid-open Patent Application No. 2005-337657). The heat storage operation is an operation for storing heat in a heat storage medium by causing the heat storage heat exchanger to function as an evaporator of the refrigerant. The defrosting operation is an operation for defrosting the outdoor heat exchanger by causing the outdoor heat exchanger to function as a heat radiator of the refrigerant. The heat-storage-utilizing operation is an operation for radiating heat from the heat storage medium by causing the heat storage heat exchanger to function as an evaporator of the refrigerant. The air-warming operation is an operation for causing the indoor heat exchanger to function as a heat radiator of the refrigerant.

SUMMARY OF THE INVENTION

[0003] In the conventional air conditioning apparatus described above, the defrosting capability of the outdoor heat exchanger needed during the defrosting operation accompanying the heat-storage-utilizing operation differs depending on climate conditions (outdoor temperature, humidity, degree of snowfall) and other factors in the region where the air conditioning apparatus is installed. One solution being considered for dealing with the differences in defrosting capability depending on the local climate conditions and other factors is to decide the specifications of the heat storage heat exchanger including the heat storage medium capacity and the like, assuming that the climate conditions and other factors are those required by most defrosting capabilities during the defrosting operation accompanying the heat-storage-utilizing operation, such as in cold regions.

[0004] However, when the specifications of the heat storage heat exchanger are decided in this manner, a large-capacity heat storage medium is required, and the size, weight, and/or cost of the heat storage heat exchanger are greatly affected. When the air conditioning apparatus is installed in a cold region, the specifications of the air conditioning apparatus including the heat storage heat exchanger are appropriate, but when the air conditioning apparatus is installed in a warm region, the specifications of the air conditioning apparatus including the heat storage heat exchanger are excessive.

[0005] As shall be apparent, if there are a wide variety of air conditioning apparatuses available with a plurality of specifications including the heat storage heat exchanger for different regions, the air conditioning apparatus can be adapted for a wide range of regions, but increasing the variety of available apparatuses has great disadvantages such as decreased productivity and increased cost.

[0006] An object of the present invention is to provide an air conditioning apparatus that comprises a refrigerant circuit having a heat storage heat exchanger for performing heat exchange between a refrigerant and a heat storage medium, that can perform a heat storage operation, and that can perform a heat-storage-utilizing operation and an air-warming operation simultaneously during a defrosting operation, wherein the air conditioning apparatus can be adapted for a wide range of regions by means of the heat storage heat exchanger having a heat storage medium of a specific capacity.

[0007] An air conditioning apparatus according to a first aspect comprises a refrigerant circuit having a compressor, an outdoor heat exchanger, indoor heat exchangers, and a heat storage heat exchanger for performing heat exchange between a refrigerant and a heat storage medium, the air conditioning apparatus being capable of performing a heat storage operation, and simultaneously performing a heat-storage-utilizing operation and an air-warming operation during a defrosting operation. The heat storage operation is an operation for storing heat in the heat storage medium by causing the heat storage heat exchanger to function as a heat radiator of the refrigerant. The defrosting operation is an operation for defrosting the outdoor heat exchanger by causing the outdoor heat exchanger to function as a heat radiator of the refrigerant. The heat-storage-utilizing operation is an operation for radiating heat from the heat storage medium by causing the heat storage heat exchanger to function as an evaporator of the refrigerant. The air-warming operation is an operation for causing the indoor heat exchangers to function as heat radiators of the refrigerant. In this air conditioning apparatus, during the defrosting operation accompanying the heat-storage-utilizing operation, the defrosting capability of the outdoor heat exchanger is altered on the basis of the outdoor temperature of the external space where the outdoor heat exchanger is installed, and/or either an outdoor heat exchange outlet temperature which is the temperature of the refrigerant in an outlet of the outdoor heat exchanger at the end of the previous defrosting operation, or the time required for the previous defrosting operation.

[0008] During the defrosting operation accompanying the heat-storage-utilizing operation herein, the defrosting capability of the outdoor heat exchanger, which must be varied according to climate conditions and other factors in the region where the air conditioning apparatus is installed, is altered based on the outdoor temperature and/or either the outdoor heat exchange outlet temperature at the end of the previous defrosting operation or the time required for the previous defrosting operation. Therefore, during the defrosting operation accompanying the heat-storage-utilizing operation, the defrosting capability of the outdoor heat exchanger can be set to a capability appropriate for the climate conditions and other factors in the region where the air conditioning apparatus is installed.

[0009] The defrosting capability of the outdoor heat exchanger can thereby can be set herein to a capability appropriate for the climate conditions and other factors in the region where the air conditioning apparatus is installed, and the air conditioning apparatus can be adapted to a wide range of regions by means of the heat storage heat exchanger having a heat storage medium of a specific capacity.

[0010] An air conditioning apparatus according to a second aspect is the air conditioning apparatus according to the first aspect, wherein during the defrosting operation accompanying the heat-storage-utilizing operation, when an alteration is required to increase the defrosting capability of the outdoor heat exchanger on the basis of the outdoor temperature and/or either the outdoor heat exchange outlet temperature at the end of the previous defrosting operation or the time required for the previous defrosting operation, the air-warming capabilities of the indoor heat exchangers are reduced while the air-warming operation is simultaneously performed.

[0011] When the air-warming operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation, some of the defrosting capability of the outdoor heat exchanger is used as the air-warming capabilities of the indoor heat exchangers. At this time, when the air-warming capabilities of the indoor heat exchangers are maintained regardless of the need to increase the defrosting capability of the outdoor heat exchanger, there is a risk that the defrosting of the outdoor heat exchanger will be insufficient.

[0012] In view of this, in cases in which the air-warming operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation as described above, the air-warming capabilities of the indoor heat exchangers are reduced when an alteration is required to increase the defrosting capability of the outdoor heat exchanger.

[0013] It is thereby possible in the defrosting operation accompanying the heat-storage-utilizing operation herein to ensure the defrosting capability of the outdoor heat exchanger while continuing the air-warming operation to the fullest extent possible.

[0014] An air conditioning apparatus according to a third aspect is the air conditioning apparatus according to the second aspect, wherein in cases in which the air-warming operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation, an interval time between the defrosting operations is altered based on the outdoor temperature and/or either the outdoor heat exchange outlet temperature at the end of the previous defrosting operation or the time required for the previous defrosting operation.

[0015] In cases in which the outdoor temperature is low, the outdoor heat exchange outlet temperature at the end of the previous defrosting operation was low, and/or a long time was required for the previous defrosting operation, it is preferable that the defrosting operation be performed frequently so that the defrosting operation is performed satisfactorily.

[0016] In view of this, the interval time between the defrosting operations is altered herein based on the outdoor temperature and/or either the outdoor heat exchange outlet temperature at the end of the previous defrosting operation or the time required for the previous defrosting operation, as described above. For example, in cases in which the outdoor temperature is low, the outdoor heat exchange outlet temperature at the end of the previous defrosting operation was low, and/or a long time was required for the previous defrosting operation, an alteration is made to shorten the interval time between the defrosting operations.

[0017] It is thereby possible herein for the frequency of the defrosting operation to be altered as necessary, and for the defrosting operation accompanying the heat-storage-utilizing operation to be performed satisfactorily.

[0018] An air conditioning apparatus according to a fourth aspect is the air conditioning apparatus according to the second or third aspect, wherein during the defrosting operation accompanying the heat-storage-utilizing operation, supply of the refrigerant to the indoor heat exchangers is ceased and the outdoor heat exchanger is defrosted when an alteration is required for further increasing the defrosting capability of the outdoor heat exchanger on the basis of the outdoor temperature and/or either the outdoor heat exchange outlet temperature at the end of the previous defrosting operation or the time required for the previous defrosting operation.

[0019] When the air-warming operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation, there are cases in which the outdoor temperature is too low, the outdoor heat exchange outlet temperature at the end of the previous defrosting operation is too low, or the time required for the previous defrosting operation is too long for the defrosting capability requirement of the outdoor heat exchanger to be met merely by reducing the air-warming capabilities of the indoor heat exchangers.

[0020] In view of this, when an alteration is required to further increase the defrosting capability of the outdoor heat exchanger during the defrosting operation accompanying the heat-storage-utilizing operation as described above, the supply of the refrigerant to the indoor heat exchangers is ceased and the outdoor heat exchanger is defrosted.

[0021] It is thereby possible in the defrosting operation accompanying the heat-storage-utilizing operation herein to ensure the defrosting capability of the outdoor heat exchanger without performing the air-warming operation, when the defrosting capability requirement of the outdoor heat exchanger cannot be met merely by reducing the air-warming capabilities of the indoor heat exchangers.

[0022] An air conditioning apparatus according to a fifth aspect is the air conditioning apparatus according to the fourth aspect, wherein during the defrosting operation accompanying the heat-storage-utilizing operation, in cases in which an alteration is required to further increase the defrosting capability of the outdoor heat exchanger on the basis of the outdoor temperature and/or either the outdoor heat exchange outlet temperature at the end of the previous defrosting operation or the time required for the previous defrosting operation, the air conditioning apparatus performs a communication pipe heat recovery operation for recovering heat held in a refrigerant pipe connecting the indoor heat exchangers and the compressor, and/or an indoor heat exchanger heat recovery operation for recovering heat obtained by the refrigerant due to the indoor heat exchangers being made to function as evaporators of the refrigerant.

[0023] There are cases in which the outdoor temperature is too low, the outdoor heat exchange outlet temperature at the end of the previous defrosting operation is too low, or the time required for the previous defrosting operation is too long for the defrosting capability requirement of the outdoor heat exchanger to be met merely by ceasing the supply of the refrigerant to the indoor heat exchangers (i.e. ceasing the air-warming operation) in the defrosting operation accompanying the heat-storage-utilizing operation.

[0024] In view of this, in cases in which an alteration is required herein to further increase the defrosting capability of the outdoor heat exchanger in the defrosting operation accompanying the heat-storage-utilizing operation as described above, the communication pipe heat recovery operation and/or the indoor heat exchanger heat recovery operation are performed while the air-warming operation is ceased.

[0025] It is thereby possible herein to ensure the defrosting capability of the outdoor heat exchanger even in cases in which it is not possible to meet the defrosting capability requirement of the outdoor heat exchanger merely by ceasing the air-warming operation in the defrosting operation accompanying the heat-storage-utilizing operation.

[0026] An air conditioning apparatus according to a sixth aspect is the air conditioning apparatus according to the fifth aspect, wherein indoor fans are also provided for supplying air to the indoor heat exchangers, and the indoor heat exchanger heat recovery operation includes a first indoor heat exchanger heat recovery operation in which the indoor fans are not operated, and a second indoor heat exchanger heat recovery operation in which the indoor fans are operated.

[0027] The indoor heat exchanger heat recovery operation herein includes the first indoor heat exchanger heat recovery operation for recovering heat from the indoor heat exchangers while minimizing the effect on the air conditioned space without operating the indoor fans, and the second indoor heat exchanger heat recovery operation in which the effect on the air conditioned space is greater due to the indoor fans being operated but more heat can be recovered than in the first indoor heat exchanger heat recovery operation. Therefore, the first indoor heat exchanger heat recovery operation can be performed when a small degree of outdoor heat exchanger defrosting capability is required, and the second indoor heat exchanger heat recovery operation can be performed when a large degree of outdoor heat exchanger defrosting capability is required.

[0028] Two indoor heat exchanger heat recovery operations having different degrees of heat recovery can thereby be used herein as necessary to ensure the defrosting capability of the outdoor heat exchanger.

[0029] An air conditioning apparatus according to a seventh aspect is the air conditioning apparatus according to fifth or sixth aspect, wherein the defrosting operation is performed every time the heat storage operation ends when the communication pipe heat recovery operation and/or the indoor heat exchanger heat recovery operation are performed during the defrosting operation accompanying the heat-storage-utilizing operation.

[0030] In cases in which a heat recovery operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation, it is preferable that the defrosting operation be performed frequently, and that sufficient heat be stored in the heat storage medium during the heat storage operation performed before the defrosting operation.

[0031] In view of this, in cases in which a heat recovery operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation as described above, the defrosting operation is designed to be performed every time the heat storage operation ends. Therefore, heat is reliably stored in the heat storage medium in the heat storage operation before the defrosting operation, and the interval time between the defrosting operations can be shortened by omitting the air-warming operation after the heat storage operation.

[0032] It is thereby possible herein to increase the frequency of the defrosting operation, to sufficiently utilize the stored heat of the heat storage medium, and to satisfactorily perform the defrosting operation accompanying the heat-storage-utilizing operation, in cases in which a heat recovery operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation.

[0033] An air conditioning apparatus according to an eighth aspect is the air conditioning apparatus according to any one of the fifth to seventh aspects, wherein a heat recovery operation setting part is provided for setting whether to allow or inhibit the communication pipe heat recovery operation and/or the indoor heat exchanger heat recovery operation in the defrosting operation accompanying the heat-storage-utilizing operation.

[0034] The heat recovery operation setting part is also designed herein to be able to set whether the heat recovery operation will be performed simultaneously or inhibited in the defrosting operation accompanying the heat-storage-utilizing operation. For example, settings can be made such that in cold regions, a heat recovery operation is performed in the defrosting operation accompanying the heat-storage-utilizing operation, and in warm regions, no heat recovery operation is performed in the defrosting operation accompanying the heat-storage-utilizing operation.

[0035] It is thereby possible herein to set, in accordance with climate conditions and other factors in the region where the air conditioning apparatus is installed, whether or not a heat recovery operation is performed.

[0036] An air conditioning apparatus according to a ninth aspect is the air conditioning apparatus according to the eighth aspect, wherein the heat recovery operation setting part is capable of setting each of the communication pipe heat recovery operation, the first indoor heat exchanger heat recovery operation, and the second indoor heat exchanger heat recovery operation in the defrosting operation accompanying the heat-storage-utilizing operation.

[0037] It is possible herein to design the heat recovery operation setting part so as to set which of the three heat recovery operations will be performed in cases when the heat recovery operation is to be performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation.

[0038] It is thereby possible herein to set, in accordance with climate conditions and other factors in the region where the air conditioning apparatus is installed, which of the heat recovery operations will be performed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039]

FIG. 1 is a schematic overview of an air conditioning apparatus according to an embodiment of the present invention;

FIG. 2 is a schematic overview of the heat storage heat exchanger;

FIG. 3 is a control block diagram of the air conditioning apparatus;

FIG. 4 is a drawing showing the flow of refrigerant within the refrigerant circuit in the air-cooling operation;

FIG. 5 is a drawing showing the flow of refrigerant within the refrigerant circuit in the air-warming operation;

FIG. 6 is a drawing showing the flow of refrigerant within the refrigerant circuit in the heat storage operation (the heat storage operation during the air-warming operation);

FIG. 7 is a drawing showing the flow of refrigerant within the refrigerant circuit in the defrosting operation (the defrosting operation accompanying the heat-storage-utilizing operation);

FIG. 8 is a table of defrosting operation patterns for altering the defrosting capability of the outdoor heat exchanger;

FIG. 9 is a flowchart of defrosting operation patterns for altering the defrosting capability of the outdoor heat exchanger;

FIG. 10 is a table of defrosting operation patterns for altering the defrosting capability of the outdoor heat exchanger according to Modification 1;

FIG. 11 is a table of defrosting operation patterns for altering the defrosting capability of the outdoor heat exchanger according to Modification 2;

FIG. 12 is a flowchart of defrosting operation patterns for altering the defrosting capability of the outdoor heat exchanger according to Modification 2;

FIG. 13 is a control block diagram of the air conditioning apparatus according to Modification 2;

FIG. 14 is a drawing showing the flow of refrigerant within the refrigerant circuit in a pattern 4 defrosting operation (the defrosting operation accompanying the heat-storage-utilizing operation) according to Modification 2; and

FIG. 15 is a drawing showing the flow of refrigerant within the refrigerant circuit in a pattern 5 or 6 defrosting operation (the defrosting operation accompanying the heat-storage-utilizing operation) according to Modification 2.

DESCRIPTION OF EMBODIMENTS

[0040] An embodiment of the air conditioning apparatus according to the present invention is described below with reference to the drawings. The specific configuration of the embodiment of the air conditioning apparatus according to the present invention is not limited to the following embodiment or the modifications thereof, and can be modified within a range that does not deviate from the scope of the invention.

(1) Basic Configuration of Air Conditioning Apparatus

[0041] FIG. 1 is a schematic overview of an air conditioning apparatus 1 according to an embodiment of the present invention. The air conditioning apparatus 1 is an apparatus used to air-condition the interior of a room in a building or the like by performing a vapor-compression refrigeration cycle operation. The air conditioning apparatus 1 is configured by connecting primarily an outdoor unit 2 and a plurality (two in this case) of indoor units 4a, 4b. The outdoor unit 2 and the plurality of indoor units 4a, 4b herein are connected via a liquid refrigerant communication pipe 6 and a gas refrigerant communication pipe 7. Specifically, a vapor-compression refrigerant circuit 10 of the air conditioning apparatus 1 is configured by connecting the outdoor unit 2 and the plurality of indoor units 4a, 4b via the refrigerant communication pipes 6, 7.

<Indoor Units>

[0042] The indoor units 4a, 4b are installed in a room. The indoor units 4a, 4b, which are connected to the outdoor unit 2 via the refrigerant communication pipes 6, 7, constitute part of the refrigerant circuit 10.

[0043] Next, the configuration of the indoor units 4a, 4b will be described. Because the indoor unit 4b has a configuration identical to that of the indoor unit 4a, only the configuration of the indoor unit 4a is described herein, and the configuration of the indoor unit 4b, for which the components are not described, uses the letter "b" in place of the letter "a" indicating the components of the indoor unit 4a.

[0044] The indoor unit 4a has primarily an indoor-side refrigerant circuit 10a constituting part of the refrigerant circuit 10 (the indoor unit 4b has an indoor-side refrigerant circuit 10b). The indoor-side refrigerant circuit 10a has primarily an indoor expansion valve 41a and an indoor heat exchanger 42a.

[0045] The indoor expansion valve 41a is a valve for depressurizing the refrigerant flowing through the indoor-side refrigerant circuit 10a and varying the flow rate of the refrigerant flowing through the indoor heat exchanger 42a. The indoor expansion valve 41a is an electric expansion valve connected to the liquid side of the indoor heat exchanger 42a.

[0046] The indoor heat exchanger 42a is composed of, e.g., a cross-fin-type fin-and-tube heat exchanger. An indoor fan 43a for sending indoor air to the indoor heat exchanger 42a is provided in proximity to the indoor heat exchanger 42a. Heat exchange between the refrigerant and indoor air is performed in the indoor heat exchanger 42a by the blowing of indoor air to the indoor heat exchanger 42a by the indoor fan 43a. The indoor fan 43a is designed to be rotatably driven by an indoor fan motor 44a. The indoor heat exchanger 42a is thereby designed to function as a heat radiator of the refrigerant and/or an evaporator of the refrigerant.

[0047] Various sensors are provided to the indoor unit 4a. A liquid-side temperature sensor 45a for detecting the temperature Trla of refrigerant in a liquid state or a gas-liquid two-phase state is provided to the liquid side of the indoor heat exchanger 42a. A gas-side temperature sensor 46a for detecting the temperature Trga of refrigerant in a gas state is provided to the gas side of the indoor heat exchanger 42a. An indoor temperature sensor 47a for detecting the temperature of indoor air (i.e. the indoor temperature Tra) in the space to be air-conditioned by the indoor unit 4a is provided in the indoor air intake port side of the indoor unit 4a. The indoor unit 4a also has an indoor-side control part 48a for controlling the actions of the components constituting the indoor unit 4a. The indoor-side control part 48a, which has components such as a microcomputer and/or a memory provided in order to perform controls for the indoor unit 4a, is designed to be capable of exchanging control signals and the like with a remote controller 49a for operating the indoor unit 4a individually, and exchanging control signals and the like with the outdoor unit 2. The remote controller 49a is a device for the user to perform various settings and/or operations/stop commands pertaining to air conditioning operation.

<Outdoor Unit>

[0048] The outdoor unit 2 is installed outside of the room. The outdoor unit 2, which is connected to the indoor units 4a, 4b via the refrigerant communication pipes 6, 7, constitutes part of the refrigerant circuit 10.

[0049] Next, the configuration of the outdoor unit 2 will be described.

[0050] The outdoor unit 2 has primarily an outdoor-side refrigerant circuit 10c constituting part of the refrigerant circuit 10. The outdoor-side refrigerant circuit 10c has primarily a compressor 21, a first switching mechanism 22, an outdoor heat exchanger 23, an outdoor expansion valve 24, a second switching mechanism 27, a heat storage heat exchanger 28, and a heat storage expansion valve 29.

[0051] The compressor 21 is a hermetic compressor accommodating a compression element (not shown) inside a casing and a compressor motor 20 for rotatably driving the compression element. The compressor motor 20 is supplied with electric power via an inverter apparatus (not shown), and the operating capacity can be varied by changing the frequency (i.e. the rotational speed) of the inverter apparatus.

[0052] The first switching mechanism 22 is a four-way switching valve for switching the direction of refrigerant flow. When the outdoor heat exchanger 23 is made to function as a heat radiator of the refrigerant, the first switching mechanism 22 performs a switch connecting the discharge side of the compressor 21 and the gas side of the outdoor heat exchanger 23, and connecting the gas side of the heat storage heat exchanger 28 and the intake side of the compressor 21 (outdoor heat-radiating switched state; refer to the solid lines of the first switching mechanism 22 in FIG. 1). When the first switching mechanism 22 is switched to the outdoor heat-radiating switched state, the heat storage heat exchanger 28 can be made to function as an evaporator of the refrigerant. When the outdoor heat exchanger 23 is made to function as an evaporator of the refrigerant, the first switching mechanism 22 performs a switch connecting the intake side of the compressor 21 and the gas side of the outdoor heat exchanger 23, and connecting the gas side of the heat storage heat exchanger 28 and the discharge side of the compressor 21 (outdoor evaporating switched state; refer to the dashed lines of the first switching mechanism 22 in FIG. 1). When the first switching mechanism 22 is switched to the outdoor evaporating switched state, the heat storage heat exchanger 28 can be made to function as a heat radiator of the refrigerant. Instead of being a four-way switching valve, the first switching mechanism 22 may be configured by combining a three-way valve, an electromagnetic valve, and/or the like to fulfill the same function.

[0053] The outdoor heat exchanger 23 is composed of, e.g., a cross-fin-type fin-and-tube heat exchanger. An outdoor fan 25 for sending outdoor air to the outdoor heat exchanger 23 is provided in proximity to the outdoor heat exchanger 23. Heat exchange between the refrigerant and outdoor air is performed in the outdoor heat exchanger 23 by the blowing of outdoor air to the outdoor heat exchanger 23 by the outdoor fan 25. The outdoor fan 25 is designed to be rotatably driven by an outdoor fan motor 26. The outdoor heat exchanger 23 is thereby designed to function as a heat radiator of the refrigerant and/or an evaporator of the refrigerant.

[0054] The outdoor expansion valve 24 is a valve for depressurizing the refrigerant flowing through the outdoor heat exchanger 23 within the outdoor-side refrigerant circuit 10c and varying the flow rate of the refrigerant flowing through the outdoor heat exchanger 23. The outdoor expansion valve 24 is an electric expansion valve connected to the liquid side of the outdoor heat exchanger 23.

[0055] The second switching mechanism 27 is a four-way switching valve for switching the direction of refrigerant flow. When the indoor heat exchangers 42a, 42b are made to function as evaporators of the refrigerant, the second switching mechanism 27 performs a switch connecting the intake side of the compressor 21 and the gas refrigerant communication pipe 7 (indoor evaporating switched state; refer to the solid lines of the second switching mechanism 27 in FIG. 1). When the indoor heat exchangers 42a, 42b are made to function as heat radiators of the refrigerant, the second switching mechanism 27 performs a switch connecting the discharge side of the compressor 21 and the gas refrigerant communication pipe 7 (indoor heat-radiating switched state; refer to the dashed lines of the second switching mechanism 27 in FIG. 1). One of the four ports of the second switching mechanism 27 (the port near the right of the image in FIG. 1) is substantially an unused port, due to being connected to the port connected to the intake side of the compressor 21 (the port near the top of the image in FIG. 1) via a capillary tube 271. Instead of being a four-way switching valve, the second switching mechanism 27 may be configured by combining a three-way valve, an electromagnetic valve, and/or the like to fulfill the same function.

[0056] The heat storage heat exchanger 28, which is a heat exchanger for performing heat exchange between the refrigerant and the heat storage medium, is made to function as a heat radiator of the refrigerant to cause heat to be stored in the heat storage medium, and is made to function as an evaporator of the refrigerant to cause heat to be radiated (heat storage to be utilized) from the heat storage medium. The heat storage heat exchanger 28 has primarily a heat storage tank 281 in which the heat storage medium is retained, and a heat transfer tube group 282 disposed so as to be submerged in the heat storage medium. The heat storage tank 281 herein is a box shaped as a substantial rectangular parallelepiped as shown in FIG. 2, the heat storage medium being retained in the interior. A substance that stores heat by changing phases is used herein as the heat storage medium. Specifically, a medium such as polyethylene glycol, sodium sulfate hydrate, paraffin, or the like, having a phase change temperature of about 30°C to 40°C, is used so that the heat storage medium changes phases (melts) and stores heat when the heat storage heat exchanger 28 is used as a heat radiator of the refrigerant, and changes phases (congeals) to allow the heat storage to be utilized when the heat storage heat exchanger 28 is used as an evaporator of the refrigerant. The heat transfer tube group 282 has a structure in which a plurality of heat transfer tubes 285 are branched and connected via a header pipe 283 and a flow diverter 284 provided to the refrigerant exit and entrance, as shown in FIG. 2. The plurality of heat transfer tubes 285 all have shapes that vertically turn back, and the ends of the plurality of heat transfer tubes 285 are connected to the header tube 283 and the flow diverter 284, thereby constituting the heat transfer tube group 282. The gas side of the heat storage heat exchanger 28 (i.e. one end of the heat transfer tube group 282) is connected to the first switching mechanism 22, and the liquid side of the heat storage heat exchanger 28 (i.e. the other end of the heat transfer tube group 282) is connected via the heat storage expansion valve 29 to the portion of the refrigerant circuit 10 (the outdoor-side refrigerant circuit 10c herein) that is between the outdoor expansion valve 24 and the liquid refrigerant communication pipe 6. FIG. 2 herein is a schematic overview of the heat storage heat exchanger 28.

[0057] The heat storage expansion valve 29 is a valve for depressurizing the refrigerant flowing through the heat storage heat exchanger 28 within the outdoor-side refrigerant circuit 10c and varying the flow rate of the refrigerant flowing through the heat storage heat exchanger 28. The heat storage expansion valve 29 is an electric expansion valve connected to the liquid side of the heat storage heat exchanger 28.

[0058] Various sensors are provided to the outdoor unit 2. The outdoor unit 2 is provided with an intake pressure sensor 31 for detecting the intake pressure Ps of the compressor 21, a discharge pressure sensor 32 for detecting the discharge pressure Pd of the compressor 21, an intake temperature sensor 33 for detecting the intake temperature Ts of the compressor 21, and a discharge temperature sensor 34 for detecting the discharge temperature Td of the compressor 21. The outdoor heat exchanger 23 is provided with an outdoor heat exchange temperature sensor 35 for detecting the temperature Tol1 of refrigerant in a gas-liquid two-phase state. The liquid side of the outdoor heat exchanger 23 is provided with a liquid-side temperature sensor 36 for detecting the temperature Tol2 of refrigerant in a liquid state or a gas-liquid two-phase state. The outdoor air intake port side of the outdoor unit 2 is provided with an outdoor temperature sensor 37 for detecting the temperature of outdoor air (i.e. the outdoor temperature Ta) in the external space where the outdoor unit 2 (i.e. the outdoor heat exchanger 23 and/or the heat storage heat exchanger 28) is located. The outdoor unit 2 also has an outdoor-side control part 38 for controlling the actions of the components constituting the outdoor unit 2. The outdoor-side control part 38, which has components such as a microcomputer and/or a memory provided in order to perform controls for the outdoor unit 2 and/or an inverter device for controlling the compressor motor 20, is designed to be capable of exchanging control signals and the like with the indoor-side control parts 48a, 48b of the indoor units 4a, 4b.

<Refrigerant Communication Pipes>

[0059] The refrigerant communication pipes 6, 7 are refrigerant pipes constructed on site when the air conditioning apparatus 1 is installed; these pipes have various lengths and diameters, depending on the conditions in which the outdoor unit 2 and the indoor units 4a, 4b are installed.

<Control Part>

[0060] The remote controllers 49a, 49b for individually operating the indoor units 4a, 4b, the indoor-side control parts 48a, 48b of the indoor units 4a, 4b, and the outdoor-side control part 38 of the outdoor unit 2 constitute a control part 8 for performing operation controls for the entire air conditioning apparatus 1, as shown in FIG. 1. The control part 8 is connected so as to be capable of receiving detection signals from various sensors such as 31 to 37, 45a, 45b, 46a, 46b, 47a, and 47b, as shown in FIG. 3. The control part 8 is configured so as to be capable of performing air conditioning operations (an air-cooling operation and an air-warming operation) by controlling various devices and valves 20, 22, 24, 26, 41a, 41b, 44a, and 44b on the basis of these detection signals and the like. FIG. 3 is a control block diagram of the air conditioning apparatus 1.

[0061] As described above, the air conditioning apparatus 1 has the refrigerant circuit 10 configured by connecting a plurality (two in this case) of indoor units 4a, 4b to the outdoor unit 2. In the air conditioning apparatus 1, operation controls such as the following are performed by the control part 8.

(2) Basic Action of the Air Conditioning Apparatus

[0062] Next, FIGS. 4 to 7 are used to describe the basic actions of the air-cooling operation, the air-warming operation, the heat storage operation, and a defrosting operation of the air conditioning apparatus 1. FIG. 4 is a drawing showing the flow of refrigerant through the refrigerant circuit in the air-cooling operation. FIG. 5 is a drawing showing the flow of refrigerant through the refrigerant circuit in the air-warming operation. FIG. 6 is a drawing showing the flow of refrigerant through the refrigerant circuit in the heat storage operation (the heat storage operation during the air-warming operation). FIG. 7 is a drawing showing the flow of refrigerant through the refrigerant circuit in the defrosting operation (the defrosting operation accompanying the heat-storage-utilizing operation).

<Air-Cooling Operation>

[0063] When an air-cooling operation command is issued from the remote controllers 49a, 49b, the first switching mechanism 22 is switched to the outdoor heat-radiating switched state (the state shown by the solid lines of the first switching mechanism 22 in FIG. 4), the second switching mechanism 27 is switched to the indoor evaporating switched state (the state shown by the solid lines of the second switching mechanism 27 in FIG. 4), the heat storage expansion valve 29 is closed (i.e. the heat storage heat exchanger 28 is not used), and the compressor 21, the outdoor fan 25, and the indoor fans 43a, 43b start up.

[0064] The low-pressure gas refrigerant in the refrigerant circuit 10 is then drawn into the compressor 21 and compressed to high-pressure gas refrigerant. This high-pressure gas refrigerant is sent through the first switching mechanism 22 to the outdoor heat exchanger 23. The high-pressure gas refrigerant sent to the outdoor heat exchanger 23 is condensed to high-pressure liquid refrigerant by being cooled by heat exchange with outdoor air supplied by the outdoor fan 25 in the outdoor heat exchanger 23 functioning as a heat radiator of the refrigerant. This high-pressure liquid refrigerant is sent through the outdoor expansion valve 24 and the liquid refrigerant communication pipe 6, from the outdoor unit 2 to the indoor units 4a, 4b.

[0065] The high-pressure liquid refrigerant sent to the indoor units 4a, 4b is depressurized by the indoor expansion valves 41a, 41b to low-pressure gas-liquid two-phase refrigerant. This low-pressure gas-liquid two-phase refrigerant is sent to the indoor heat exchangers 42a, 42b. The low-pressure gas-liquid two-phase refrigerant sent to the indoor heat exchangers 42a, 42b is evaporated to low-pressure gas refrigerant by being heated by heat exchange with indoor air supplied by the indoor fans 43a, 43b in the indoor heat exchangers 42a, 42b functioning as evaporators of the refrigerant. This low-pressure gas refrigerant is sent through the gas refrigerant communication pipe 7, from the indoor units 4a, 4b to the outdoor unit 2.

[0066] The low-pressure gas refrigerant sent to the outdoor unit 2 is drawn through the second switching mechanism 27 back into the compressor 21.

<Air-Warming Operation>

[0067] When an air-warming operation command is issued from the remote controllers 49a, 49b, the first switching mechanism 22 is switched to the outdoor evaporating switched state (the state shown by the dashed lines of the first switching mechanism 22 in FIG. 5), the second switching mechanism 27 is switched to the indoor heat-radiating switched state (the state shown by the dashed lines of the second switching mechanism 27 in FIG. 5), the heat storage expansion valve 29 is closed (i.e. the heat storage heat exchanger 28 is not used), and the compressor 21, the outdoor fan 25, and the indoor fans 43a, 43b start up.

[0068] The low-pressure gas refrigerant in the refrigerant circuit 10 is then drawn into the compressor 21 and compressed to high-pressure gas refrigerant. This high-pressure gas refrigerant is sent through the second switching mechanism 27 and the gas refrigerant communication pipe 7, from the outdoor unit 2 to the indoor units 4a, 4b.

[0069] The high-pressure gas refrigerant sent to the indoor units 4a, 4b is sent to the indoor heat exchangers 42a, 42b. The high-pressure gas refrigerant sent to the indoor heat exchangers 42a, 42b is condensed to high-pressure liquid refrigerant by being cooled by heat exchange with indoor air supplied by the indoor fans 43a, 43b in the indoor heat exchangers 42a, 42b functioning as heat radiators of the refrigerant. This high-pressure liquid refrigerant is depressurized by the indoor expansion valves 41a, 41b. The refrigerant depressurized by the indoor expansion valves 41a, 41b is sent through the gas refrigerant communication pipe 7, from the indoor units 4a, 4b to the outdoor unit 2.

[0070] The refrigerant sent to the outdoor unit 2 is sent to the outdoor expansion valve 24 and is depressurized by the outdoor expansion valve 24 to low-pressure gas-liquid two-phase refrigerant. This low-pressure gas-liquid two-phase refrigerant is sent to the outdoor heat exchanger 23. The low-pressure gas-liquid two-phase refrigerant sent to the outdoor heat exchanger 23 is evaporated to low-pressure gas refrigerant by being heated by heat exchange with outdoor air supplied by the outdoor fan 25 in the outdoor heat exchanger 23 functioning as an evaporator of the refrigerant. This low-pressure gas refrigerant is drawn through the first switching mechanism 22 back into the compressor 21.

<Heat Storage Operation (heat storage operation during air-warming operation)>

[0071] During the air-warming operation, the heat storage operation is performed, in which heat is stored in the heat storage medium by causing the heat storage heat exchanger 28 to function as a heat radiator of the refrigerant. Specifically, during the air-warming operation in which the outdoor heat exchanger 23 is made to function as an evaporator of the refrigerant and the indoor heat exchangers 42a, 42b are made to function as heat radiators of the refrigerant, the heat storage operation (the heat storage operation during the air-warming operation) is performed wherein heat is stored in the heat storage medium by causing the heat storage heat exchanger 28 to function as a heat radiator of the refrigerant. The heat storage operation during the air-warming operation is performed by opening the heat storage expansion valve 29 when the switching mechanisms 22, 27 have been switched to the same switched state as the air-warming operation (see FIG. 6).

[0072] The low-pressure gas refrigerant in the refrigerant circuit 10 is then drawn into the compressor 21 and compressed to high-pressure gas refrigerant. Some of this high-pressure gas refrigerant is sent through the second switching mechanism 27 and the gas refrigerant communication pipe 7, from the outdoor unit 2 to the indoor units 4a, 4b, similar to the air-warming operation. This high-pressure gas refrigerant sent to the indoor units 4a, 4b is condensed to high-pressure liquid refrigerant by being cooled by heat exchange with indoor air supplied by the indoor fans 43a, 43b in the indoor heat exchangers 42a, 42b functioning as heat radiators of the refrigerant. This high-pressure liquid refrigerant is depressurized by the indoor expansion valves 41a, 41b. The refrigerant depressurized by the indoor expansion valves 41a, 41b is sent through the gas refrigerant communication pipe 7, from the indoor units 4a, 4b to the outdoor unit 2.

[0073] The rest of the high-pressure gas refrigerant discharged from the compressor 21 is sent through the first switching mechanism 22 to the heat storage heat exchanger 28. The high-pressure gas refrigerant sent to the heat storage heat exchanger 28 is condensed to high-pressure liquid refrigerant by being cooled by heat exchange with the heat storage medium in the heat storage heat exchanger 28 functioning as a heat radiator of the refrigerant. This high-pressure liquid refrigerant is depressurized by the heat storage expansion valve 29. The heat storage medium of the heat storage heat exchanger 28 herein changes phases (melts) and stores heat due to being heated by heat exchange with the refrigerant.

[0074] The refrigerant depressurized by the heat storage expansion valve 29 converges with the refrigerant sent from the indoor units 4a, 4b to the outdoor unit 2, and the converged refrigerant is sent to the outdoor expansion valve 24 and depressurized by the outdoor expansion valve 24 to low-pressure gas-liquid two-phase refrigerant. This low-pressure gas-liquid two-phase refrigerant is sent to the outdoor heat exchanger 23. The low-pressure gas-liquid two-phase refrigerant sent to the outdoor heat exchanger 23 is evaporated to low-pressure gas refrigerant by being heated by heat exchange with outdoor air supplied by the outdoor fan 25 in the outdoor heat exchanger 23 functioning as an evaporator of the refrigerant. This low-pressure gas refrigerant is drawn through the first switching mechanism 22 back into the compressor 21. Thus, in the heat storage operation during the air-warming operation, the heat storage heat exchanger 28 is designed to function as a heat radiator of the refrigerant in parallel with the indoor heat exchangers 42a, 42b. Specifically, the refrigerant circuit 10 is configured to be capable of sending high-pressure gas refrigerant discharged from the compressor 21 in parallel to the indoor heat exchangers 42a, 42b and the heat storage heat exchanger 28 in the heat storage operation during the air-warming operation.

<Defrosting Operation (defrosting operation accompanying heat-storage-utilizing operation)>

[0075] During the air-warming operation, the defrosting operation is performed for defrosting the outdoor heat exchanger by causing the outdoor heat exchanger 23 to function as a heat radiator of the refrigerant. During the defrosting operation, the heat-storage-utilizing operation is performed for radiating heat from the heat storage medium by causing the heat storage heat exchanger 28 to function as an evaporator of the refrigerant. Specifically, the heat-storage-utilizing operation (the heat-storage-utilizing operation during the defrosting operation, and the defrosting operation accompanying the heat-storage-utilizing operation) is performed wherein the outdoor heat exchanger 23 is made to function as a heat radiator of the refrigerant and the heat storage heat exchanger 28 is made to function as an evaporator of the refrigerant. Moreover, the air-warming operation is also performed simultaneously herein by causing the indoor heat exchangers 42a, 42b to function as heat radiators of the refrigerant. Specifically, the heat-storage-utilizing operation and the air-warming operation are performed simultaneously during the defrosting operation (or the air-warming operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation). This heat-storage-utilizing operation during the defrosting operation (or the defrosting operation accompanying the heat-storage-utilizing operation) is performed by opening the heat storage expansion valve 29 when the first switching mechanism 22 has been switched to the outdoor heat-radiating switched state and the second switching mechanism 27 has been switched to the indoor heat-radiating switched state (see FIG. 7). During the defrosting operation, the outdoor fan 25 is stopped.

[0076] The low-pressure gas refrigerant in the refrigerant circuit 10 is then drawn into the compressor 21 and compressed to high-pressure gas refrigerant. Some of this high-pressure gas refrigerant is sent through the second switching mechanism 27 and the gas refrigerant communication pipe 7, from the outdoor unit 2 to the indoor units 4a, 4b, similar to the air-warming operation. The high-pressure gas refrigerant sent to the indoor units 4a, 4b is condensed to high-pressure liquid refrigerant by being cooled by heat exchange with indoor air supplied by the indoor fans 43a, 43b in the indoor heat exchangers 42a, 42b functioning as heat radiators of the refrigerant. This high-pressure liquid refrigerant is depressurized by the indoor expansion valves 41a, 41b. The refrigerant depressurized by the indoor expansion valves 41a, 41b is sent through the gas refrigerant communication pipe 7, from the indoor units 4a, 4b to the outdoor unit 2.

[0077] The rest of the high-pressure gas refrigerant discharged from the compressor 21 is sent through the first switching mechanism 22 to the outdoor heat exchanger 23. The high-pressure gas refrigerant sent to the outdoor heat exchanger 23 is cooled by heat exchange with the frost and/or ice adhering to the outdoor heat exchanger 23, in the outdoor heat exchanger 23 functioning as a heat radiator of the refrigerant. This high-pressure refrigerant is depressurized by the outdoor expansion valve 24. The frost and/or ice adhering to the outdoor heat exchanger 23 herein is melted by being heated by heat exchange with the refrigerant, and the outdoor heat exchanger 23 is defrosted.

[0078] The high-pressure refrigerant depressurized by the outdoor expansion valve 24 converges with the refrigerant sent from the indoor units 4a, 4b to the outdoor unit 2, and this converged refrigerant is sent to the heat storage expansion valve 29 and depressurized by the heat storage expansion valve 29 to low-pressure gas-liquid two-phase refrigerant. This low-pressure gas-liquid two-phase refrigerant is sent to the heat storage heat exchanger 28. The low-pressure gas-liquid two-phase refrigerant sent to the heat storage heat exchanger 28 is evaporated to low-pressure gas refrigerant by being heated by heat exchange with the heat storage medium in the heat storage heat exchanger 28 functioning as an evaporator of the refrigerant. This low-pressure gas refrigerant is drawn through the first switching mechanism 22 back into the compressor 21. The heat storage medium of the heat storage heat exchanger 28 herein changes phases (congeals) due to being cooled by heat exchange with the refrigerant, and the heat storage medium is utilized for heat storage. Thus, when the air-warming operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation (or the heat-storage-utilizing operation during the defrosting operation), the indoor heat exchangers 42a, 42b are designed to function as heat radiators of the refrigerant in parallel with the outdoor heat exchanger 23. Specifically, the refrigerant circuit 10 is configured so as to be capable of sending the high-pressure gas refrigerant discharged from the compressor 21 in parallel to the outdoor heat exchanger 23 and the indoor heat exchangers 42a, 42b, when the air-warming operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation (or the heat-storage-utilizing operation during the defrosting operation).

<Controls of Air-Cooling Operation, Air-Warming Operation, and Heat Storage Operation>

-Air-Cooling Operation-

[0079] In the air-cooling operation described above, the control part 8 determines and controls the opening degrees of the indoor expansion valves 41a, 41b so that the degrees of superheating SHra, SHrb of the refrigerant in the outlets of the indoor heat exchangers 42a, 42b reach target degrees of superheating SHras, SHrbs (this control is referred to below as "degree of superheating control by the indoor expansion valves"). The degrees of superheating SHra, SHrb herein are calculated from the intake pressure Ps detected by the intake pressure sensor 31, and the temperatures Trga, Trgb of refrigerant on the gas sides of the indoor heat exchangers 42a, 42b detected by the gas-side temperature sensors 46a, 46b. More specifically, first, the intake pressure Ps is converted to the refrigerant saturation temperature to obtain the evaporation temperature Te which is a state quantity equivalent to the evaporation pressure Pe in the refrigerant circuit 10 (i.e., the evaporation pressure Pe and the evaporation temperature Te are different terms but refer essentially to the same state quantity). The term "evaporation pressure Pe" means a pressure representing the low-pressure refrigerant flowing from the outlets of the indoor expansion valves 41a, 41b, through the indoor heat exchangers 42a, 42b, to the intake side of the compressor 21 during the air-cooling operation. The degrees of superheating SHra, SHrb are then obtained by subtracting the evaporation temperature Te from the temperatures Trga, Trgb of refrigerant on the gas sides of the indoor heat exchangers 42a, 42b.

[0080] In the air-cooling operation, the controls of the different devices of the indoor units 4a, 4b, including the indoor expansion valves 41a, 41b, are performed by the indoor-side control parts 48a, 48b of the control part 8. The controls of the different devices of the outdoor unit 2, including the outdoor expansion valve 24, are performed by the outdoor-side control part 38 of the control part 8.

-Air-Warming Operation-

[0081] In the air-warming operation described above, the control part 8 determines and controls the opening degrees of the indoor expansion valves 41a, 41b so that the degrees of subcooling SCra, SCrb of the refrigerant in the outlets of the indoor heat exchangers 42a, 42b reach target degrees of subcooling SCras, SCrbs (this control is referred to below as "degree of subcooling control by the indoor expansion valves"). The degrees of subcooling SCra, SCrb herein are calculated from the discharge pressure Pd detected by the discharge pressure sensor 32, and the temperatures Trla, Trlb of refrigerant on the liquid sides of the indoor heat exchangers 42a, 42b detected by the liquid-side temperature sensors 45a, 45b. More specifically, first, the discharge pressure Pd is converted to the refrigerant saturation temperature to obtain the condensation temperature Tc which is a state quantity equivalent to the condensation pressure Pc in the refrigerant circuit 10 (i.e., the condensation pressure Pc and the condensation temperature Tc are different terms but mean essentially the same state quantity). The term "condensation pressure Pc" means a pressure representing the high-pressure refrigerant flowing from the discharge side of the compressor 21, through the indoor heat exchangers 42a, 42b, to the indoor expansion valves 41a, 41b during the air-warming operation. The degrees of subcooling SCra, SCrb are then obtained by subtracting the temperatures Trla, Trlb of refrigerant in the liquid sides of the indoor heat exchangers 42a, 42b from the condensation temperature Tc.

[0082] In the air-warming operation, the controls of the different devices of the indoor units 4a, 4b, including the indoor expansion valves 41a, 41b, are performed by the indoor-side control parts 48a, 48b of the control part 8. The controls of the different devices of the outdoor unit 2, including the outdoor expansion valve 24, are performed by the outdoor-side control part 38 of the control part 8.

-Heat Storage Operation-

[0083] In the heat storage operation described above, the control part 8 ends the heat storage operation and transitions to the air-warming operation when heat storage in the heat storage medium of the heat storage heat exchanger 28 has ended. When a predetermined interval time Δtbet has elapsed after the start of the heat storage operation, a transition is made to the defrosting operation. Specifically, the interval time Δtbet means the interval time between the defrosting operations. Basically, during the interval time Δtbet, the heat storage operation during the air-warming operation and the air-warming operation following the end of the heat storage operation are performed, and the defrosting operation is performed with each elapse of the interval time Δtbet.

[0084] As described above, the air conditioning apparatus 1 is designed so that operation can switch between air-cooling and air-warming. Heat can be stored in the heat storage medium while the air-warming operation is continued by performing the heat storage operation during the air-warming operation, and the heat storage of the heat storage medium can be utilized to perform the defrosting operation by performing the heat-storage-utilizing operation during the defrosting operation.

(3) Control During Defrosting Operation

[0085] During the defrosting operation accompanying the heat-storage-utilizing operation described above, the required defrosting capability of the outdoor heat exchanger 23 differs depending on the climate conditions (outdoor temperature, humidity, rate of snowfall) and other factors in the region where the air conditioning apparatus 1 is installed. One solution being considered for dealing with the differences in defrosting capability depending on the local climate conditions and other factors is to decide the specifications of the heat storage heat exchanger including the heat storage medium capacity and the like, assuming that the climate conditions and other factors are those required by most defrosting capabilities during the defrosting operation accompanying the heat-storage-utilizing operation, such as in cold regions. However, when the specifications of the heat storage heat exchanger 28 are decided in this manner, a large-capacity heat storage medium is required, and the size, weight, and/or cost of the heat storage heat exchanger 28 are greatly affected. When the air conditioning apparatus 1 is installed in a cold region, the specifications of the air conditioning apparatus 1 including the heat storage heat exchanger 28 are appropriate, but when the air conditioning apparatus 1 is installed in a warm region, the specifications of the air conditioning apparatus 1 including the heat storage heat exchanger 28 are excessive. Of course, if there are a wide variety of air conditioning apparatuses 1 available with a plurality of specifications including the heat storage heat exchanger 28 for different regions, the air conditioning apparatus can be adapted for a wide range of regions, but increasing the variety of available apparatuses has great disadvantages such as decreased productivity and increased cost.

[0086] When the air-warming operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation, some of the defrosting capability of the outdoor heat exchanger 23 is used as the air-warming capabilities of the indoor heat exchangers 42a, 42b. At this time, there is a risk that the defrosting capability of the outdoor heat exchanger 23 will be insufficient when the air-warming capabilities of the indoor heat exchangers 42a, 42b are maintained, regardless of the need to increase the defrosting capability of the outdoor heat exchanger 23.

[0087] In view of this, in the defrosting operation accompanying the heat-storage-utilizing operation, the defrosting capability of the outdoor heat exchanger 23 is altered based on the outdoor temperature Ta of the external space where the outdoor heat exchanger 23 is located, and/or the outdoor heat exchange outlet temperature Tol2 which is the temperature of refrigerant in the outlet of the outdoor heat exchanger 23 at the end of the previous defrosting operation. Particularly, when an alteration for increasing the defrosting capability of the outdoor heat exchanger 23 is required in the defrosting operation accompanying the heat-storage-utilizing operation, the air-warming capabilities of the indoor heat exchangers 42a, 42b are reduced while the air-warming operation is performed.

[0088] Specifically, the defrosting capability of the outdoor heat exchanger 23 is altered according to the table of defrosting operation patterns for altering the defrosting capability of the outdoor heat exchanger 23 shown in FIG. 8, and steps ST1 to ST3 shown in the flowchart of defrosting operation patterns for altering the defrosting capability of the outdoor heat exchanger 23 in FIG. 9.

[0089] When the defrosting operation accompanying the heat-storage-utilizing operation is started, a determination is first made as to whether or not a pattern 1 transition condition is satisfied. In the case where the previous defrosting operation was a pattern 2 (described hereinafter) defrosting operation, a determination is made as to whether or not a pattern 1 resume condition is satisfied. When the pattern 1 transition condition is satisfied or when the pattern 1 resume condition is satisfied, a pattern 1 defrosting operation of step ST1 is performed. The pattern 1 transition condition is a condition for determining whether or not the pattern 1 defrosting operation can be performed, based on the outdoor temperature Ta representing the situation at the start of the defrosting operation. When the outdoor temperature Ta herein is higher than a threshold temperature obtained based on a predetermined first outdoor temperature Tadef1 (e.g., a value resulting from adding a predetermined temperature ΔTadef to the first outdoor temperature Tadef1), it is concluded that there is no risk of the defrosting of the outdoor heat exchanger 23 being insufficient even if the defrosting operation is performed while the air-warming capabilities of the indoor heat exchangers 42a, 42b are being ensured, and that the pattern 1 transition condition is satisfied. The pattern 1 resume condition is a condition for determining whether or not the pattern 1 defrosting operation can be resumed after a pattern 2 defrosting operation, on the basis of the outdoor temperature Ta representing the situation at the start of the defrosting operation, and the outdoor heat exchange outlet temperature Tol2 representing the situation at the end of the previous defrosting operation. When any of the outdoor heat exchange outlet temperatures Tol2 at the end of the three previous defrosting operations is equal to or greater than a predetermined first defrosting operation determination temperature Tdef1 (the same as a defrosting operation ending temperature Tdefe indicating the end of the defrosting operation herein) and the outdoor temperature Ta is higher than a predetermined second outdoor temperature Tadef2 (a temperature lower than the first outdoor temperature Tadef1 herein), it is concluded that there is no risk of the defrosting of the outdoor heat exchanger 23 being insufficient even if the defrosting operation is performed while the air-warming capabilities of the indoor heat exchangers 42a, 42b are being ensured, and that the pattern 1 resume condition is satisfied. The pattern 1 defrosting operation is an operation for defrosting the outdoor heat exchanger 23 while ensuring the air-warming capabilities of the indoor heat exchangers 42a, 42b, and is performed herein by supplying high-pressure gas refrigerant to the indoor heat exchangers 42a, 42b functioning as heat radiators of the refrigerant with the indoor expansion valves 41a, 41b opened to a predetermined opening degree, and operating the indoor fans 43a, 43b at a minimum rotational speed, as shown in FIG. 8. In the pattern 1 defrosting operation described above, the outdoor-side control part 38 is designed to decide not only the control specifics of the devices constituting the outdoor unit 2 (the compressor 21, the switching mechanisms 22, 27, the outdoor expansion valve 24, the outdoor fan 25, and/or the heat storage expansion valve 29), but also the control specifics of the devices constituting the indoor units 4a, 4b (the indoor expansion valves 41a, 41b and/or the indoor fans 43a, 43b).

[0090] However, when the previous defrosting operation was the pattern 1 defrosting operation, there is a risk of the defrosting of the outdoor heat exchanger 23 being insufficient when the defrosting operation is performed while the air-warming capabilities of the indoor heat exchangers 42a, 42b are being ensured. In view of this, when the previous defrosting operation was the pattern 1 defrosting operation, a determination is made as to whether or not a pattern 2 transition condition is satisfied. When the pattern 2 transition condition is satisfied, the pattern 2 defrosting operation of step ST2 is performed. The pattern 2 transition condition is a condition for determining whether or not a transition should be made from the pattern 1 defrosting operation to the pattern 2 defrosting operation, on the basis of the outdoor temperature Ta representing the situation at the start of the defrosting operation, and the outdoor heat exchange outlet temperature Tol2 representing the situation at the end of the previous defrosting operation. When the outdoor heat exchange outlet temperature Tol2 at the end of the previous defrosting operation herein is lower than the predetermined first defrosting operation determination temperature Tdef1 (the same as the defrosting operation ending temperature Tdefe indicating the end of the defrosting operation herein), and either the outdoor temperature Ta is equal to or less than a predetermined first outdoor temperature Tadef1 or the outdoor temperature Ta is equal to or less than the predetermined second outdoor temperature Tadef2, it is concluded that there is a risk of the defrosting of the outdoor heat exchanger 23 being insufficient when the defrosting operation is performed while the air-warming capabilities of the indoor heat exchangers 42a, 42b are being ensured, and that the pattern 2 transition condition is satisfied. The pattern 2 defrosting operation is performed by defrosting the outdoor heat exchanger 23 while reducing the air-warming capabilities of the indoor heat exchangers 42a, 42b, supplying high-pressure gas refrigerant to the indoor heat exchangers 42a, 42b functioning as heat radiators of the refrigerant with reduced opening degrees in the indoor expansion valves 41a, 41b (e.g., opening degrees 15% or less of fully open), and operating the indoor fans 43a, 43b at a minimum rotational speed, as shown in FIG. 8. In the pattern 2 defrosting operation described above, the outdoor-side control part 38 is designed to decide not only the control specifics of the devices constituting the outdoor unit 2 (the compressor 21, the switching mechanisms 22, 27, the outdoor expansion valve 24, the outdoor fan 25, and/or the heat storage expansion valve 29), but also the control specifics of the devices constituting the indoor units 4a, 4b (the indoor expansion valves 41a, 41b and/or the indoor fans 43a, 43b).

[0091] However, when the previous defrosting operation was the pattern 2 defrosting operation, merely reducing the air-warming capabilities of the indoor heat exchangers 42a, 42b by reducing the opening degrees of the indoor expansion valves 41a, 41b is sometimes not enough to resolve insufficient defrosting of the outdoor heat exchanger 23. In view of this, when the previous defrosting operation was the pattern 2 defrosting operation, a determination is made as to whether or not a pattern 3 transition condition is satisfied. When the pattern 3 transition condition is satisfied, a pattern 3 defrosting operation of step ST3 is performed. The pattern 3 transition condition is a condition for determining whether or not a transition can be made from the pattern 2 defrosting operation to the pattern 3 defrosting operation, on the basis of the outdoor heat exchange outlet temperature Tol2 representing the situation at the end of the previous defrosting operation. When the outdoor heat exchange outlet temperature Tol2 at the end of the previous defrosting operation herein is lower than a predetermined second defrosting operation determination temperature Tdef2 (the same as the defrosting operation ending temperature Tdefe indicating the end of the defrosting operation herein), it is concluded that there is a risk of the defrosting of the outdoor heat exchanger 23 being insufficient when the defrosting operation is performed merely by reducing the air-warming capabilities of the indoor heat exchangers 42a, 42b, and that the pattern 3 transition condition is satisfied. The pattern 3 defrosting operation ceases the supply of air-warming capability to the indoor heat exchangers 42a, 42b and defrosts the outdoor heat exchanger 23 as shown in FIG. 8, and this operation herein is performed by fully closing the indoor expansion valves 41a, 41b and stopping the indoor fans 43a, 43b.

[0092] When the previous defrosting operation was the pattern 3 defrosting operation, insufficient defrosting of the outdoor heat exchanger 23 is sometimes resolved by ceasing the supply of air-warming capability to the indoor heat exchangers 42a, 42b and defrosting the outdoor heat exchanger 23. In view of this, when the previous defrosting operation was the pattern 3 defrosting operation, a determination is made as to whether or not a pattern 2 resume condition is satisfied. When the pattern 2 resume condition is satisfied, the pattern 2 defrosting operation of step ST 2 is performed. The pattern 2 resume condition is a condition for determining whether or not the pattern 2 defrosting operation can be resumed from the pattern 3 defrosting operation, on the basis of the outdoor heat exchange outlet temperature Tol2 representing the situation at the end of the previous defrosting operation. When any of the outdoor heat exchange outlet temperatures Tol2 at the end of the three previous defrosting operations is equal to or greater than the predetermined second defrosting operation determination temperature Tdef2 (the same as the defrosting operation ending temperature Tdefe indicating the end of the defrosting operation herein), it is concluded that there is no risk of the defrosting of the outdoor heat exchanger 23 being insufficient even if the outdoor heat exchanger 23 is defrosted while air-warming capability is supplied to the indoor heat exchangers 42a, 42b, and that the pattern 2 resume condition is satisfied. In the pattern 3 defrosting operation described above, the outdoor-side control part 38 is designed to decide not only the control specifics of the devices constituting the outdoor unit 2 (the compressor 21, the switching mechanisms 22, 27, the outdoor expansion valve 24, the outdoor fan 25, and/or the heat storage expansion valve 29), but also the control specifics of the devices constituting the indoor units 4a, 4b (the indoor expansion valves 41a, 41b and/or the indoor fans 43a, 43b).

[0093] Thus, in the defrosting operation accompanying the heat-storage-utilizing operation, the required defrosting capability of the outdoor heat exchanger 23, which changes depending on the climate conditions and other factors in the region where the air conditioning apparatus 1 is installed, is altered based on the outdoor temperature Ta and/or the outdoor heat exchange outlet temperature Tol2 at the end of the previous defrosting operation. Therefore, in the defrosting operation accompanying the heat-storage-utilizing operation, the defrosting capability of the outdoor heat exchanger 23 can be set to a capability appropriate for the climate conditions and other factors in the region where the air conditioning apparatus 1 is installed. The air conditioning apparatus can thereby be adapted for a wide range of regions, by means of the heat storage heat exchanger 28 having a heat storage medium of a specific capacity. It is also possible to ensure the defrosting capability of the outdoor heat exchanger 23 while continuing the air-warming operation to the fullest extent possible in the defrosting operation accompanying the heat-storage-utilizing operation herein.

[0094] In the defrosting operation accompanying the heat-storage-utilizing operation described above (the defrosting operation of patterns 1 to 3), the outdoor-side control part 38 is designed to decide not only the control specifics of the devices constituting the outdoor unit 2 (the compressor 21, the switching mechanisms 22, 27, the outdoor expansion valve 24, the outdoor fan 25, and/or the heat storage expansion valve 29), but also the control specifics of the devices constituting the indoor units 4a, 4b (the indoor expansion valves 41a, 41b and/or the indoor fans 43a, 43b), and this point differs between cases of performing only the air-cooling operation and/or cases of performing only the air-warming operation. Therefore, the outdoor-side control part 38 is capable of performing the controls of all the devices of the entire air conditioning apparatus 1 in the defrosting operation accompanying the heat-storage-utilizing operation, and the controls of the devices are performed appropriately.

(4) Modification 1

[0095] In the defrosting operation accompanying the heat-storage-utilizing operation of the above embodiment, when the outdoor temperature Ta is low and/or when the outdoor heat exchange outlet temperature Tol2 at the end of the previous defrosting operation is low, it is preferable that the defrosting operation be performed frequently to ensure the defrosting operation is performed satisfactorily.

[0096] In view of this, the interval time Δtbet between the defrosting operations is altered based on the outdoor temperature Ta and/or the outdoor heat exchange outlet temperature Tol2 at the end of the previous defrosting operation, as shown in FIG. 10. For example, when the outdoor temperature Ta is low and/or when the outdoor heat exchange outlet temperature Tol2 at the end of the previous defrosting operation is low (when the pattern 2 defrosting operation is performed), an alteration is made to lower the interval time Δtbet between the defrosting operations.

[0097] The defrosting operation can thereby be altered frequently as necessary, and the defrosting operation accompanying the heat-storage-utilizing operation can be performed satisfactorily.

(5) Modification 2

[0098] When the air-warming operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation of the above embodiment and Modification 1, there are cases in which the outdoor temperature Ta is too low, or the outdoor heat exchange outlet temperature Tol2 at the end of the previous defrosting operation is too low, for the defrosting capability requirement of the outdoor heat exchanger 23 to be met merely by reducing the air-warming capabilities of the indoor heat exchangers 42a, 42b (including ceasing the supply of air-warming capability). Specifically, there are cases in which it is not possible to meet the defrosting capability requirement of the outdoor heat exchanger 23 merely with the defrosting operations of patterns 1 to 3 of the above embodiment.

[0099] In view of this, when an alteration is required to further increase the defrosting capability of the outdoor heat exchanger 23 in the defrosting operation accompanying the heat-storage-utilizing operation (when the defrosting capability requirement of the outdoor heat exchanger 23 cannot be met by the pattern 3 defrosting operation), a communication pipe heat recovery operation and/or an indoor heat exchange heat recovery operation are performed without simultaneously performing the air-warming operation.

[0100] Specifically, the defrosting capability of the outdoor heat exchanger 23 is altered according to the table of defrosting operation patterns for altering the defrosting capability of the outdoor heat exchanger 23 shown in FIG. 11, and steps ST1 to ST6 shown in the flowchart of defrosting operation patterns for altering the defrosting capability of the outdoor heat exchanger 23 in FIG. 12.

[0101] When the defrosting operation accompanying the heat-storage-utilizing operation is started, the defrosting operation is performed while the air-warming capabilities of the indoor heat exchangers 42a, 42b are reduced (including ceasing the supply of air-warming capability), similar to patterns 1 to 3 (steps ST1 to ST3) of the above embodiment.

[0102] However, when the previous defrosting operation was the pattern 3 defrosting operation, sometimes insufficient defrosting of the outdoor heat exchanger 23 is not resolved merely by ceasing the supply of air-warming capability to the indoor heat exchangers 42a, 42b by fully closing the indoor expansion valves 41a, 41b. In view of this, when the previous defrosting operation was the pattern 3 defrosting operation, a determination is made as to whether or not a pattern 4 transition condition is satisfied. When the pattern 4 transition condition is satisfied, a pattern 4 defrosting operation of step ST4 is performed. The pattern 4 transition condition is a condition for determining whether or not a transition should be made from the pattern 3 defrosting operation to the pattern 4 defrosting operation, on the basis of the outdoor heat exchange outlet temperature Tol2 representing the situation at the end of the previous defrosting operation. When the outdoor heat exchange outlet temperature Tol2 at the end of the previous defrosting operation herein is lower than a predetermined third defrosting operation determination temperature Tdef3 (the same as the defrosting operation ending temperature Tdefe indicating the end of the defrosting operation herein) and the setting for performing the pattern 4 defrosting operation has been enabled, it is concluded that there is a risk of the defrosting of the outdoor heat exchanger 23 being insufficient merely with ceasing the supply of air-warming capability to the indoor heat exchangers 42a, 42b, and that the pattern 4 transition condition is satisfied. The setting of whether or not to perform the pattern 4 defrosting operation (including a setting of whether or not to perform the defrosting operation of pattern 5 or 6) herein is performed by a heat recovery operation setting part 81 provided to the control part 8, as shown in FIG. 13. The heat recovery operation setting part 81 herein is memory provided to the outdoor-side control part 38 of the control part 8, and is designed to be able to set whether or not to perform the defrosting operations of patterns 4 to 6, according to communications from the external devices for performing various control settings and the like of the air conditioning apparatus 1. The heat recovery operation setting part 81 is not limited to that described above, and is preferably part that can set whether or not to perform the defrosting operations of patterns 4 to 6 in the manner of, e.g., a dipswitch or the like provided to the outdoor-side control part 38. In the pattern 4 defrosting operation, the supply of air-warming capability to the indoor heat exchangers 42a, 42b is ceased by fully closing the indoor expansion valves 41a, 41b as shown in FIGS. 11 and 14, and in this state, the outdoor heat exchanger 23 is defrosted while a communication pipe heat recovery operation is performed for recovering the heat contained in the refrigerant pipe connecting the indoor heat exchangers 42a, 42b and the compressor 21 (primarily the gas refrigerant communication pipe 7). This operation is performed by switching the second switching mechanism 27, which had been switched to the indoor heat-radiating switched state in order to cause the indoor heat exchangers 42a, 42b to function as heat radiators of the refrigerant, to the indoor evaporating switched state for making the indoor heat exchangers 42a, 42b function as evaporators of the refrigerant, whereby pressure is lowered in the refrigerant pipe connecting the indoor heat exchangers 42a, 42b and the compressor 21 (primarily the gas refrigerant communication pipe 7), and the high-temperature gas refrigerant retained in this refrigerant pipe is drawn into the compressor 21 along with the low-pressure refrigerant from the heat storage heat exchanger 28 (see FIG. 14). In the pattern 4 defrosting operation described above, the outdoor-side control part 38 is designed to decide not only the control specifics of the devices constituting the outdoor unit 2 (the compressor 21, the switching mechanisms 22, 27, the outdoor expansion valve 24, the outdoor fan 25, and/or the heat storage expansion valve 29), but also the control specifics of the devices constituting the indoor units 4a, 4b (the indoor expansion valves 41a, 41b and/or the indoor fans 43a, 43b).

[0103] When the previous defrosting operation was the pattern 4 defrosting operation, insufficient defrosting of the outdoor heat exchanger 23 is sometimes resolved by defrosting the outdoor heat exchanger 23 while performing the communication pipe heat recovery operation. In view of this, when the previous defrosting operation was the pattern 4 defrosting operation, a determination is made as to whether or not a pattern 3 resume condition is satisfied. When the pattern 3 resume condition is satisfied, the pattern 3 defrosting operation of step ST3 is performed. The pattern 3 resume condition is a condition for determining whether or not the pattern 3 defrosting operation can be resumed from the pattern 4 defrosting operation, on the basis of the outdoor heat exchange outlet temperature Tol2 representing the situation at the end of the previous defrosting operation. When the pattern 4 transition condition has ceased to be satisfied herein, it is concluded that there is no risk of the defrosting of the outdoor heat exchanger 23 being insufficient even if the outdoor heat exchanger 23 is defrosted merely by ceasing the supply of air-warming capability to the indoor heat exchangers 42a, 42b, and that the pattern 3 resume condition is satisfied.

[0104] However, when the previous defrosting operation was the pattern 4 defrosting operation, insufficient defrosting of the outdoor heat exchanger 23 is sometimes not resolved merely by defrosting the outdoor heat exchanger 23 while performing the communication pipe heat recovery operation. In view of this, when the previous defrosting operation was the pattern 4 defrosting operation, a determination is made as to whether or not the pattern 5 and 6 transition condition is satisfied. When the pattern 5 and 6 transition condition is satisfied, the defrosting operation of pattern 5 of step ST5 or of pattern 6 of ST 6 is performed. The pattern 5 and 6 transition condition is a condition for determining whether or not a transition should be made from the pattern 4 defrosting operation to the pattern 5 or 6 defrosting operation, on the basis of the outdoor heat exchange outlet temperature Tol2 representing the situation at the end of the previous defrosting operation. When the outdoor heat exchange outlet temperature Tol2 at the end of the previous defrosting operation herein is lower than a predetermined fourth defrosting operation determination temperature Tdef4 (the same as a defrosting operation ending temperature Tdefe indicating the end of the defrosting operation herein) and a setting has been implemented to perform the defrosting operation of pattern 5 or pattern 6, it is concluded that there is a risk of the defrosting of the outdoor heat exchanger 23 being insufficient with merely defrosting the outdoor heat exchanger 23 while performing the communication pipe heat recovery operation, and that the pattern 5 and 6 transition condition is satisfied. The setting of whether or not to perform the pattern 5 or 6 defrosting operation is performed by the heat recovery operation setting part 81 provided to the control part 8, similar to the case described above. In the pattern 5 or 6 defrosting operation, the outdoor heat exchanger 23 is defrosted while the communication pipe heat recovery operation is performed as shown in FIGS. 11 and 15, and in this state, the outdoor heat exchanger 23 is defrosted while an indoor heat exchanger heat recovery operation for recovering heat acquired by the refrigerant is performed by causing the indoor heat exchangers 42a, 42b to function as evaporators of the refrigerant. This operation is performed by opening the indoor expansion valves 41a, 41b, which has been fully closed in the communication pipe heat recovery operation, to cause the indoor heat exchangers 42a, 42b to function as evaporators of the refrigerant (see FIG. 15). When the pattern 5 defrosting operation has been set by the heat recovery operation setting part 81, a first indoor heat exchanger heat recovery operation is performed for recovering heat without operating the indoor fans 43a, 43b, and when the pattern 6 defrosting operation has been set, a second indoor heat exchanger heat recovery operation is performed in which the indoor fans 43a, 43b are operated (see FIG. 11).

[0105] When the previous defrosting operation was the pattern 5 or pattern 6 defrosting operation, insufficient defrosting of the outdoor heat exchanger 23 is sometimes resolved by defrosting the outdoor heat exchanger 23 while performing the first indoor heat exchanger heat recovery operation or the second indoor heat exchanger heat recovery operation. In view of this, when the previous defrosting operation was the pattern 5 or pattern 6 defrosting operation, a determination is made as to whether or not a pattern 4 resume condition is satisfied. When the pattern 4 resume condition is satisfied, the pattern 4 defrosting operation of step ST4 is performed. The pattern 4 resume condition herein is a condition for determining whether or not the pattern 4 defrosting operation can be resumed from the pattern 5 or pattern 6 defrosting operation, on the basis of the outdoor heat exchange outlet temperature Tol2 representing the situation at the end of the previous defrosting operation. When the pattern 5 and 6 transition condition has ceased to be satisfied herein, it is concluded that there is no risk of the defrosting of the outdoor heat exchanger 23 being insufficient even if the outdoor heat exchanger 23 is defrosted merely by defrosting the outdoor heat exchanger 23 while performing the communication pipe heat recovery operation, and that the pattern 4 resume condition is satisfied. In the above-described pattern 5 and 6 defrosting operations as well, the outdoor-side control part 38 is designed to decide not only the control specifics of the devices constituting the outdoor unit 2 (the compressor 21, the switching mechanisms 22, 27, the outdoor expansion valve 24, the outdoor fan 25, and/or the heat storage expansion valve 29), but also the control specifics of the devices constituting the indoor units 4a, 4b (the indoor expansion valves 41a, 41b and/or the indoor fans 43a, 43b).

[0106] Thus, in the defrosting operation accompanying the heat-storage-utilizing operation herein, when it is not possible to meet the defrosting capability requirement of the outdoor heat exchanger 23 merely by reducing the air-warming capabilities of the indoor heat exchangers 42a, 42b, the defrosting capability of the outdoor heat exchanger 23 can be ensured by performing a heat recovery operation such as those of patterns 4 to 6 without performing the air-warming operation. The configuration is designed so that the pattern 4 defrosting operation (communication pipe heat recovery operation) is performed prior to the pattern 5 or pattern 6 defrosting operation (indoor heat exchanger heat recovery operation), but the pattern 4 defrosting operation may be omitted. For example, when the pattern 4 transition condition is satisfied, a transition may be made from the pattern 3 defrosting operation to the pattern 5 or pattern 6 defrosting operation, and when the pattern 4 resume condition is satisfied, the pattern 3 defrosting operation may be resumed from the pattern 5 or pattern 6 defrosting operation. In terms of keeping the room interior as comfortable as possible, it is preferable that the pattern 4 defrosting operation be performed prior to the pattern 5 or pattern 6 defrosting operation.

[0107] The indoor heat exchanger heat recovery operations herein include the first indoor heat exchanger heat recovery operation for recovering heat from the indoor heat exchangers 42a, 42b while minimizing the effect on the air conditioned space without operating the indoor fans 43a, 43b, and the second indoor heat exchanger heat recovery operation in which the indoor fans 43a, 43b are operated, whereby the effect on the air conditioned space is greater but more heat is recovered than in the first indoor heat exchanger heat recovery operation. Therefore, the first indoor heat exchanger heat recovery operation can be performed when only a small degree of defrosting capability of the outdoor heat exchanger 23 is required, and the second indoor heat exchanger heat recovery operation can be performed when a large degree of defrosting capability of the outdoor heat exchanger 23 is required. Two indoor heat exchanger heat recovery operations having different degrees of heat recovery can thereby be used herein as necessary to ensure the defrosting capability of the outdoor heat exchanger 23.

[0108] The heat recovery operation setting part 81 provided to the control part 8 are also designed herein to be able to set whether the heat recovery operation will be simultaneously performed or inhibited in the defrosting operation accompanying the heat-storage-utilizing operation. For example, settings can be made such that in cold regions, a heat recovery operation is performed in the defrosting operation accompanying the heat-storage-utilizing operation, and in warm regions, a heat recovery operation is not performed in the defrosting operation accompanying the heat-storage-utilizing operation. It is thereby possible herein to set whether or not a heat recovery operation is performed in accordance with climate conditions and other factors in the region where the air conditioning apparatus 1 is installed.

[0109] It is also possible herein to design the heat recovery operation setting part 81 to set which of the three heat recovery operations (the communication pipe heat recovery operation, the first indoor heat exchanger heat recovery operation, and the second indoor heat exchanger heat recovery operation) will be performed in cases when the heat recovery operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation.

[0110] It is thereby possible herein to set which of the heat recovery operations will be performed according to climate conditions and other factors in the region where the air conditioning apparatus 1 is installed.

[0111] In cases in which a heat recovery operation such as those of patterns 4 to 6 is simultaneously performed in the defrosting operation accompanying the heat-storage-utilizing operation, it is preferable that the defrosting operation be performed frequently, and that sufficient heat be stored in the heat storage medium in the heat storage operation performed before the defrosting operation.

[0112] In view of this, in cases in which a heat recovery operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation, the defrosting operation is designed to be performed every time the heat storage operation ends as shown in FIG. 11. Therefore, heat is reliably stored in the heat storage medium in the heat storage operation before the defrosting operation, and the interval time Δt-bet between the defrosting operations can be shortened by omitting the air-warming operation after the heat storage operation.

[0113] It is thereby possible herein to increase the frequency of the defrosting operation, to sufficiently utilize the stored heat of the heat storage medium, and to satisfactorily perform the defrosting operation accompanying the heat-storage-utilizing operation in cases in which a heat recovery operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation.

[0114] In the defrosting operations of patterns 4 to 6 added in the present modification, the outdoor-side control part 38 is designed so as to decide not only the control specifics of the devices constituting the outdoor unit 2, but also the control specifics of the devices constituting the indoor units 4a, 4b, similar to the defrosting operations of patterns 1 to 3. Therefore, the outdoor-side control part 38 is capable of performing the controls of all the devices of the entire air conditioning apparatus 1 in the defrosting operation accompanying the heat-storage-utilizing operation, and the controls of the devices are performed appropriately.

(6) Modification 3

[0115] The above embodiment and Modifications 1 and 2 are designed so that in the defrosting operation accompanying the heat-storage-utilizing operation, the defrosting capability of the outdoor heat exchanger 23 is altered based on the outdoor temperature Ta as an indicator representing the situation at the start of the defrosting operation, and/or the outdoor heat exchange outlet temperature Tol2 as an indicator representing the situation at the end of the previous defrosting operation, as shown in FIGS. 9 and/or 12.

[0116] However, the indicator representing the situation at the end of the previous defrosting operation is not limited to this option. For example, the time tdef required for the previous defrosting operation may be used in cases in which the defrosting operation is designed to be ended when the outdoor heat exchange outlet temperature Tol2 is equal to or greater than the predetermined defrosting operation ending temperature Tdefe.

[0117] Specifically, in the process of altering defrosting operation patterns in FIGS. 9 and/or 12, the condition that "the outdoor heat exchange outlet temperature Tol2 at the end of the previous defrosting operation be lower than the defrosting operation determination temperatures Tdef1, Tdef2, Tdef3, Tdef4" is preferably altered to the condition that "the time tdef required for the previous defrosting operation be greater than a predetermined time." The condition that "any of the outdoor heat exchange outlet temperatures Tol2 at the end of the three previous defrosting operations be equal to or greater than the defrosting operation determination temperatures Tdef1, Tdef2" is also preferably altered to the condition that "any of the times tdef required for the three previous defrosting operations be equal to or less than a predetermined time."

[0118] Thus, the defrosting operation accompanying the heat-storage-utilizing operation herein is designed so that the defrosting capability of the outdoor heat exchanger 23, which must be varied according to the climate conditions and other factors in the region where the air conditioning apparatus 1 is installed, is altered based on the outdoor temperature Ta and/or the time tdef required for the previous defrosting operation. Therefore, in the defrosting operation accompanying the heat-storage-utilizing operation, the defrosting capability of the outdoor heat exchanger 23 can be set to a capability appropriate for the climate conditions and other factors in the region where the air conditioning apparatus 1 is installed, similar to the above embodiment and Modifications 1 and 2. The heat storage heat exchanger 28, having a heat storage medium of a specific capacity, thereby makes it possible to adapt to a wide range of regions. It is also possible in the defrosting operation accompanying the heat-storage-utilizing operation herein to ensure the defrosting capability of the outdoor heat exchanger 23 while continuing the air-warming operation to the fullest extent possible.

[0119] When a long time tdef was required for the previous defrosting operation, it is preferable that the defrosting operation be performed frequently so that the defrosting operation is performed satisfactorily. When a heat recovery operation is simultaneously performed in the defrosting operation accompanying the heat-storage-utilizing operation, it is preferable that the defrosting operation be performed frequently, and also that sufficient heat be stored in the heat storage medium in the heat storage operation performed before the defrosting operation.

[0120] In view of this, the interval time Δtbet between the defrosting operations herein is altered based on the outdoor temperature Ta and/or the time required for the previous defrosting operation, similar to the above Modifications 1 and 2. For example, when a long time was required for the previous defrosting operation (when the pattern 2 defrosting operation is performed herein), an alteration is made to shorten the interval time Δtbet between the defrosting operations, as shown in FIGS. 10 and 11. When a heat recovery operation is simultaneously performed in the defrosting operation accompanying the heat-storage-utilizing operation (when a defrosting operation of any pattern 4 to 6 is performed herein), the defrosting operation is performed every time the heat storage operation ends, similar to Modification 2 (see FIG. 11).

[0121] The frequency of the defrosting operation can thereby be varied herein as necessary, and the defrosting operation accompanying the heat-storage-utilizing operation can be performed satisfactorily. Heat can also be reliably stored in the heat storage medium during the heat storage operation before the defrosting operation, and the interval time Δtbet between the defrosting operations can be shortened by omitting the air-warming operation after the heat storage operation.

INDUSTRIAL APPLICABILITY

[0122] The present invention can be widely applied to air conditioning apparatuses comprising a refrigerant circuit having a heat storage heat exchanger for performing heat exchange between a refrigerant and a heat storage medium, wherein a heat storage operation for storing heat in a heat storage medium can be performed by causing the heat storage heat exchanger to function as a heat radiator of the refrigerant, and an air-warming operation and a heat-storage-utilizing operation for radiating heat from the heat storage medium can be performed simultaneously by causing the heat storage heat exchanger to function as an evaporator of the refrigerant during a defrosting operation.

REFERENCE SIGNS LIST

[0123]

1	Air conditioning apparatus
10	Refrigerant circuit
21	Compressor
23	Outdoor heat exchanger
28	Heat storage heat exchanger
29	Heat storage expansion valve
41a, 41b	Indoor expansion valves
42a, 42b	Indoor heat exchangers
43a, 43b	Indoor fans
81	Heat recovery operation setting part

CITATION LIST

PATENT LITERATURE

[0124] [Patent Literature 1] Japanese Laid-open Patent Application No. 2005-337657

Claims

1. An air conditioning apparatus (1) comprising a refrigerant circuit (10) having a compressor (21), an outdoor heat exchanger (23), indoor heat exchang-

ers (42a, 42b), and a heat storage heat exchanger (28) for performing heat exchange between a refrigerant and a heat storage medium, the air conditioning apparatus being capable of performing a heat storage operation for storing heat in the heat storage medium by causing the heat storage heat exchanger to function as a heat radiator of the refrigerant, and simultaneously performing a heat-storage-utilizing operation for radiating heat from the heat storage medium by causing the heat storage heat exchanger to function as an evaporator of the refrigerant and an air-warming operation for causing the indoor heat exchangers to function as heat radiators of the refrigerant during a defrosting operation for defrosting the outdoor heat exchanger by causing the outdoor heat exchanger to function as a heat radiator of the refrigerant;
during the defrosting operation accompanying the heat-storage-utilizing operation, the defrosting capability of the outdoor heat exchanger being altered based on the outdoor temperature of the external space where the outdoor heat exchanger is installed, and/or either an outdoor heat exchange outlet temperature, which is the temperature of the refrigerant in an outlet of the outdoor heat exchanger at the end of the previous defrosting operation, or the time required for the previous defrosting operation.

2. The air conditioning apparatus (1) according to claim 1, wherein
during the defrosting operation accompanying the heat-storage-utilizing operation, when an alteration is required to increase the defrosting capability of the outdoor heat exchanger (23) on the basis of the outdoor temperature and/or either the outdoor heat exchange outlet temperature at the end of the previous defrosting operation or the time required for the previous defrosting operation, the air-warming capabilities of the indoor heat exchangers (42a, 42b) are reduced while the air-warming operation is simultaneously performed.

3. The air conditioning apparatus (1) according to claim 2, wherein
in cases in which the air-warming operation is performed simultaneously during the defrosting operation accompanying the heat-storage-utilizing operation, an interval time between the defrosting operations is altered based on the outdoor temperature and/or either the outdoor heat exchange outlet temperature at the end of the previous defrosting operation or the time required for the previous defrosting operation.

4. The air conditioning apparatus (1) according to claim 2 or 3, wherein
during the defrosting operation accompanying the heat-storage-utilizing operation, supply of the refrigerant to the indoor heat exchangers (42a, 42b) is ceased and the outdoor heat exchanger (23) is defrosted when an alteration is required for further increasing the defrosting capability of the outdoor heat exchanger (23) on the basis of the outdoor temperature and/or either the outdoor heat exchange outlet temperature at the end of the previous defrosting operation or the time required for the previous defrosting operation.

5. The air conditioning apparatus (1) according to claim 4, wherein
during the defrosting operation accompanying the heat-storage-utilizing operation, in cases in which an alteration is required to further increase the defrosting capability of the outdoor heat exchanger (23) on the basis of the outdoor temperature and/or either the outdoor heat exchange outlet temperature at the end of the previous defrosting operation or the time required for the previous defrosting operation, the air conditioning apparatus performs a communication pipe heat recovery operation for recovering heat in a refrigerant pipe connecting the indoor heat exchangers (42a, 42b) and the compressor (21), and/or an indoor heat exchanger heat recovery operation for recovering heat obtained by the refrigerant due to the indoor heat exchangers being made to function as evaporators of the refrigerant.

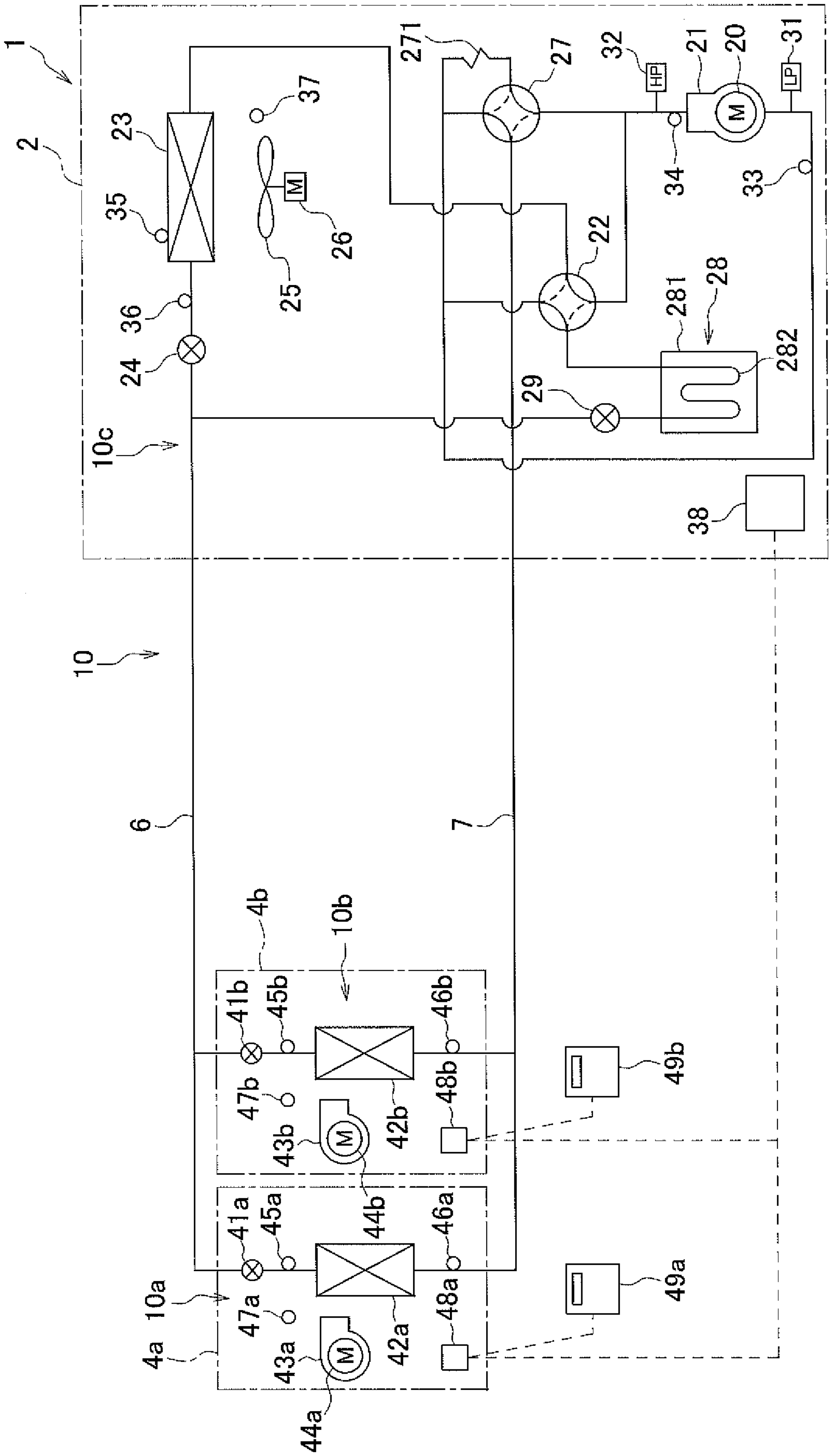
6. The air conditioning apparatus (1) according to claim 5, wherein
indoor fans (43a, 43b) are also provided for supplying air to the indoor heat exchangers (42a, 42b), and the indoor heat exchanger heat recovery operation includes a first indoor heat exchanger heat recovery operation in which the indoor fans are not operated, and a second indoor heat exchanger heat recovery operation in which the indoor fans are operated.

7. The air conditioning apparatus (1) according to claim 5 or 6, wherein
the defrosting operation is performed every time the heat storage operation ends when the communication pipe heat recovery operation and/or the indoor heat exchanger heat recovery operation are performed during the defrosting operation accompanying the heat-storage-utilizing operation.

8. The air conditioning apparatus (1) according to any one of claims 5 to 7, wherein
a heat recovery operation setting part (81) is provided for setting whether to allow or inhibit the communication pipe heat recovery operation and/or the indoor heat exchanger heat recovery operation in the defrosting operation accompanying the heat-storage-utilizing operation.

9. The air conditioning apparatus (1) according to claim

8, wherein
the heat recovery operation setting part (81) is capable of setting each of the communication pipe heat recovery operation, the first indoor heat exchanger heat recovery operation, and the second indoor heat exchanger heat recovery operation in the defrosting operation accompanying the heat-storage-utilizing operation.


1
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M
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281
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38
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4b
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41b
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46b
47b
48b
42b
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43a
44a
49a

FIG. 1

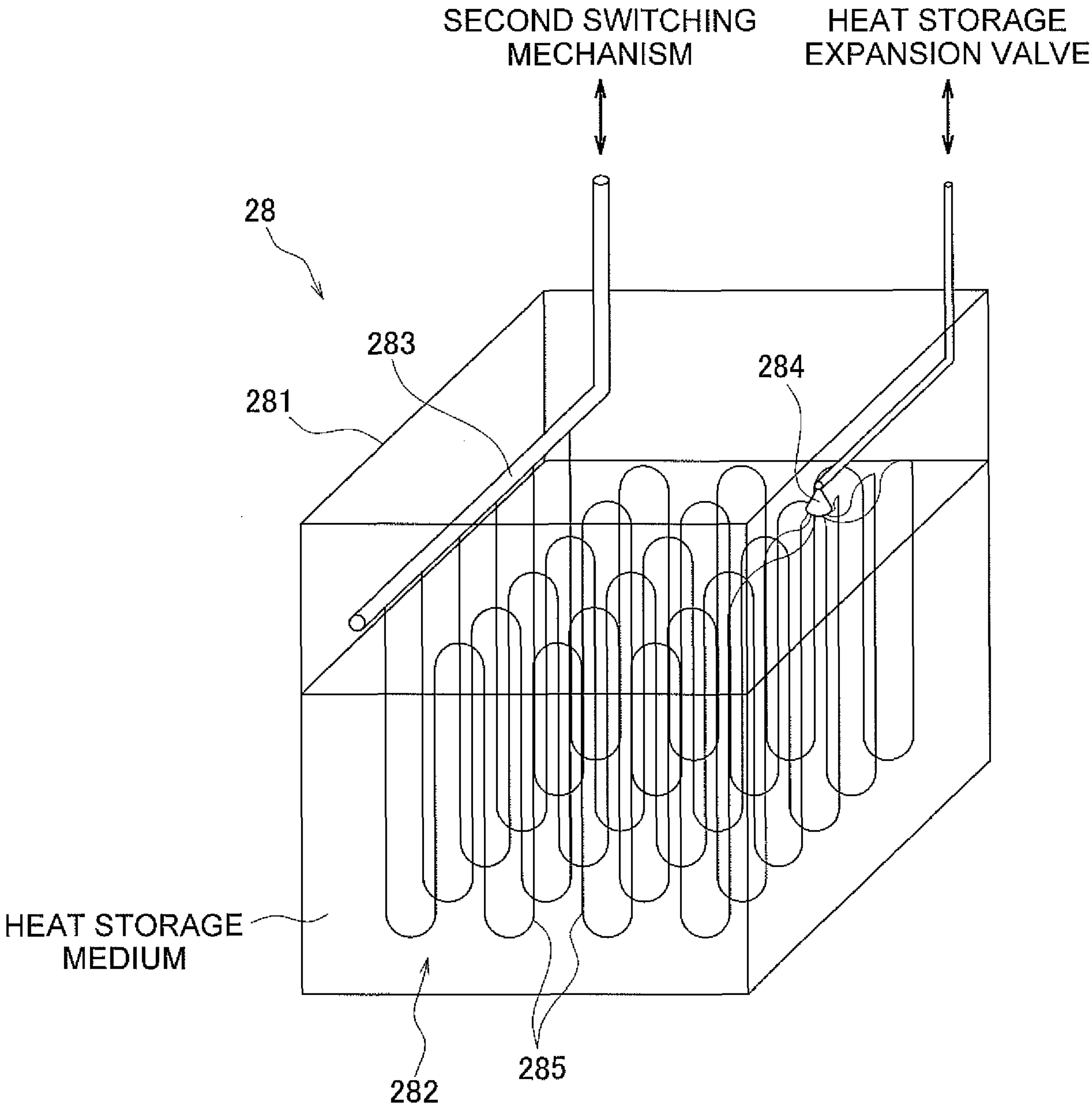
SECOND SWITCHING
MECHANISM
HEAT STORAGE
EXPANSION VALVE
28
283
281
284
HEAT STORAGE
MEDIUM
282
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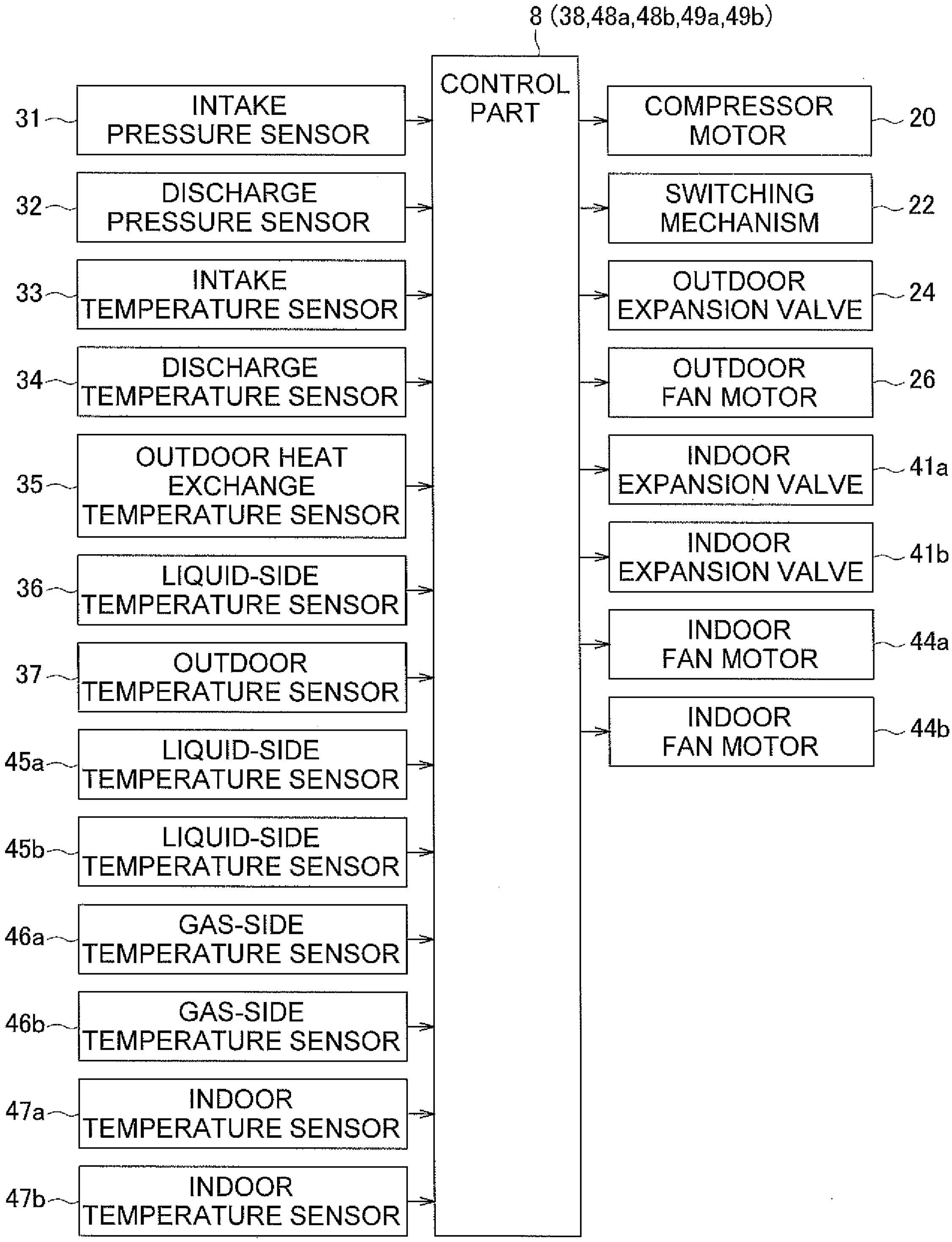
FIG. 2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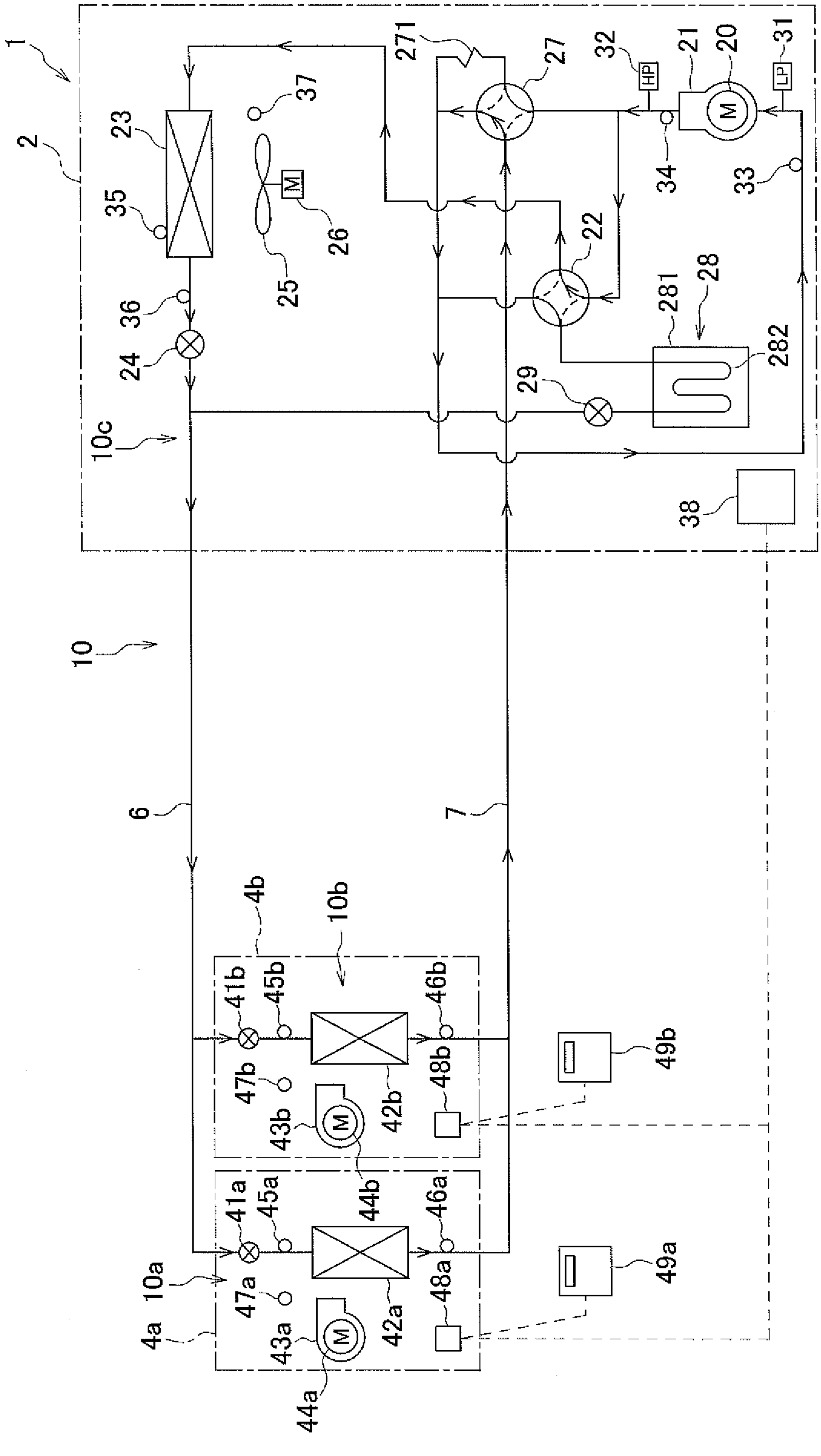
32 DISCHARGE PRESSURE SENSOR
33 INTAKE TEMPERATURE SENSOR
34 DISCHARGE TEMPERATURE SENSOR
35 OUTDOOR HEAT EXCHANGE TEMPERATURE SENSOR
36 LIQUID-SIDE TEMPERATURE SENSOR
37 OUTDOOR TEMPERATURE SENSOR
45a LIQUID-SIDE TEMPERATURE SENSOR
45b LIQUID-SIDE TEMPERATURE SENSOR
46a GAS-SIDE TEMPERATURE SENSOR
46b GAS-SIDE TEMPERATURE SENSOR
47a INDOOR TEMPERATURE SENSOR
47b INDOOR TEMPERATURE SENSOR
COMPRESSOR MOTOR 20
SWITCHING MECHANISM 22
OUTDOOR EXPANSION VALVE 24
OUTDOOR FAN MOTOR 26
INDOOR EXPANSION VALVE 41a
INDOOR EXPANSION VALVE 41b
INDOOR FAN MOTOR 44a
INDOOR FAN MOTOR 44b

FIG. 3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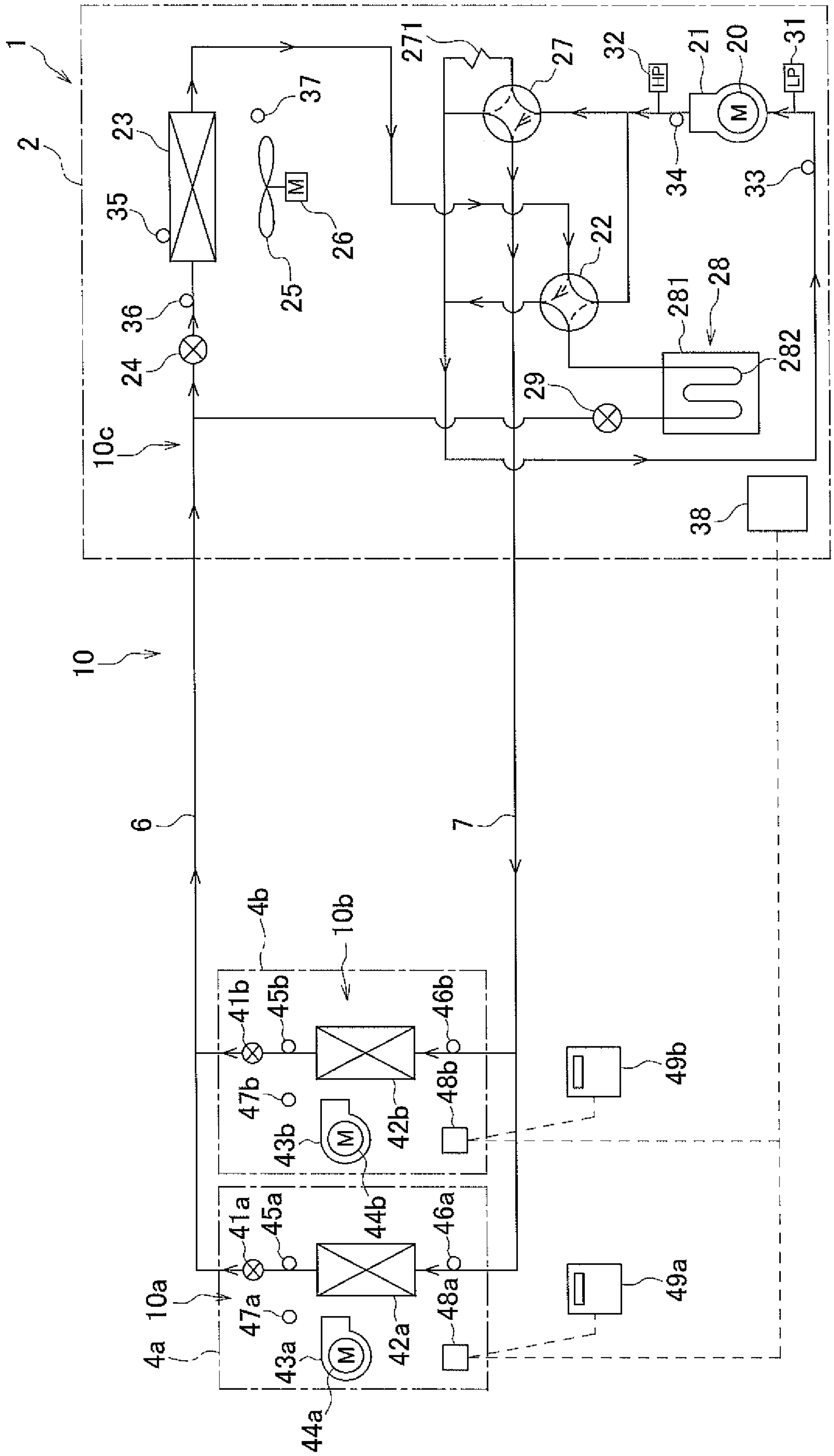
49a

FIG. 4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49a
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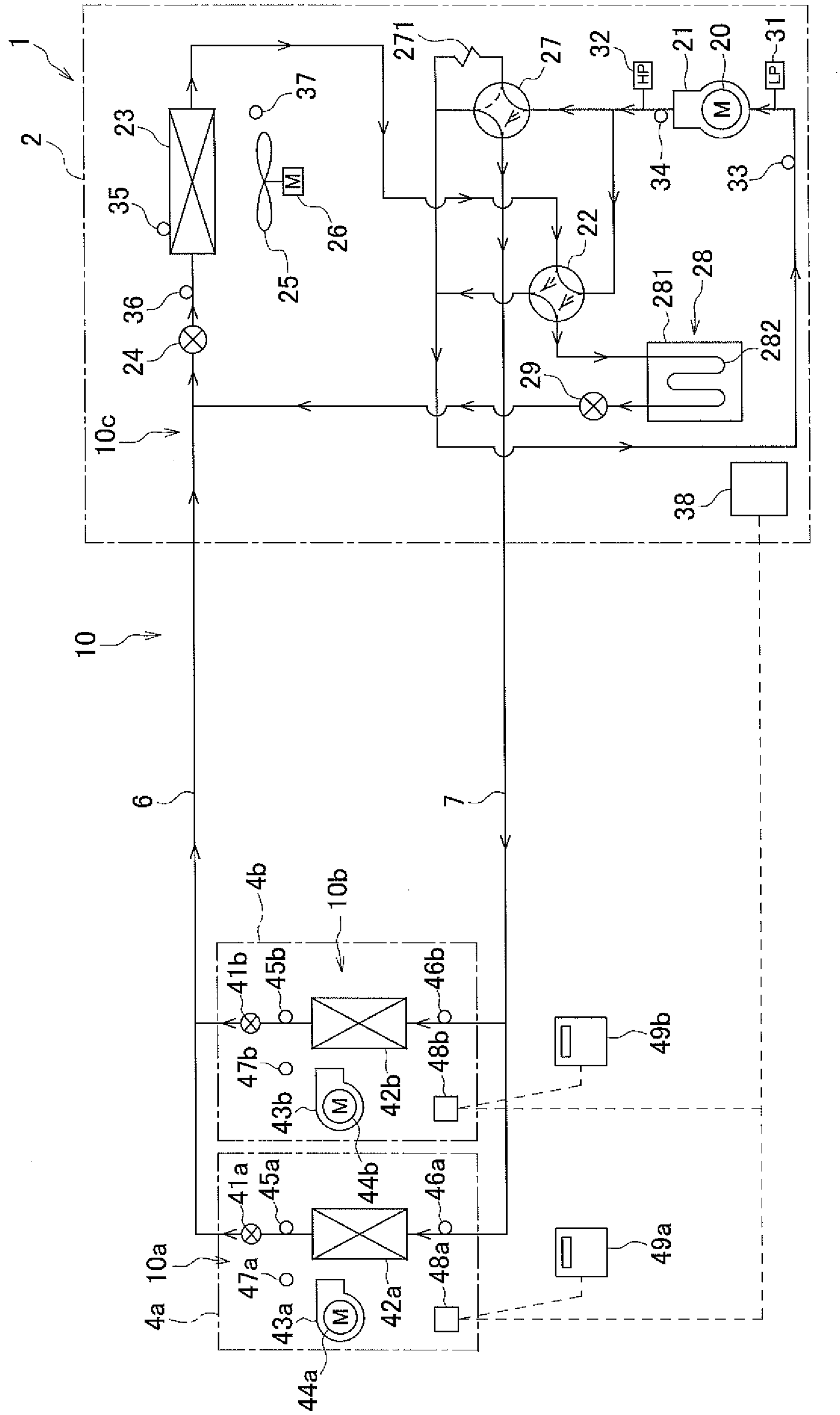
FIG. 5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49b

FIG. 6

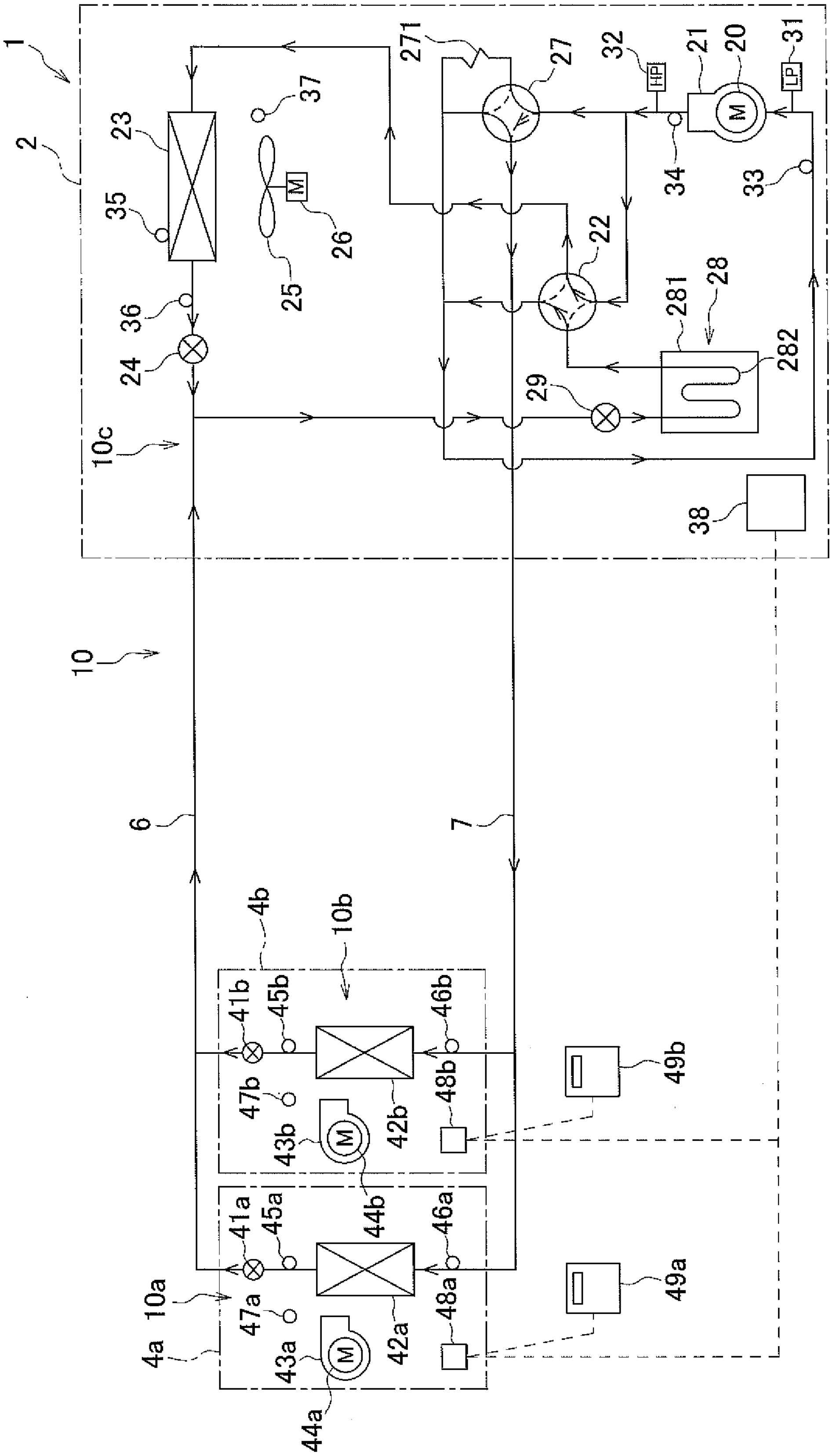
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FIG. 7

	INDOOR EXPANSION VALVES (AIR-WARMING CAPABILITY SUPPLIED)	STATE OF INDOOR HEAT EXCHANGERS	INDOOR FANS
PATTERN 1	OPEN (YES)	CONDENSERS	MINIMUM ROTATIONAL SPEED
PATTERN 2	OPEN SLIGHTLY (YES)	CONDENSERS	MINIMUM ROTATIONAL SPEED
PATTERN 3	FULLY CLOSED (NO)	CONDENSERS	STOPPED

FIG. 8

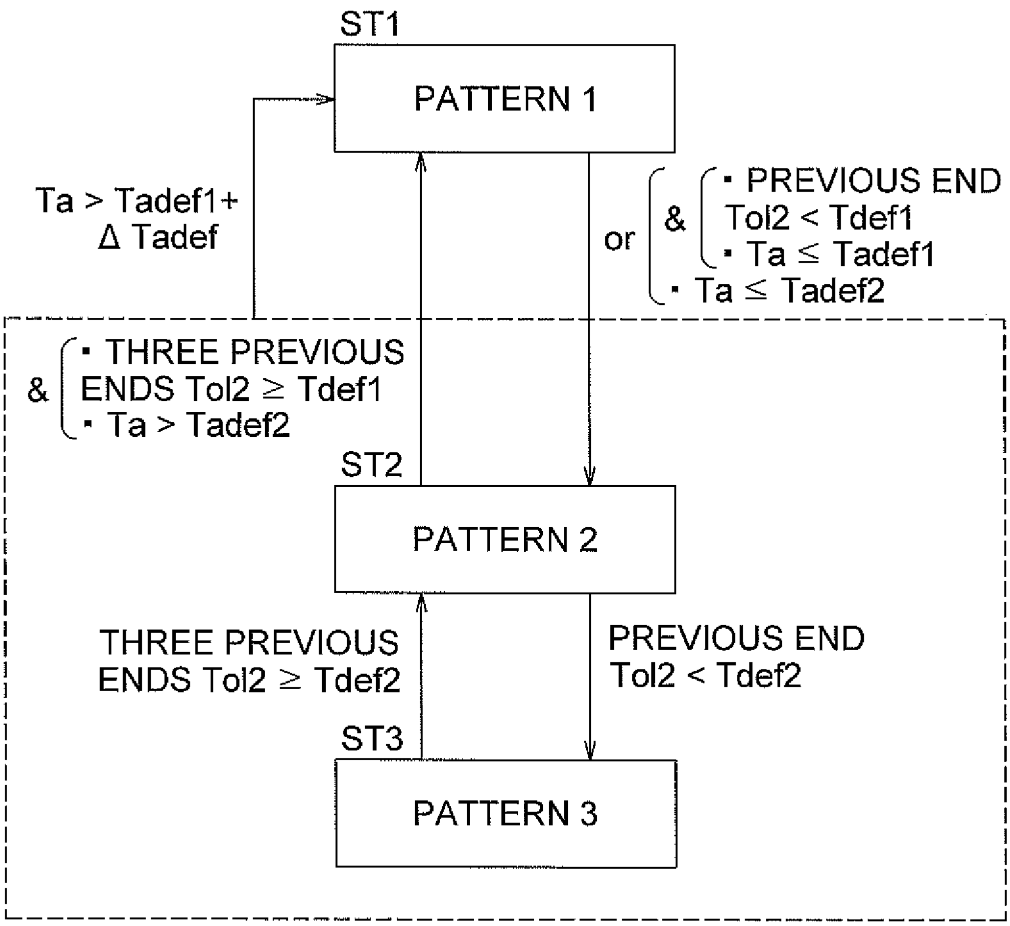

ST1
PATTERN 1
Ta > Tadef1+
Δ Tadef
or
&
· PREVIOUS END
Tol2 < Tdef1
· Ta ≤ Tadef1
· Ta ≤ Tadef2
&
· THREE PREVIOUS
ENDS Tol2 ≥ Tdef1
· Ta > Tadef2
ST2
PATTERN 2
THREE PREVIOUS
ENDS Tol2 ≥ Tdef2
PREVIOUS END
Tol2 < Tdef2
ST3
PATTERN 3

FIG. 9

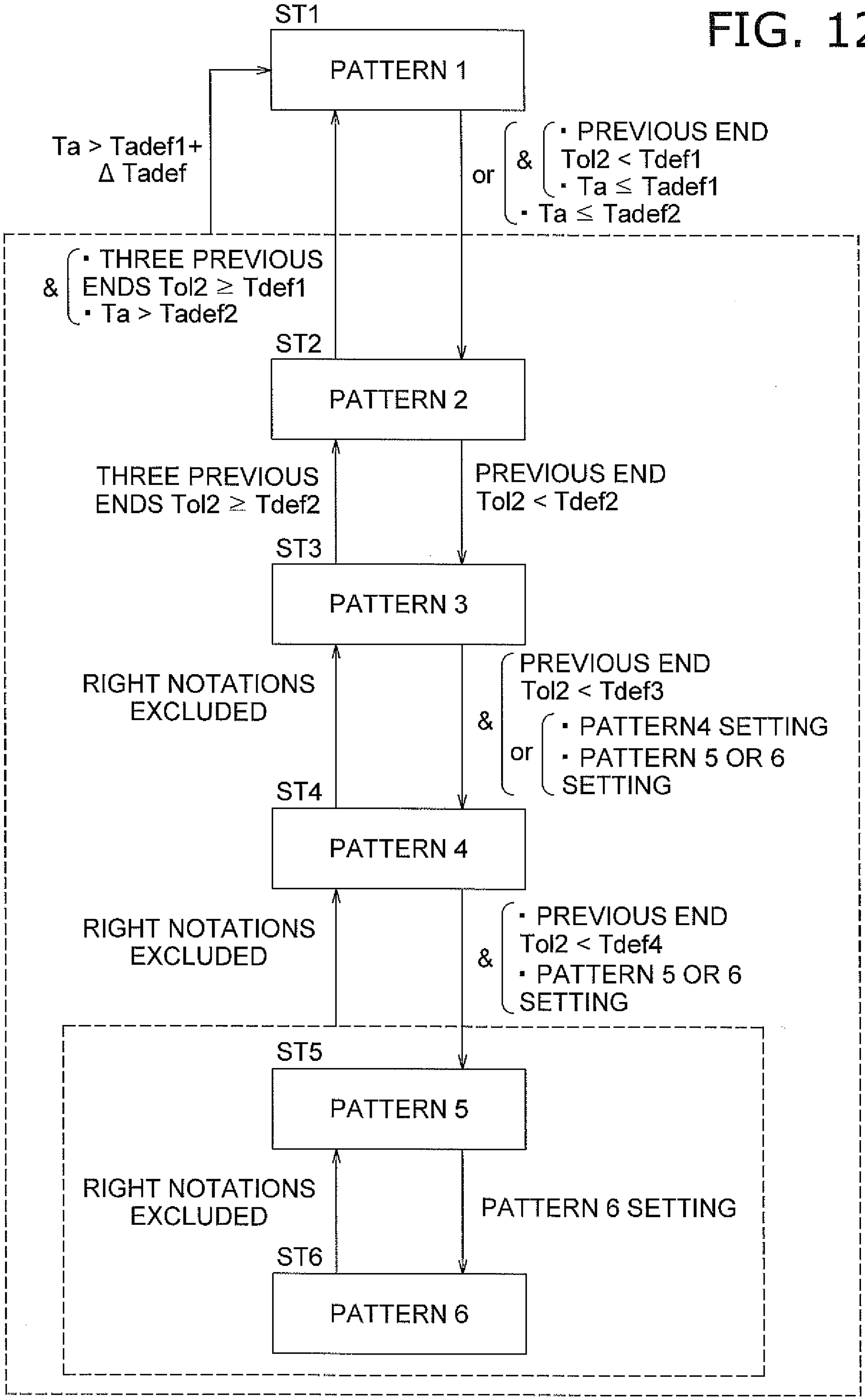
	INDOOR EXPANSION VALVES (AIR-WARMING CAPABILITY SUPPLIED)	STATE OF INDOOR HEAT EXCHANGERS	INDOOR FANS	INTERVAL TIME OF DEFROSTING OPERATION
PATTERN 1	OPEN (YES)	CONDENSERS	MINIMUM ROTATIONAL SPEED	NORMAL
PATTERN 2	OPEN SLIGHTLY (YES)	CONDENSERS	MINIMUM ROTATIONAL SPEED	SHORTENED
PATTERN 3	FULLY CLOSED (NO)	CONDENSERS	STOPPED	WITH EACH ENDING OF HEAT STORAGE OPERATION

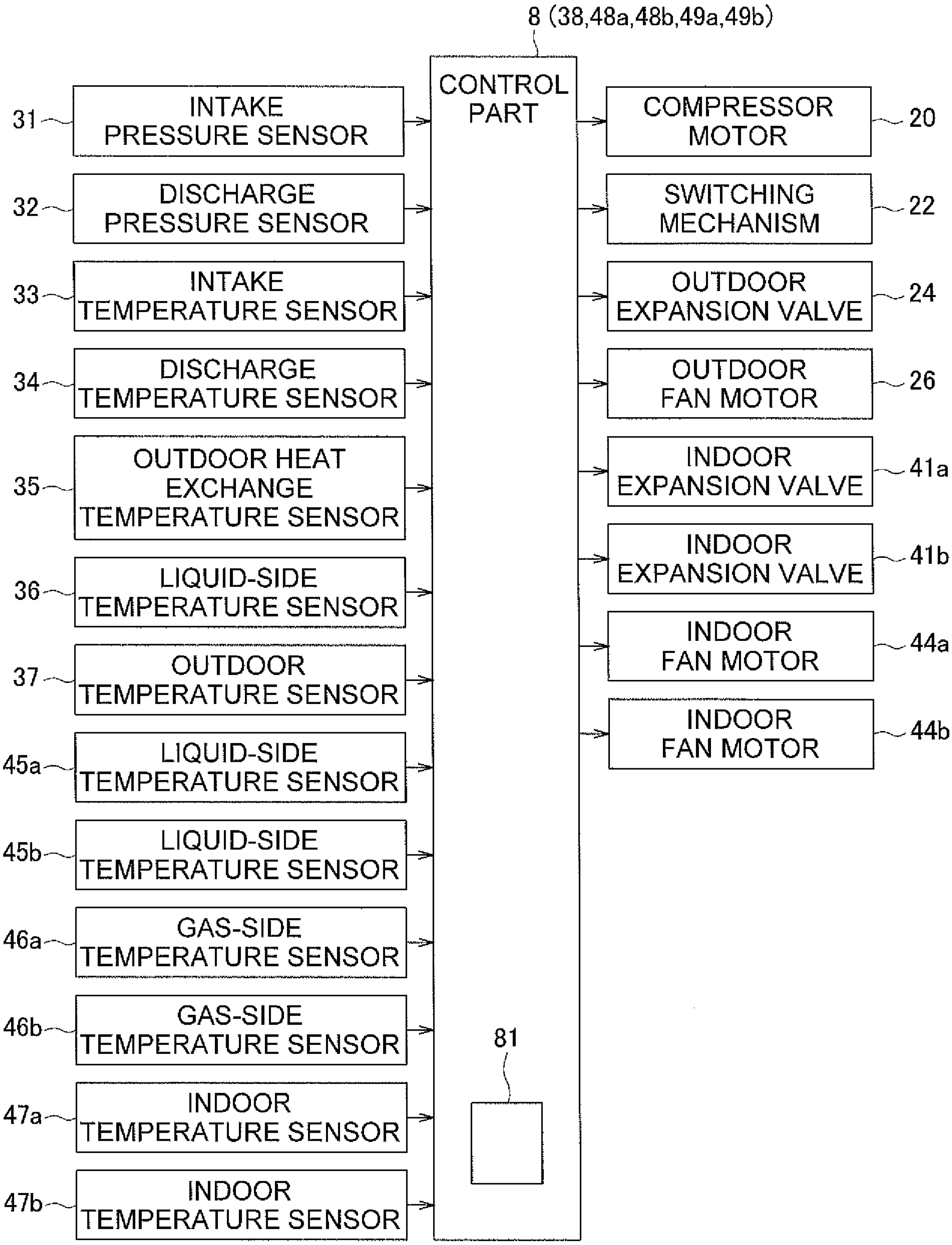
FIG. 10

	INDOOR EXPANSION VALVES (AIR-WARMING CAPABILITY SUPPLIED)	HEAT RECOVERY FROM INDOOR HEAT EXCHANGERS	STATE OF INDOOR HEAT EXCHANGERS	INDOOR FANS	INTERVAL TIME OF DEFROSTING OPERATION
PATTERN 1	OPEN (YES)	NO	CONDENSERS	MINIMUM ROTATIONAL SPEED	NORMAL
PATTERN 2	OPEN SLIGHTLY (YES)	NO	CONDENSERS	MINIMUM ROTATIONAL SPEED	SHORTENED
PATTERN 3	FULLY CLOSED (NO)	NO	CONDENSERS	STOPPED	WITH EACH ENDING OF HEAT STORAGE OPERATION
PATTERN 4	FULLY CLOSED (NO)	NO	EVAPORATORS	STOPPED	WITH EACH ENDING OF HEAT STORAGE OPERATION
PATTERN 5	OPEN (NO)	YES	EVAPORATORS	STOPPED	WITH EACH ENDING OF HEAT STORAGE OPERATION
PATTERN 6	OPEN (NO)	YES	EVAPORATORS	MINIMUM ROTATIONAL SPEED	WITH EACH ENDING OF HEAT STORAGE OPERATION

FIG. 11

FIG. 12


ST1
PATTERN 1
Ta > Tadef1+
Δ Tadef
or
&
・PREVIOUS END
Tol2 < Tdef1
・Ta ≤ Tadef1
・Ta ≤ Tadef2
&
・THREE PREVIOUS
ENDS Tol2 ≥ Tdef1
・Ta > Tadef2
ST2
PATTERN 2
THREE PREVIOUS
ENDS Tol2 ≥ Tdef2
PREVIOUS END
Tol2 < Tdef2
ST3
PATTERN 3
RIGHT NOTATIONS
EXCLUDED
&
PREVIOUS END
Tol2 < Tdef3
or
・PATTERN4 SETTING
・PATTERN 5 OR 6
SETTING
ST4
PATTERN 4
RIGHT NOTATIONS
EXCLUDED
&
・PREVIOUS END
Tol2 < Tdef4
・PATTERN 5 OR 6
SETTING
ST5
PATTERN 5
RIGHT NOTATIONS
EXCLUDED
PATTERN 6 SETTING
ST6
PATTERN 6


8 (38,48a,48b,49a,49b)
CONTROL PART
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46a GAS-SIDE TEMPERATURE SENSOR
46b GAS-SIDE TEMPERATURE SENSOR
47a INDOOR TEMPERATURE SENSOR
47b INDOOR TEMPERATURE SENSOR
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COMPRESSOR MOTOR 20
SWITCHING MECHANISM 22
OUTDOOR EXPANSION VALVE 24
OUTDOOR FAN MOTOR 26
INDOOR EXPANSION VALVE 41a
INDOOR EXPANSION VALVE 41b
INDOOR FAN MOTOR 44a
INDOOR FAN MOTOR 44b

FIG. 13

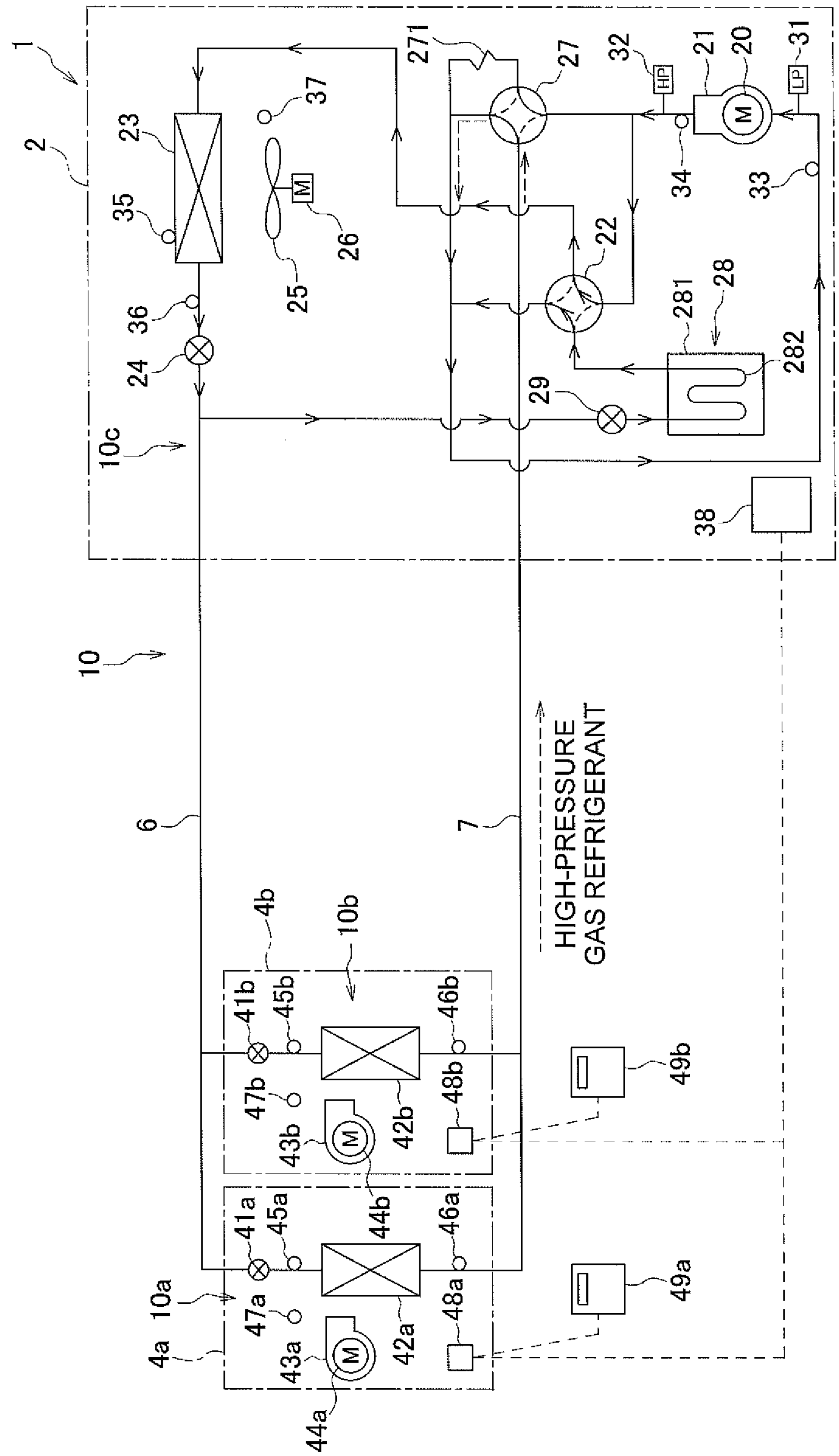
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FIG. 14

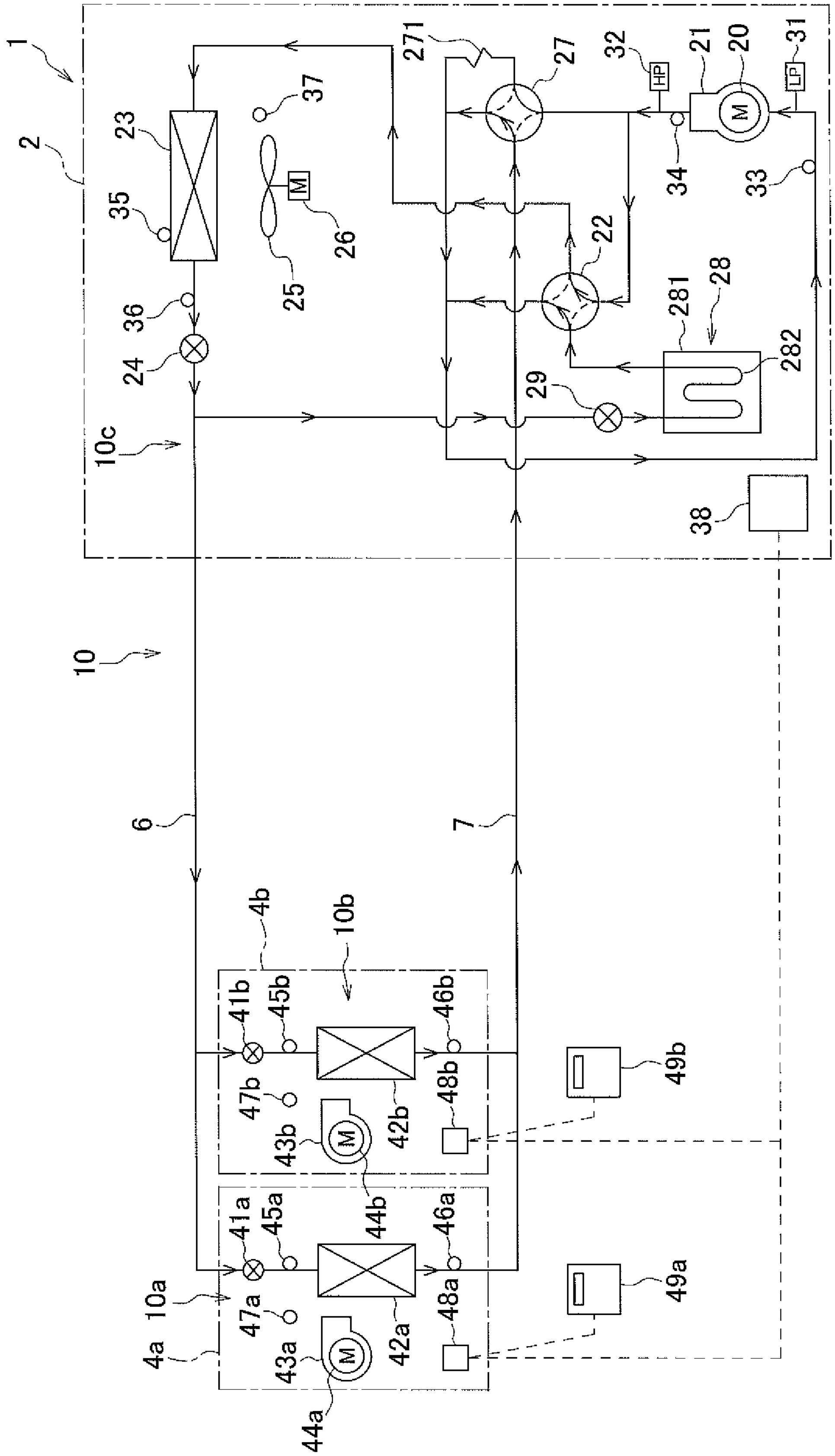

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FIG. 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/076940

A. CLASSIFICATION OF SUBJECT MATTER
F25B47/02(2006.01)i, *F25B13/00*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25B47/02, F25B13/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 4-270876 A (Matsushita Electric Industrial Co., Ltd.), 28 September 1992 (28.09.1992), paragraphs [0032] to [0036]; fig. 1 to 7 (Family: none)	1,2
Y	JP 2007-51805 A (Matsushita Electric Industrial Co., Ltd.), 01 March 2007 (01.03.2007), claims 2, 3; paragraphs [0019], [0040]; fig. 1 to 4 & CN 101382365 A & CN 101382366 A & CN 101382367 A	1,2

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 November, 2012 (15.11.12)	27 November, 2012 (27.11.12)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2012/076940

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 63-306377 A (Matsushita Electric Industrial Co., Ltd.), 14 December 1988 (14.12.1988), claim 1; page 3, lower left column, line 9 to lower right column, line 11 (Family: none)	1,2
A	JP 3-28673 A (Daikin Industries, Ltd.), 06 February 1991 (06.02.1991), claim 1; page 6, upper left column, line 20 to lower left column, line 2 (Family: none)	1-9
A	JP 2010-145020 A (Mitsubishi Electric Corp.), 01 July 2010 (01.07.2010), claim 4; paragraph [0033] (Family: none)	1-9

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Patent documents cited in the description

- JP 2005337657 A **[0002] [0124]**