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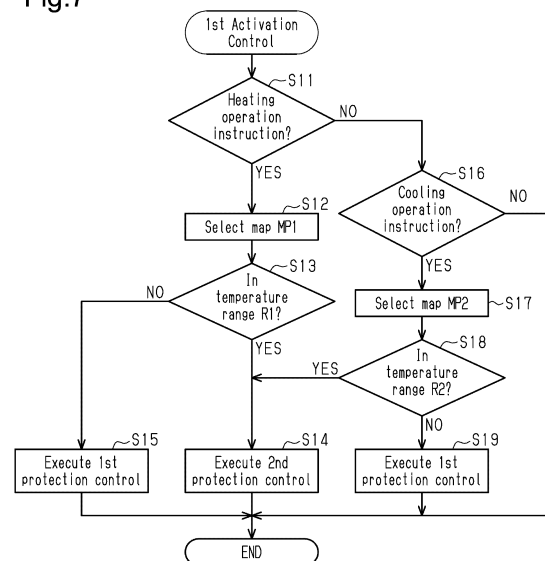
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(54) **AIR CONDITIONER**

(57) An air conditioner includes a compressor, the operation frequency of which is variable, and a controller for executing compressor protection control to raise the operation frequency of the compressor to a required operation frequency at the start of the cooling or heating operation. The compressor protection control includes a first protection control and a second protection control. In the first protection control, the operation frequency of the compressor is controlled such that the time period from the activation of the compressor to the time at which the operation frequency reaches the required operation frequency should become relatively long. In the second protection control, the operation frequency of the compressor is controlled such that the time period from the activation of the compressor to the time at which the operation frequency reaches the required operation frequency should be relatively short. The control unit executes the second protection control when the predetermined condition is satisfied at the time of executing the compressor protection control.

Fig.7



Description

TECHNICAL FIELD

[0001] The present disclosure relates to an air conditioner.

BACKGROUND ART

[0002] When starting a cooling or heating operation, a typical air conditioner performs an activation operation that lowers the operating frequency of a compressor for a predetermined time from when the compressor is activated in order to prevent backflow of liquid to the compressor (for example, refer to Patent Document 1).

PRIOR ART DOCUMENT

Patent Document

[0003] Patent Document 1: Japanese Laid-Open Patent Publication No. 6-341720

SUMMARY OF THE INVENTION

Problems that the Invention is to Solve

[0004] However, when starting the cooling or heating operation, the liquid backflow to the compressor does not always occur. More specifically, the probability of occurrence of the liquid backflow to the compressor may be low depending on the surrounding environment of the compressor at a time of starting the cooling or heating operation. When the activation operation that lowers the operating frequency of the compressor is performed even in such a case, the time from when the compressor is activated to when the room temperature reaches the set temperature extends. This hinders a quick startup of the cooling or heating operation.

[0005] It is an objective of the present disclosure to provide an air conditioner that starts up the cooling or heating operation quickly.

Means for Solving the Problems

[0006] To achieve the above objective, an air conditioner includes a compressor in which an operating frequency is changeable and a control unit that executes a compressor protection control. The compressor protection control increases the operating frequency of the compressor to a necessary operating frequency when starting a cooling operation or a heating operation. The compressor protection control includes a first protection control and a second protection control. The first protection control controls the operating frequency so that a time from when the compressor is activated to when the operating frequency reaches the necessary operating frequency is relatively long. The second protection control

controls the operating frequency so that the time from when the compressor is activated to when the operating frequency reaches the necessary operating frequency is relatively short. When executing the compressor protection control, if a predetermined condition is satisfied, the control unit executes the second protection control.

[0007] In this configuration, if the predetermined condition is satisfied when executing the compressor protection control, the second protection control is executed.

This shortens the time from when the compressor 11 is activated to when the operating frequency of the compressor 11 reaches the necessary operating frequency FN. As a result, the time from when the cooling or heating operation is started to when the room temperature DA reaches the set temperature is shortened, and the cooling or heating operation starts up quickly.

[0008] The predetermined condition refers to a condition that lowers the probability of occurrence of problems with the compressor caused by sudden increases in the operating frequency of the compressor when activated, such as a rise in the degree of dilution caused by a lowered surface of oil in the compressor or a returned refrigerant, backflow of liquid to the compressor, freezing of the outdoor heat exchanger and the indoor heat exchanger used as evaporators, and negative pressure of the suction side of the compressor.

[0009] Preferably, the control unit sets a first target frequency and a second target frequency in the compressor protection control. The second target frequency is greater than the first target frequency and is less than the necessary operating frequency. The control unit maintains the operating frequency at the first target frequency for a first period and at the second target frequency for a second period so that the operating frequency is increased in a stepped manner. The first target frequency of the second protection control is greater than the first target frequency of the first protection control. The second target frequency of the second protection control is greater than the second target frequency of the first protection control.

[0010] In this configuration, the second protection control shortens the time from when the compressor is activated to when the operating frequency of the compressor reaches the necessary operating frequency. Thus, the cooling or heating operation starts up quickly.

[0011] Preferably, the control unit sets a first target frequency and a second target frequency in the compressor protection control. The second target frequency is greater than the first target frequency and is less than the necessary operating frequency. The control unit maintains the operating frequency at the first target frequency for a first period and at the second target frequency for a second period so that the operating frequency is increased in a stepped manner. The first period of the second protection control is shorter than the first period of the first protection control. The second period of the second protection control is shorter than the second period of the second protection control.

[0012] In this configuration, the second protection control shortens the time from when the compressor is activated to when the operating frequency of the compressor reaches the necessary operating frequency. Thus, the cooling or heating operation starts up quickly.

[0013] Preferably, the predetermined condition in the heating operation differs from the predetermined condition in the cooling operation.

[0014] In this configuration, the second protection control is appropriately executed in the cooling or heating operation.

[0015] Preferably, the predetermined condition includes an indoor air temperature, an outdoor air temperature, and a temperature difference between the indoor air temperature and the outdoor air temperature.

[0016] Preferably, the predetermined condition in the heating operation is that the indoor air temperature is less than or equal to a room temperature threshold value, that the outdoor air temperature is greater than or equal to an outdoor temperature threshold value, and that the temperature difference between the indoor air temperature and the outdoor air temperature is less than or equal to a temperature difference threshold value.

[0017] In this configuration, the indoor air temperature and the outdoor air temperature, which are easily obtained information about the air conditioner, are used to set the condition that limits occurrence of problems with the compressor such as backflow of liquid to the compressor in the compressor protection control.

[0018] Preferably, the predetermined condition includes a temperature of a discharge pipe of the compressor and an outdoor air temperature.

[0019] In this configuration, the second protection control is more appropriately executed in the cooling or heating operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Fig. 1 is a conceptual diagram showing a first embodiment of an air conditioner.

Fig. 2 is a block diagram showing the electrical configuration of the air conditioner.

Fig. 3 is a graph showing changes in the operating frequency of a compressor in a compressor protection control.

Fig. 4 is a graph showing the relationship among a room temperature, an ambient temperature, a difference in temperature between the room temperature and the ambient temperature, and the probability of problems with the compressor.

Fig. 5 is a map used to select a first protection control and a second protection control in the heating operation.

Fig. 6 is a map used to select the first protection control and the second protection control in the cooling operation.

Fig. 7 is a flowchart showing the procedures of a first activation control executed by the air conditioner.

Fig. 8 is a flowchart showing the procedures of a second activation control executed by a second embodiment of an air conditioner.

Fig. 9 is a map showing the relationship between the ambient temperature and the temperature of a discharge pipe of a compressor in a modified example of an air conditioner.

MODES FOR CARRYING OUT THE INVENTION

First Embodiment

[0021] An air conditioner 1 will now be described with reference to the drawings.

[0022] As shown in Fig. 1, the air conditioner 1 includes a refrigerant circuit 40. The refrigerant circuit 40 includes a refrigerant pipe 30 that circulates a refrigerant between an outdoor unit 10 and an indoor unit 20. The air conditioner 1 of the present embodiment includes the refrigerant circuit 40 formed by connecting the refrigerant pipe 30 to the outdoor unit 10, which is installed outdoors, and the indoor unit 20, which is a wall-installation type and is installed on an indoor wall surface or the like.

[0023] The outdoor unit 10 includes, for example, a compressor 11 in which the operating frequency is changeable, a four-way switching valve 12, an outdoor heat exchanger 13, an expansion valve 14, an outdoor fan 15, and an outdoor controller 16. The outdoor fan 15 includes a motor 15a and an impeller 15b connected to the output shaft of the motor 15a. The motor 15a is a drive source having a changeable rotational speed. An example of the impeller 15b is a propeller fan.

[0024] The compressor 11 is, for example, a rocking piston compressor and includes, for example, a compression mechanism, a motor, and a crankshaft that transmits driving power of the motor to the compression mechanism (none shown). The compressor 11 includes an accumulator 11a that separates the refrigerant into gas and liquid. An example of the motor is a three-phase brushless motor. The expansion valve 14 is, for example, an electronic expansion valve. The outdoor fan 15 rotates the impeller 15b using the motor 15a to facilitate heat exchange between the outdoor air and the refrigerant flowing through a heat transfer tube of the outdoor heat exchanger 13. Thus, the outdoor fan 15 generates a flow of outdoor air that passes through the outdoor heat exchanger 13. The outdoor controller 16 is electrically connected to the motor of the compressor 11, the four-way switching valve 12, the expansion valve 14, and the motor 15a of the outdoor fan 15.

[0025] The indoor unit 20 includes, for example, an indoor heat exchanger 21, an indoor fan 22, and an indoor controller 23. The indoor fan 22 includes a motor 22a and an impeller (not shown) connected to the output shaft of the motor 22a. The motor 22a is a drive source having a changeable rotational speed. An example of the impeller

is a crossflow fan. The indoor fan 22 rotates the impeller using the motor 22a to facilitate heat exchange between the indoor air and the refrigerant flowing through a heat transfer tube of the indoor heat exchanger 21. Thus, the indoor fan 22 generates a flow of indoor air that passes through the indoor heat exchanger 21. The indoor controller 23 is electrically connected to the motor 22a of the indoor fan 22. The indoor controller 23 is, for example, configured to perform wireless communication with a remote controller 51 (refer to Fig. 2) of the air conditioner 1 using infrared light or the like. The indoor controller 23 is configured to perform wired communication with the outdoor controller 16 through a signal line. The indoor controller 23 controls the indoor unit 20, and the outdoor controller 16 controls the outdoor unit 10 based on an operating instruction of the remote controller 51.

[0026] The refrigerant circuit 40 is configured by connecting the compressor 11, the four-way switching valve 12, the outdoor heat exchanger 13, the expansion valve 14, and the indoor heat exchanger 21 with the refrigerant pipe 30 as a loop. The refrigerant circuit 40 is configured to execute a vapor compression refrigeration cycle that reversibly circulates the refrigerant by switching the four-way switching valve 12.

[0027] More specifically, when the four-way switching valve 12 is switched to a cooling mode connection state (illustrated with solid lines), the refrigerant circuit 40 forms a cooling cycle in which the refrigerant circulates in the order of the compressor 11, the four-way switching valve 12, the outdoor heat exchanger 13, the expansion valve 14, the indoor heat exchanger 21, the four-way switching valve 12, and the compressor 11. As a result, the air conditioner 1 performs the cooling operation in which the outdoor heat exchanger 13 acts as a condenser and the indoor heat exchanger 21 acts as an evaporator. When the four-way switching valve 12 is switched to a heating mode connection state (illustrated with broken lines), the refrigerant circuit 40 forms a heating cycle in which the refrigerant circulates in the order of the compressor 11, the four-way switching valve 12, the indoor heat exchanger 21, the expansion valve 14, the outdoor heat exchanger 13, the four-way switching valve 12, and the compressor 11. As a result, the air conditioner 1 performs the heating operation in which the indoor heat exchanger 21 acts as a condenser and the outdoor heat exchanger 13 acts as an evaporator.

[0028] As shown in Fig. 2, a control unit 50 that controls the air conditioner 1 includes the outdoor controller 16 and the indoor controller 23. Each of the outdoor controller 16 and the indoor controller 23 includes, for example, a storage device and an arithmetic processing device that executes a predetermined control program. The arithmetic processing device includes, for example, a central processing unit (CPU) or a micro processing unit (MPU). The storage unit stores various control programs and information used for various control processes. The storage device includes, for example, a nonvolatile memory and a volatile memory.

[0029] The control unit 50 is connected to the remote controller 51, an indoor temperature sensor 52, an outdoor temperature sensor 53, and a discharge pipe temperature sensor 54 so that communication is performed.

[0030] More specifically, the control unit 50 is configured to perform wireless communication with the remote controller 51 (refer to Fig. 3) using, for example, infrared light. More specifically, the remote controller 51 transmits signals of an operating instruction (instruction to perform cooling operation, heating operation, etc.) and a deactivating instruction to the control unit 50. The indoor temperature sensor 52, the outdoor temperature sensor 53, and the discharge pipe temperature sensor 54 are electrically connected to the control unit 50. The indoor temperature sensor 52 is used to measure the indoor air temperature (room temperature) and is disposed, for example, in the vicinity of an inlet of the indoor unit 20. The indoor temperature sensor 52 transmits a signal corresponding to the room temperature to the control unit 50. The outdoor temperature sensor 53 is used to measure the outdoor air temperature (outdoor temperature) and is disposed, for example, in the vicinity of an inlet of the outdoor unit 10. The outdoor temperature sensor 53 transmits a signal corresponding to the outdoor temperature to the control unit 50. The discharge pipe temperature sensor 54 is used to measure the temperature of a discharge pipe of the compressor 11, that is, the temperature of a discharged gas refrigerant discharged from the compressor 11. The discharge pipe temperature sensor 54 is attached to the discharge pipe of the compressor 11. The discharge pipe temperature sensor 54 transmits a signal corresponding to the temperature of the gas refrigerant discharged from the compressor 11 to the control unit 50. As described above, the control unit 50 receives various signals (operating instruction and measurement information) from the remote controller 51, the indoor temperature sensor 52, the outdoor temperature sensor 53, and the discharge pipe temperature sensor 54. The control unit 50 obtains the room temperature (hereafter, referred to as "room temperature DA") based on measurement information of the indoor temperature sensor 52, obtains the outdoor temperature (hereafter, referred to as "ambient temperature DOA") based on measurement information of the outdoor temperature sensor 53, and obtains a temperature DF of the discharge pipe of the compressor 11 (temperature of discharged gas refrigerant) based on measurement information of the discharge pipe temperature sensor 54.

[0031] Since the indoor controller 23 is electrically connected to the outdoor controller 16, the operating instruction and the room temperature DA, which are received by the indoor controller 23, may be transmitted to the outdoor controller 16. Also, the ambient temperature DOA and the temperature DF of the discharge pipe of the compressor 11, which are received by the outdoor controller 16, may be transmitted to the indoor controller 23.

[0032] The indoor controller 23 controls the rotational

speed of the motor 22a of the indoor fan 22 based on an operating instruction of the remote controller 51 and measurement information.

[0033] The outdoor controller 16 controls the operating frequency of the compressor 11, the switching of the four-way switching valve 12 between the cooling mode connection state and the heating mode connection state, the opening degree of the expansion valve 14, and the rotational speed of the motor 15a of the outdoor fan 15 based on an operating instruction of the remote controller 51 and measurement information.

[0034] The control unit 50 executes the cooling operation and the heating operation through the indoor controller 23 and the outdoor controller 16 based on an operating instruction of the remote controller 51 and measurement information. In the cooling operation and the heating operation, the control unit 50 controls the compressor 11, the expansion valve 14, the outdoor fan 15, and the indoor fan 22 so that the indoor temperature reaches the temperature set by the remote controller 51.

[0035] In the cooling operation and the heating operation, the control unit 50 sets an increase rate at which the operating frequency of the compressor 11 is increased and a decrease rate at which the operating frequency is decreased so that the increase rate is equal to the decrease rate. An example of the increase rate and the decrease rate, which are change rates of the operating frequency of the compressor 11 in the cooling operation and the heating operation, is 2 Hz per second.

[0036] In addition, when activating the compressor 11 to start the cooling or heating operation, the control unit 50 increases the low operating frequency of the compressor 11 to an operating frequency necessary for the cooling or heating operation (hereafter, referred to as "necessary operating frequency FN"). In this case, the control unit 50 executes a compressor protection control when activating the compressor 11. In the compressor protection control, in order to prevent problems with the compressor 11, the operating frequency of the compressor 11 is low at the beginning and is increased in a stepped manner as time elapses to the necessary operating frequency FN, at which the compressor 11 stably operates. Examples of problems with the compressor 11 caused by sudden increases in the operating frequency of the compressor 11 when activated include a rise in the degree of dilution caused by a lowered surface of oil in the compressor 11 or a returned refrigerant, backflow of liquid to the compressor 11, freezing of the outdoor heat exchanger 13 and the indoor heat exchanger 21 used as evaporators, and negative pressure of the suction side of the compressor 11.

[0037] Graph GX indicated by the broken line in Fig. 3 is a schematic graph showing a typical compressor protection control.

[0038] As indicated by graph GX in Fig. 3, in the compressor protection control, the operating frequency of the compressor 11 is changed so that the operating frequency is maintained at multistage target frequencies for a

predetermined time before reaching the necessary operating frequency FN. More specifically, in the compressor protection control, the control unit 50 stores a first target frequency FX1, a second target frequency FX2 that is greater than the first target frequency FX1, a third target frequency FX3 that is greater than the second target frequency FX2, and a fourth target frequency FX4 that is greater than the third target frequency FX3. At time t1, the control unit 50 drives the compressor 11 so that the operating frequency of the compressor 11 reaches the first target frequency FX1. From time t1 to time t3, the control unit 50 drives the compressor 11 so that the operating frequency of the compressor 11 is maintained at the first target frequency FX1. At time t3, the control unit 50 drives the compressor 11 so that the operating frequency of the compressor 11 changes from the first target frequency FX1 to the second target frequency FX2. From time t3 to time t5, the control unit 50 drives the compressor 11 so that the operating frequency of the compressor 11 is maintained at the second target frequency FX2. At time t5, the control unit 50 drives the compressor 11 so that the operating frequency of the compressor 11 changes from the second target frequency FX2 to the third target frequency FX3. From time t5 to time t6, the control unit 50 drives the compressor 11 so that the operating frequency of the compressor 11 is maintained at the third target frequency FX3. At time t6, the control unit 50 drives the compressor 11 so that the operating frequency of the compressor 11 changes from the third target frequency FX3 to the fourth target frequency FX4. From time t6 to time t7, the control unit 50 drives the compressor 11 so that the operating frequency of the compressor 11 is maintained at the fourth target frequency FX4. At time t7, the control unit 50 drives the compressor so that the operating frequency of the compressor 11 changes from the fourth target frequency FX4 to the necessary operating frequency FN.

[0039] In graph GX shown in Fig. 3, the difference (FX2-FX1) between the second target frequency FX2 and the first target frequency FX1, the difference (FX3-FX2) between the third target frequency FX3 and the second target frequency FX2, and the difference (FX4-FX3) between the fourth target frequency FX4 and the third target frequency FX3 are equal to each other. In addition, a first period TX1 during which the operating frequency of the compressor 11 is maintained at the first target frequency FX1, a second period TX2 during which the second target frequency FX2 is maintained, and a third period TX3 during which the third target frequency FX3 is maintained, and a fourth period TX4 during which the fourth target frequency FX4 is maintained are equal to each other.

[0040] When starting the cooling or heating operation, if the compressor protection control is executed, problems with the compressor 11 are avoided. However, since the operating frequency of the compressor 11 is gradually increased as indicated by graph GX shown in Fig. 3, the time from when the user issues an instruction

to perform the cooling or heating operation using the remote controller 51 to when the indoor air temperature reaches the set temperature extends. That is, when starting the cooling or heating operation, the startup of the cooling or heating operation is impeded. As a result, the cooling performance or the heating performance is lowered when starting the cooling or heating operation.

[0041] The probability of occurrence of problems with the compressor 11 may be low depending on the surrounding environment (outdoor air temperature and indoor air temperature) of the compressor 11. When the probability of occurrence of problems with the compressor 11 is low, if the compressor protection control indicated by graph GX shown in Fig. 3 is executed, the compressor 11 is operated with a low cooling performance or a low heating performance even though problems with the compressor 11 is not likely to occur.

[0042] In this regard, in the present embodiment, the control unit 50 executes a first activation control that changes the mode of the compressor protection control based on whether the probability of occurrence of problems with the compressor 11 is high or low. More specifically, when the probability of occurrence of problems with the compressor 11 is high, the control unit 50 executes a first protection control, that is, the compressor protection control indicated by graph GX shown in Fig. 3. When the probability of occurrence of problems with the compressor 11 is low, the control unit 50 executes a second protection control. The second protection control increases the operating frequency of the compressor 11 to the necessary operating frequency FN more quickly than the compressor protection control (first protection control) indicated by graph GX shown in Fig. 3.

[0043] The second protection control will now be described in detail.

[0044] The second protection control has a first target frequency FA1 and a second target frequency FA2. That is, the number of target frequencies of the second protection control is less than the number of target frequencies of the first protection control. The first target frequency FA1 is greater than the first target frequency FX1 of the first protection control. In the present embodiment, the first target frequency FA1 is equal to the second target frequency FX2 of graph GX. The second target frequency FA2 is greater than the second target frequency FX2 of the first protection control. In the present embodiment, the second target frequency FA2 is greater than the fourth target frequency FX4 of graph GX and is less than the necessary operating frequency FN. The first target frequency FA1 is equal to the difference (FA2-FA1) between the second target frequency FA2 and the first target frequency FA1. The difference (FA2-FA1) between the second target frequency FA2 and the first target frequency FA1 is greater than the difference (FN-FA2) between the necessary operating frequency FN and the second target frequency FA2. A first period TA1 during which the operating frequency of the compressor 11 is maintained at the first target frequency FA1 is equal to a second period

TA2 during which the operating frequency of the compressor 11 is maintained at the second target frequency FA2.

[0045] In the second protection control, after controlling the operating frequency of the compressor 11 to reach the first target frequency FA1, the control unit 50 controls the operating frequency of the compressor 11 to be maintained at the first target frequency FA1 for a predetermined time. Subsequently, the control unit 50 controls the operating frequency of the compressor 11 to change from the first target frequency FA1 to the second target frequency FA2. After controlling the operating frequency of the compressor 11 to be maintained at the second target frequency FA2 for a predetermined time, the control unit 50 controls the operating frequency of the compressor 11 to change from the second target frequency FA2 to the necessary operating frequency FN. The first period TA1, in which the operating frequency of the compressor 11 is controlled to be maintained at the first target frequency FA1 in the second protection control, is shorter than the first period TX1, in which the operating frequency of the compressor 11 is controlled to be maintained at the first target frequency FX1 in the first protection control. Also, the second period TA2, in which the operating frequency of the compressor 11 is controlled to be maintained at the second target frequency FA2, is shorter than the second period TX2, in which the operating frequency of the compressor 11 is controlled to be maintained at the second target frequency FX2 in the first protection control.

[0046] Graph GA shown in Fig. 3 shows changes in the operating frequency of the compressor 11 in the second protection control. As indicated by graph GA, at time t1, the control unit 50 drives the compressor 11 so that the operating frequency of the compressor 11 reaches the first target frequency FA1. From time t1 to time t2 (during the period TA1), the control unit 50 drives the compressor 11 so that the operating frequency of the compressor 11 is maintained at the first target frequency FA1. At time t2, the control unit 50 drives the compressor 11 so that the operating frequency of the compressor 11 changes from the first target frequency FA1 to the second target frequency FA2. From time t2 to time t4 (during the period TA2), the control unit 50 drives the compressor 11 so that the operating frequency of the compressor 11 is maintained at the second target frequency FA2. At time t4, the control unit 50 drives the compressor 11 so that the operating frequency of the compressor 11 changes from the second target frequency FA2 to the necessary operating frequency FN. As described above, a period TA (from time t1 to time t4) from when the compressor 11 is activated to when the operating frequency of the compressor 11 reaches the necessary operating frequency FN in the second protection control is shorter than a period TX (from time t1 to time t8) from when the compressor 11 is activated to when the operating frequency of the compressor 11 reaches the necessary operating frequency FN in the first protection control.

[0047] The probability of occurrence of problems with the compressor 11 will now be described.

[0048] The probability of occurrence of problems with the compressor 11 may be estimated using the indoor air temperature (room temperature) and the outdoor air temperature (outdoor temperature). More specifically, the probability of occurrence of problems with the compressor 11 may be estimated based on the room temperature DA, the ambient temperature DOA, and the difference in temperature between the room temperature DA and the ambient temperature DOA. A temperature condition under which the probability of occurrence of problems with the compressor 11 is low when starting the heating operation, and a temperature condition under which the probability of occurrence of problems with the compressor 11 is low when starting the cooling operation are found through tests conducted by the inventors of the present application.

[0049] When starting the heating operation, if the room temperature DA is high, the need for quickly increasing the room temperature DA is low, that is, the need for increasing the heating performance is low. When starting the cooling operation, if the room temperature DA is low, the need for quickly decreasing the room temperature DA is low, that is, the need for increasing the cooling performance is low. As described above, when the need for increasing the heating performance or the cooling performance is low, the first protection control is executed as the compressor protection control, so that problems with the compressor 11 are more assuredly avoided.

[0050] Fig. 4 is an example of results of tests conducted by the inventors of the present application to determine whether problems with the compressor 11 occur when the second protection control of the compressor protection control is executed at the time of starting the heating operation, with changes in the room temperature DA, the ambient temperature DOA, and the difference in temperature between the room temperature DA and the ambient temperature DOA. In Fig. 4, the vertical axis indicates the room temperature DA, and the horizontal axis indicates the ambient temperature DOA. In this temperature map, diagonal lines indicate indoor-outdoor temperature differences, that is, differences (DA-DOA) in temperature between the room temperature DA and the ambient temperature DOA. In the temperature map shown in Fig. 4, the shaded section indicates an example of a temperature region (hereafter, referred to as "temperature region RL") in which when starting the heating operation, the probability of occurrence of problems with the compressor 11 is low and the need for increasing the heating performance is high. The temperature region RL is surrounded by conditions of the room temperature DA being less than or equal to 20°C, the ambient temperature DOA being greater than or equal to 0°C, and the indoor-outdoor temperature difference being less than or equal to X5. An example of the indoor-outdoor temperature difference X5 is 10°C. More specifically, when the ambient temperature DOA is greater than or equal to 0°C and the

indoor-outdoor temperature difference is less than or equal to 10°C, if the second protection control of the compressor protection control is executed at the time of starting the heating operation, the probability of occurrence of problems with the compressor 11 is low. In other words, when the ambient temperature DOA is less than 0°C or the indoor-outdoor temperature difference is greater than 10°C, if the second protection control of the compressor protection control is executed at the time of starting the heating operation, the probability of occurrence of problems with the compressor 11 is high. When the room temperature DA is greater than 20°C and the indoor-outdoor temperature difference is less than or equal to 10°C, if the second protection control of the compressor protection control is executed at the time of starting the heating operation, the probability of occurrence of problems with the compressor 11 is low. However, the heating performance does not need to be increased.

[0051] Although not shown in the drawings, in the same manner as the heating operation, for the cooling operation, the inventors of the present application conducted tests to determine whether problems with the compressor 11 occur when the second protection control of the compressor protection control is executed at the time of starting the cooling operation, with changes in the room temperature DA, the ambient temperature DOA, and the difference in temperature between the room temperature DA and the ambient temperature DOA. Temperature conditions under which when starting the cooling or heating operation, the probability of occurrence of problems with the compressor 11 is low, and the need for increasing the cooling or heating performance is high are determined based on these tests and described below. Such temperature conditions of the cooling or heating operation are stored in the control unit 50, for example, as a map MP1 shown in Fig. 5 for the heating operation and a map MP2 shown in Fig. 6 for the cooling operation.

[0052] [Heating Operation] (a1) The room temperature DA is less than or equal to a first determination temperature DAX1 (room temperature threshold value) ($DA \leq DAX1$). (a2) The ambient temperature DOA is in a first temperature range ($DOAL1 \leq DOA \leq DOAH1$). Here, DOAL1 denotes the lower limit value of the first temperature range, and DOAH1 denotes the upper limit value of the first temperature range. (a3) The difference in temperature between the room temperature DA and the ambient temperature DOA is less than or equal to a first determination temperature difference DDX1 (temperature difference threshold value) ($DA - DOA \leq DDX1$).

[0053] The first determination temperature DAX1 is a determination value of the room temperature that determines whether the heating performance needs to be increased. An example of the first determination temperature DAX1 is 13°C. The lower limit value DOAL1 of the first temperature range is a determination value of the ambient temperature that determines whether the probability of occurrence of problems with the compressor 11 is low when starting the heating operation. An example

of the lower limit value DOAL1 is 0°C. The upper limit value DOAH1 of the first temperature range is a determination value of the ambient temperature that determines whether the heating performance needs to be increased. An example of the upper limit value DOAH1 is 24°C. The first determination temperature difference DDX1 is a determination value of the indoor-outdoor temperature difference that determines whether the probability of occurrence of problems with the compressor 11 is low when starting the heating operation. An example of the first determination temperature difference DDX1 is 10°C.

[0054] [Cooling Operation] (b1) The room temperature DA is greater than or equal to a second determination temperature DAX2 (room temperature threshold value) ($DA \geq DAX2$). (b2) The ambient temperature DOA is in a second temperature range ($DOAL2 \leq DOA \leq DOAH2$). Here, DOAL2 denotes the lower limit value of the second temperature range, and DOAH2 denotes the upper limit value of the second temperature range. (b3) The difference in temperature between the room temperature DA and the ambient temperature DOA is less than or equal to a second determination temperature difference DDX2 (temperature difference threshold value) ($DA - DOA \leq DDX2$).

[0055] The second determination temperature DAX2 is a determination value of the room temperature that determines whether the cooling performance needs to be increased. An example of the second determination temperature DAX2 is 25°C. The lower limit value DOAL2 of the second temperature range is a determination value of the ambient temperature that determines whether the cooling performance needs to be increased. An example of the lower limit value DOAL2 is 25°C. The upper limit value DOAH2 of the second temperature range is a determination value of the ambient temperature that determines whether the probability of occurrence of problems with the compressor 11 is low when starting the cooling operation. An example of the upper limit value DOAH2 is 45°C. The second determination temperature difference DDX2 is a determination value of the indoor-outdoor temperature difference that determines whether the probability of occurrence of problems with the compressor 11 is low when starting the cooling operation. An example of the second determination temperature difference DDX2 is -10°C.

[0056] The control unit 50 uses the map MP1 to select the first protection control and the second protection control when starting the heating operation based on the temperature conditions a1, a2, and a3 of the heating operation. The control unit 50 uses the map MP2 to select the first protection control and the second protection control when starting the cooling operation based on the temperature conditions b1, b2, and b3 of the cooling operation.

[0057] In the map MP1, the vertical axis indicates the room temperature DA, and the horizontal axis indicates the ambient temperature DOA. In the map MP1, the di-

agonal line indicates a boundary condition of the indoor-outdoor temperature difference. In the map MP1, the shading indicates a temperature region R1 in which all of the temperature conditions a1, a2, and a3 are satisfied. More specifically, the second protection control is selected in the temperature region R1, and the first protection control is selected in a region excluding the temperature region R1.

[0058] The temperature region R1 of the map MP1 may be the same as the temperature region RL shown in Fig. 4. More specifically, in the temperature conditions a1, a2, and a3 of the heating operation, the first determination temperature DAX1 may be 20°C, the lower limit value DOAL1 of the first temperature range may be 0°C, the upper limit value DOAH1 may be 30°C, and the first determination temperature difference DDX1 may be 10°C.

[0059] In the map MP2, the vertical axis indicates the room temperature DA, and the horizontal axis indicates the ambient temperature DOA. In the map MP2, the diagonal line indicates a boundary condition of the indoor-outdoor temperature difference. In the map MP2, the shading indicates a temperature region R2 in which all of the temperature conditions b1, b2, and b3 are satisfied. More specifically, the second protection control is selected in the temperature region R2, and the first protection control is selected in a region excluding the temperature region R2.

[0060] In the first activation control, the control unit 50 uses the map MP1 to select one of the first protection control and the second protection control when starting the heating operation, and uses the map MP2 to select one of the first protection control and the second protection control when starting the cooling operation.

[0061] The procedures of the first activation control will now be described with reference to Fig. 7.

[0062] In step S11, the control unit 50 determines whether the heating operation is instructed to be performed. The determination of step S11 is made, for example, based on whether the control unit 50 receives an instruction to perform the heating operation from the remote controller 51. When determining in step S11 that the heating operation is instructed to be performed (step S11: YES), the control unit 50 selects the map MP1 in step S12. In step S13, the control unit 50 determines whether the coordinates specified by the room temperature DA and the ambient temperature DOA are in the range of the temperature region R1 in the map MP1. When determining that the coordinates specified by the room temperature DA and the ambient temperature DOA are in the range of the temperature region R1 (step S13: YES), that is, when determining that all of the temperature conditions a1 to a3 are satisfied, the control unit 50 selects the second protection control in step S14. When determining that the coordinates specified by the room temperature DA and the ambient temperature DOA are outside the range of the temperature region R1 (step S13: NO), that is, when determining that at least one of the temperature conditions a1 to a3 is not satisfied, the con-

trol unit 50 selects the first protection control in step S15.

[0063] When determining in step S11 that the heating operation is not instructed to be performed (step S11: NO), the control unit 50 determines in step S16 whether the cooling operation is instructed to be performed. The determination of step S16 is made, for example, based on whether the control unit 50 receives an instruction to perform the cooling operation from the remote controller 51. When determining in step S16 that the cooling operation is instructed to be performed (step S16: YES), the control unit 50 selects the map MP2 in step S17. In step S18, the control unit 50 determines whether the coordinates specified by the room temperature DA and the ambient temperature DOA are in the range of the temperature region R2 in the map MP2. When determining that the coordinates specified by the room temperature DA and the ambient temperature DOA are in the range of the temperature region R2 (step S18: YES), that is, when determining that all of the temperature conditions b1 to b3 are satisfied, the control unit 50 proceeds to step S14. That is, the control unit 50 selects the second protection control. When determining that the coordinates specified by the room temperature DA and the ambient temperature DOA are outside the range of the temperature region R2 (step S18: NO), that is, when determining that at least one of the temperature conditions b1 to b3 is not satisfied, the control unit 50 selects the first protection control in step S19.

[0064] When determining in step S16 that the cooling operation is not instructed to be performed, the control unit 50 terminates the first activation control. In this case, a dehumidifying operation is an example of an operation other than the heating operation and the cooling operation.

[0065] The present embodiment has the following advantages.

(1-1) When performing the cooling or heating operation, the control unit 50 uses the map MP1 or the map MP2 to execute one of the first protection control and the second protection control. The time from when the compressor 11 is activated to when the operating frequency of the compressor 11 reaches the necessary operating frequency FN in the second protection control is shorter than the time from when the compressor 11 is activated to when the operating frequency of the compressor 11 reaches the necessary operating frequency FN in the first protection control. In this configuration, the second protection control is executed to shorten the time from when the compressor 11 is activated to when the operating frequency of the compressor 11 reaches the necessary operating frequency FN. Thus, the cooling or heating operation starts up quickly. As a result, the time from when the cooling or heating operation is started to when the room temperature DA reaches the set temperature is shortened, thereby increasing the heating performance or the cooling performance.

(1-2) The first target frequency FA1 in the second protection control is greater than the first target frequency FX1 in the first protection control. The second target frequency FA2 in the second protection control is greater than the second target frequency FX2 in the first protection control. In this configuration, the number of target frequencies that are set in the second protection control from when the compressor 11 is activated to when the operating frequency of the compressor 11 reaches the necessary operating frequency FN is less than the number of target frequencies that are set in the first protection control from when the compressor 11 is activated to when the operating frequency of the compressor 11 reaches the necessary operating frequency FN. The second protection control shortens the time from when the compressor 11 is activated to when the operating frequency of the compressor 11 reaches the necessary operating frequency FN. This allows for a quick startup of the cooling or heating operation.

(1-3) The first period TA1, in which the operating frequency of the compressor 11 is controlled to be maintained at the first target frequency FA1 in the second protection control, is shorter than the first period TX1, in which the operating frequency of the compressor 11 is controlled to be maintained at the first target frequency FX1 in the first protection control. The second period TA2, in which the operating frequency of the compressor 11 is controlled to be maintained at the second target frequency FA2 in the second protection control, is shorter than the second period TX2, in which the operating frequency of the compressor 11 is controlled to be maintained at the second target frequency FX2 in the first protection control. In this configuration, the number of target frequencies that are set in the second protection control from when the compressor 11 is activated to when the operating frequency of the compressor 11 reaches the necessary operating frequency FN is less than the number of target frequencies that are set in the first protection control from when the compressor 11 is activated to when the operating frequency of the compressor 11 reaches the necessary operating frequency FN. The second protection control shortens the time from when the compressor 11 is activated to when the operating frequency of the compressor 11 reaches the necessary operating frequency FN. This allows for a quick startup of the cooling or heating operation.

(1-4) The control unit 50 uses the map MP1 in the cooling operation to select one of the first protection control and the second protection control and uses the map MP2 in the heating operation to select one of the first protection control and the second protection control. As described above, the condition for executing the second protection control in the cooling operation differs from the condition for executing the second protection control in the heating operation.

tion. That is, the conditions are separately set for the cooling operation and the heating operation. This allows the control unit 50 to appropriately execute the second protection control in the cooling operation or the heating operation.

(1-5) In the map MP1 and the map MP2, the conditions for executing the second protection control are specified based on the room temperature DA, the ambient temperature DOA, and the indoor-outdoor temperature difference. As described above, the indoor temperature sensor 52 and the outdoor temperature sensor 53, which are normally included in the air conditioner 1, are used to set the conditions for executing the second protection control. The use of the room temperature DA and the ambient temperature DOA, which are easily obtained information about the air conditioner 1, eliminates the need for a dedicated sensor that sets the conditions for executing the second protection control. This limits increases in the cost of the air conditioner 1.

Second Embodiment

[0066] A second embodiment of an air conditioner 1 will now be described with reference to Figs. 1 and 8. The air conditioner 1 of the present embodiment differs from the air conditioner 1 of the first embodiment in the first activation control. In the following description, components of the air conditioner 1 refer to the components of the air conditioner 1 shown in Fig. 1.

[0067] When the operation of the air conditioner 1 is stopped, the refrigerant may condense and accumulate at a side corresponding to the lower one of the indoor air temperature and the outdoor air temperature. When the outdoor air temperature is lower than the indoor air temperature, a stagnation phenomenon is generated, that is, the liquid refrigerant dissolves and accumulates in the lubricant oil of the compressor 11 or the liquid refrigerant accumulates in the outdoor heat exchanger 13. When the stagnation phenomenon is generated and the compressor 11 is activated in the heating operation, if the increase rate of the operating frequency of the compressor 11 is increased, generation of oil foaming in the compressor 11 is facilitated. This causes a failure of the compressor 11. Also, when the stagnation phenomenon is generated and the compressor 11 is activated in the cooling operation, if the increase rate of the operating frequency of the compressor 11 is increased, generation of oil foaming in the compressor 11 is facilitated in the same manner as in the heating operation.

[0068] In this regard, the control unit 50 executes a refrigerant discharge activation operation to avoid a failure of the compressor 11 caused by the stagnation phenomenon when starting the cooling or heating operation. In the refrigerant discharge activation operation that is performed when starting the heating operation, when activating the compressor 11 in accordance with the start of the heating operation, the control unit 50 operates the

compressor 11 with the four-way switching valve 12 switched to the reverse cycle (cooling mode connection state) for a predetermined time (e.g., one minute). This allows the liquid refrigerant accumulated in the outdoor heat exchanger 13 to flow to the indoor heat exchanger 21. In the refrigerant discharge activation operation, the liquid refrigerant in the indoor heat exchanger 21 is evaporated by the indoor heat exchanger 21 and becomes gas refrigerant. The gas refrigerant is drawn into the compressor 11. This limits generation of oil foaming in the compressor 11. Also, in the refrigerant discharge activation operation that is performed when starting the cooling operation, when activating the compressor 11 in accordance with the start of the cooling operation, the control unit 50 operates the compressor 11 with the four-way switching valve 12 switched to the reverse cycle (heating mode connection state) for a predetermined time (e.g., one minute). This allows the liquid refrigerant accumulated in the indoor heat exchanger 21 to flow to the outdoor heat exchanger 13. In the refrigerant discharge activation operation, the liquid refrigerant in the outdoor heat exchanger 13 is evaporated by the outdoor heat exchanger 13 and becomes gas refrigerant. The gas refrigerant is drawn into the compressor 11. This limits generation of oil foaming in the compressor 11. As described above, when the refrigerant discharge activation operation is performed at a start of the cooling or heating operation, the probability of occurrence of problems with the compressor 11 is lowered.

[0069] In this regard, in the present embodiment, when the refrigerant discharge activation operation is performed, the control unit 50 executes a second activation control that selects the second protection control after the refrigerant discharge activation operation. The procedures of the second activation control will now be described with reference to Fig. 8.

[0070] In step S21, the control unit 50 determines whether the refrigerant discharge activation operation is performed. When determining in step S21 that the refrigerant discharge activation operation is performed (step S21: YES), the control unit 50 determines in step S22 whether the refrigerant discharge activation operation is completed. When determining in step S22 that the refrigerant discharge activation operation is completed (step S22: YES), the control unit 50 selects the second protection control in step S23. When determining in step S22 that the refrigerant discharge activation operation is not completed (step S22: NO), the control unit 50 again proceeds to the determination of step S22.

[0071] When determining in step S21 that the refrigerant discharge activation operation is not performed (step S21: NO), the control unit 50 proceeds to the first activation control in step S24. The control unit 50 selects one of the first protection control and the second protection control based on the first activation control.

[0072] The present embodiment has the following advantages.

(2-1) When the refrigerant discharge activation operation

is performed, the control unit 50 executes the second protection control. When the refrigerant discharge activation operation has been completed, the probability of occurrence of problems with the compressor 11 is lowered. Execution of the second protection control after the refrigerant discharge activation operation allows the operating frequency of the compressor 11 to reach the necessary operating frequency FN quickly after the refrigerant discharge activation operation. Thus, the cooling or heating operation starts up quickly.

Modified Examples

[0073] The description related to the above embodiments exemplifies, without any intention to limit, applicable forms of an air conditioner according to the present disclosure. In addition to the embodiments described above, the air conditioner according to present disclosure is applicable to, for example, modified examples of the above embodiment that are described below and combinations of at least two of the modified examples that do not contradict each other.

[0074] In the embodiments, the control executed on the compressor 11 to increase the operating frequency of the compressor 11 to the necessary operating frequency FN in the second protection control may be changed in any manner. More specifically, the control may be changed in any manner on condition that the time for the operating frequency of the compressor 11 to reach the necessary operating frequency FN in the second protection control is shorter than the time for the operating frequency of the compressor 11 to reach the necessary operating frequency FN in the first protection control. The second protection control may be changed, for example, as described below in (A) to (F). (A) The first target frequency FA1 and the second target frequency FA2 may be changed in any manner. For example, the first target frequency FA1 and the second target frequency FX2 may have different values. In an example, the value of the first target frequency FA1 may be greater than the value of the second target frequency FX2 and less than the value of the third target frequency FX3. In another example, the second target frequency FA2 may be equal to the fourth target frequency FX4. (B) The first period TA1 and the second period TA2, during which the compressor 11 respectively maintains the first target frequency FA1 and the second target frequency FA2, may be longer than or equal to the first to fourth periods TX1 to TX4 of the first protection control. (C) The first period TA1 and the second period TA2, during which the compressor 11 respectively maintains the first target frequency FA1 and the second target frequency FA2, may be changed in any manner. For example, the first period TA1 may differ from the second period TA2. More specifically, the first period TA1 and the second period TA2 may be separately set. (D) The number of target frequencies in the second protection control is not limited to two and may be changed in any manner. That is, the number of target frequencies

in the second protection control may be one or three or greater. (E) The modifications (A) to (D) may be combined with one another. (F) When starting the second protection control, the operating frequency of the compressor 11 may be set to the necessary operating frequency FN. That is, the target frequencies such as the first target frequency FA1 may be omitted.

[0075] In the embodiments, the control executed on the compressor 11 to increase the operating frequency of the compressor 11 to the necessary operating frequency FN in the first protection control may be changed, for example, as follows. (G) Each of the first to fourth target frequencies FX1 to FX4 may be changed in any manner. For example, the difference between the second target frequency FX2 and the first target frequency FX1 may differ from the difference between the third target frequency FX3 and the second target frequency FX2. The difference between the fourth target frequency FX4 and the third target frequency FX3 may differ from the difference between the third target frequency FX3 and the second target frequency FX2. (H) The first to fourth periods TX1 to TX4, during which the compressor 11 respectively maintains the first to fourth target frequencies FX1 to FX4, may be changed in any manner. For example, some of the first to fourth periods TX1 to TX4 may differ from the rest of the first to fourth periods TX1 to TX4. (I) The number of target frequencies in the first protection control is not limited to four and may be changed in any manner. That is, the number of target frequencies in the first protection control may be three or five or greater.

[0076] In the embodiments, the temperature DF of the discharge pipe of the compressor 11 and the ambient temperature DOA may be added to the conditions for selecting the first protection control and the second protection control. (c1) The temperature DF of the discharge pipe is greater than or equal to a temperature threshold value DFX ($DF \geq DFX$). (c2) The ambient temperature DOA is greater than or equal to a determination temperature threshold value DOAY ($DOA \geq DOAY$). (c3) The difference in temperature between the temperature DF of the discharge pipe and the ambient temperature DOA is greater than or equal to the temperature difference threshold value DDY ($DF - DOA \geq DDY$).

[0077] The temperature threshold value DFX is a threshold value that limits the condition for proceeding to the maps MP1 and MP2 and is set in advance through tests or the like. An example of the temperature threshold value DFX is -3°C . The determination temperature threshold value DOAY is a determination value that limits the condition for proceeding to the maps MP1 and MP2 and is set in advance through tests or the like. An example of the determination temperature threshold value DOAY is -15°C . The temperature difference threshold value DDY is a threshold value that limits the condition for proceeding to the maps MP1 and MP2 and is set in advance through tests or the like.

[0078] The control unit 50 stores a map MP3 specifying

the relationship between the temperature DF of the discharge pipe of the compressor 11 and the ambient temperature DOA to select the first protection control and the second protection control. Fig. 9 shows an example of the map MP3. In the map MP3, the vertical axis indicates the temperature DF of the discharge pipe of the compressor 11, and the horizontal axis indicates the ambient temperature DOA. In the map MP3, the diagonal line indicates the boundary condition of the difference in temperature between the temperature DF of the discharge pipe and the ambient temperature DOA. In the map MP3, the unshaded region indicates a temperature region R3 in which all of temperature conditions c1, c2, and c3 are satisfied.

[0079] In the first activation control, after determination of step S11 or determination of step S16, when determining that the cooling or heating operation is instructed to be performed, the control unit 50 determines whether the temperature DF of the discharge pipe and the ambient temperature DOA are in the temperature region R3. More specifically, the control unit 50 determines whether the temperature DF of the discharge pipe of the compressor 11 and the ambient temperature DOA are in the temperature region R3. When determining that the temperatures are in the temperature region R3, that is, when determining that the temperature conditions c1, c2, and c3 are satisfied, the control unit 50 uses the map MP1 when starting the heating operation to select one of the first protection control and the second protection control, and uses the map MP2 when starting the cooling operation to select one of the first protection control and the second protection control. When determining that the temperature DF of the discharge pipe and the ambient temperature DOA are in a region outside the temperature region R3, that is, when determining that at least one of the temperature conditions c1, c2, and c3 is not satisfied, the control unit 50 executes the first protection control. As described above, when the relationship between the temperature DF of the discharge pipe of the compressor 11 and the ambient temperature DOA is added to the conditions for executing the second protection control, the second protection control is executed more appropriately in the cooling or heating operation.

[0080] In the map MP3 shown in Fig. 9, in a temperature region R4 in which the ambient temperature DOA is less than the determination temperature threshold value DOAY, a third protection control that differs from the first protection control and the second protection control may be executed as the compressor protection control. In an example of the third protection control, the control unit 50 controls the compressor 11 so that the time for the operating frequency of the compressor 11 to reach the necessary operating frequency FN is longer than the time (the period TX) for the operating frequency of the compressor 11 to reach the necessary operating frequency FN in the first protection control.

[0081] In the map MP3 shown in Fig. 9, in a temperature region R5, the ambient temperature DOA is greater

than or equal to the determination temperature threshold value DOAY and less than a determination temperature threshold value DOAZ that is greater than the determination temperature threshold value DOAY ($DOAZ > DOAY$), and the temperature DF of the discharge pipe of the compressor 11 is less than the temperature threshold value DFX. In the temperature region R5, a fourth protection control that differs from the first protection control and the second protection control may be executed as the compressor protection control. In an example of the fourth protection control, the control unit 50 controls the compressor 11 so that the time for the operating frequency of the compressor 11 to reach the necessary operating frequency FN is longer than the time (the period TX) for the operating frequency of the compressor 11 to reach the necessary operating frequency FN in the first protection control and is shorter than the time for the operating frequency of the compressor 11 to reach the necessary operating frequency FN in the third protection control.

[0082] In the map MP3 shown in Fig. 9, in a temperature region R6, the ambient temperature DOA is greater than or equal to the determination temperature threshold value DOAZ, and the difference in temperature between the temperature DF of the discharge pipe and the ambient temperature DOA is less than the temperature difference threshold value DDY. In the temperature region R6, a fifth protection control that differs from the first protection control and the second protection control may be executed as the compressor protection control. In an example of the fifth protection control, the control unit 50 controls the compressor 11 so that the time for the operating frequency of the compressor 11 to reach the necessary operating frequency FN is longer than the time (the period TX) for the operating frequency of the compressor 11 to reach the necessary operating frequency FN in the first protection control and is shorter than the time for the operating frequency of the compressor 11 to reach the necessary operating frequency FN in the fourth protection control.

[0083] In the embodiments, at least one of the temperature condition a1 of the heating operation or the temperature condition b1 of the cooling operation may be omitted from the first activation control.

[0084] In the embodiments, one of the outdoor controller 16 and the indoor controller 23 may be omitted. For example, when the indoor controller 23 is omitted, the indoor temperature sensor 52 is connected to the outdoor controller 16 by wire or through wireless communication. In addition, the indoor fan 22 is connected to the outdoor controller 16 by wire. In this case, the outdoor controller 16 corresponds to the control unit.

Claims

1. An air conditioner, comprising:

- a compressor (11) in which an operating frequency is changeable; and
 a control unit (50) that executes a compressor protection control, the compressor protection control increasing the operating frequency of the compressor (11) to a necessary operating frequency (FN) when starting a cooling operation or a heating operation, wherein
 the compressor protection control includes a first protection control and a second protection control,
 the first protection control controls the operating frequency so that a time from when the compressor (11) is activated to when the operating frequency reaches the necessary operating frequency (FN) is relatively long,
 the second protection control controls the operating frequency so that the time from when the compressor (11) is activated to when the operating frequency reaches the necessary operating frequency (FN) is relatively short, and
 when executing the compressor protection control, if a predetermined condition is satisfied, the control unit (50) executes the second protection control.
2. The air conditioner according to claim 1, wherein
- the control unit (50) sets a first target frequency (FA1, FX1) and a second target frequency (FA2, FX2) in the compressor protection control, the second target frequency (FA2, FX2) is greater than the first target frequency (FA1, FX1) and is less than the necessary operating frequency (FN),
 the control unit (50) maintains the operating frequency at the first target frequency (FA1, FX1) for a first period (TA1, TX1) and at the second target frequency (FA2, FX2) for a second period (TA2, TX2) so that the operating frequency is increased in a stepped manner,
 the first target frequency (FA1) of the second protection control is greater than the first target frequency (FX1) of the first protection control, and
 the second target frequency (FA2) of the second protection control is greater than the second target frequency (FX2) of the first protection control.
3. The air conditioner according to claim 1 or 2, wherein
- the control unit (50) sets a first target frequency (FA1, FX1) and a second target frequency (FA2, FX2) in the compressor protection control, the second target frequency (FA2, FX2) is greater than the first target frequency (FA1, FX1) and is less than the necessary operating frequency
- (FN),
 the control unit (50) maintains the operating frequency at the first target frequency (FA1, FX1) for a first period (TA1, TX1) and at the second target frequency (FA2, FX2) for a second period (TA2, TX2) so that the operating frequency is increased in a stepped manner,
 the first period (TA1) of the second protection control is shorter than the first period (TX1) of the first protection control, and
 the second period (TA2) of the second protection control is shorter than the second period (TX2) of the second protection control.
4. The air conditioner according to any one of claims 1 to 3, wherein the predetermined condition in the heating operation differs from the predetermined condition in the cooling operation.
5. The air conditioner according to any one of claims 1 to 4, wherein the predetermined condition includes an indoor air temperature (DA), an outdoor air temperature (DOA), and a temperature difference (DA-DOA) between the indoor air temperature and the outdoor air temperature.
6. The air conditioner according to claim 5, wherein the predetermined condition in the heating operation is that the indoor air temperature (DA) is less than or equal to a room temperature threshold value (DAX1, DAX2), that the outdoor air temperature (DOA) is greater than or equal to an outdoor temperature threshold value (DOAX1, DOAX 2), and that the temperature difference (DA-DOA) between the indoor air temperature (DA) and the outdoor air temperature (DOA) is less than or equal to a temperature difference threshold value (DDX1, DDX2).
7. The air conditioner according to any one of claims 1 to 6, wherein the predetermined condition includes a temperature (DF) of a discharge pipe of the compressor and an outdoor air temperature (DOA).

Fig.1

1 ↙

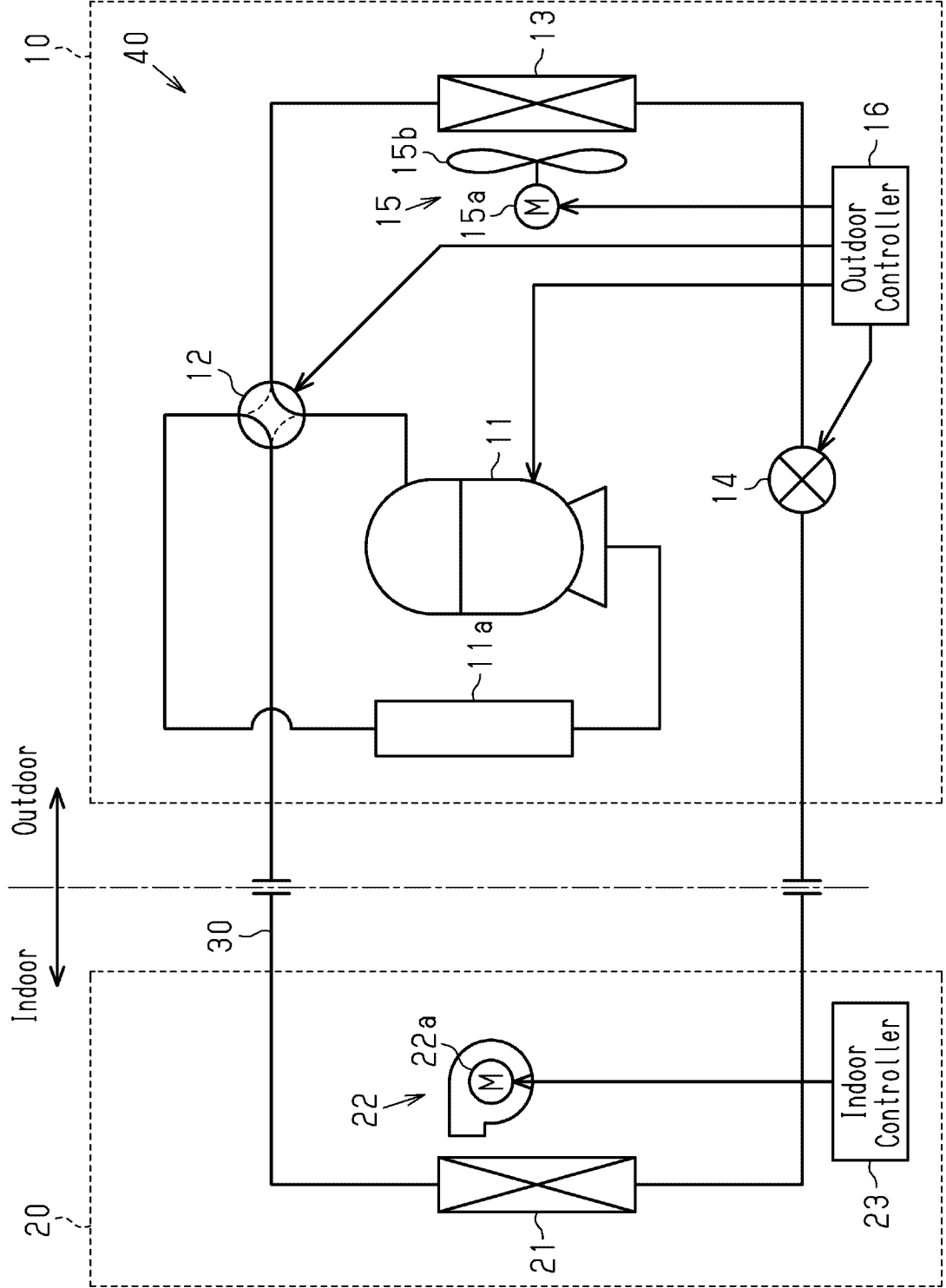


Fig.2

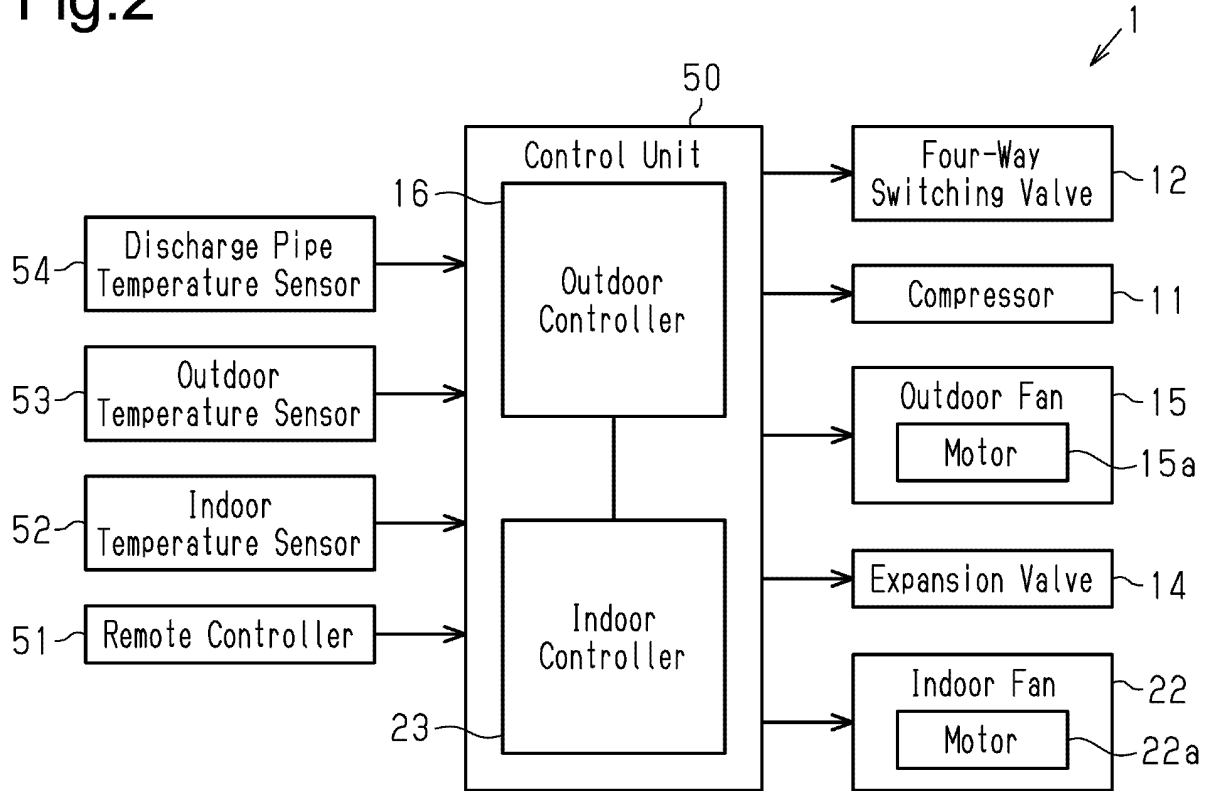


Fig.3

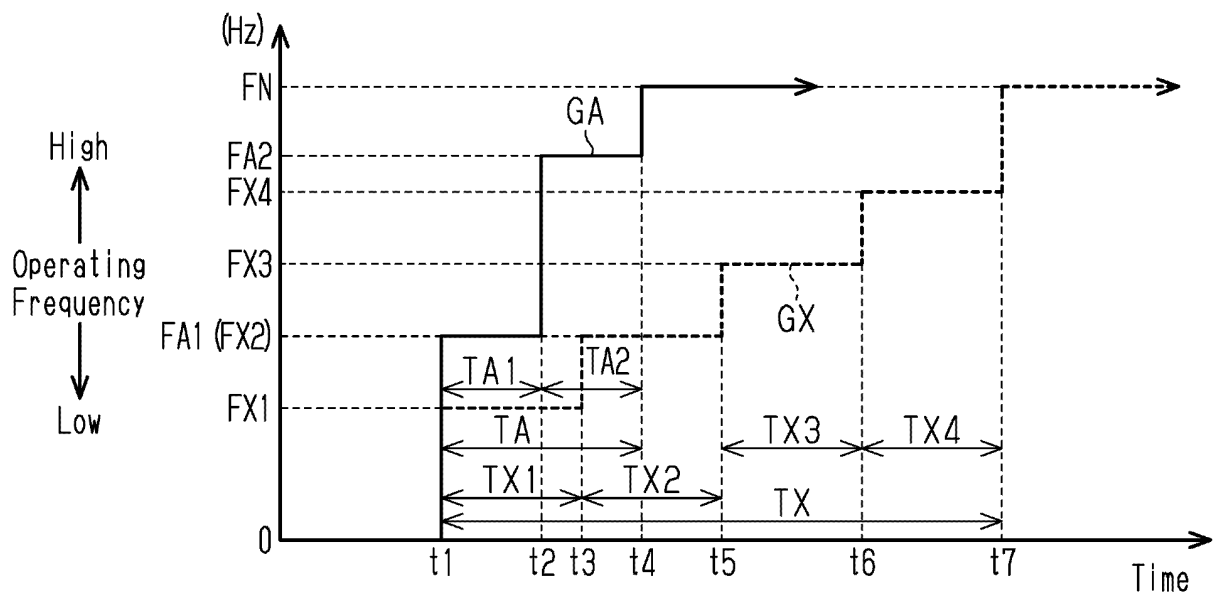


Fig.4

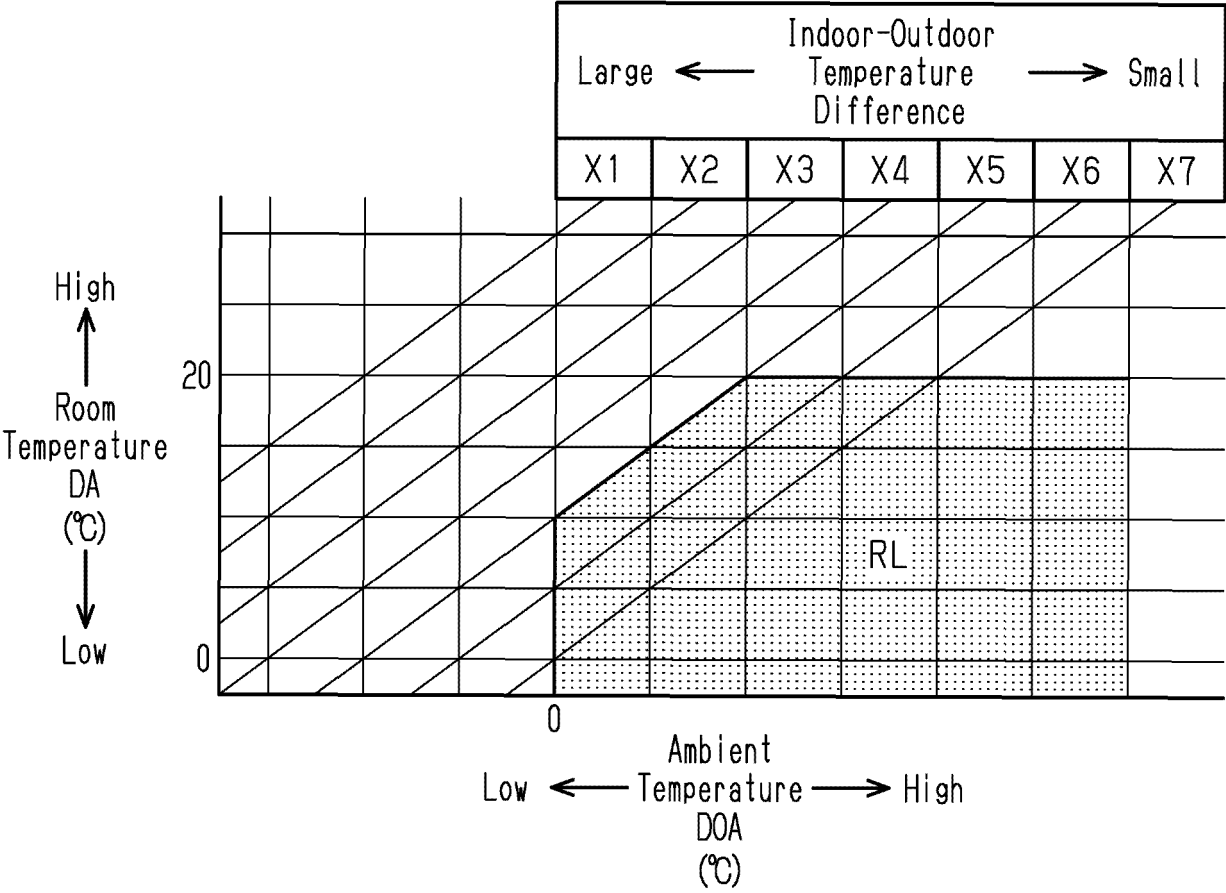


Fig.5

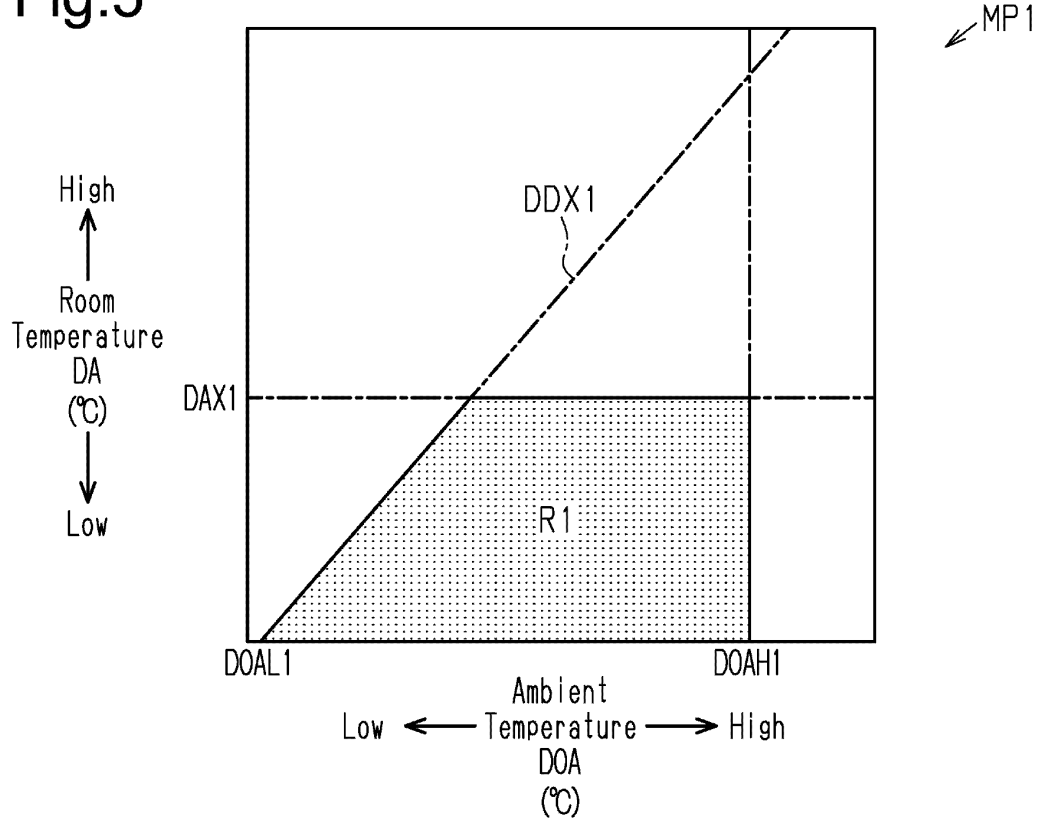


Fig.6

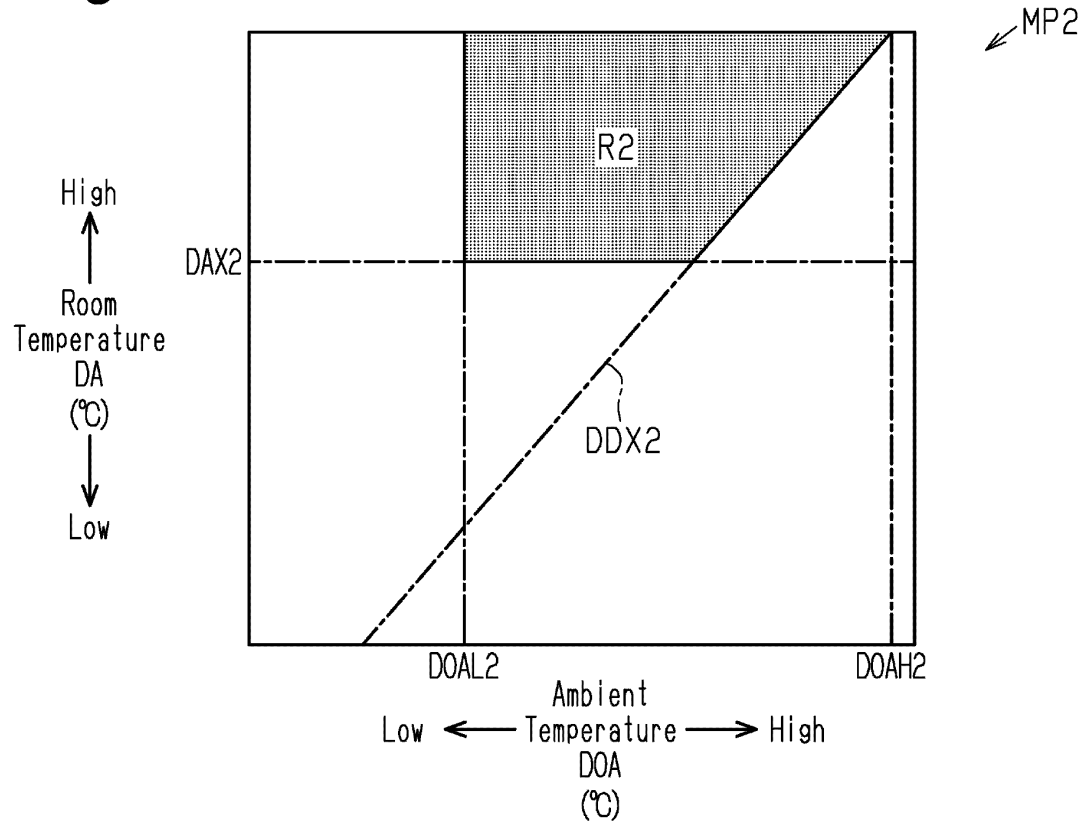


Fig.7

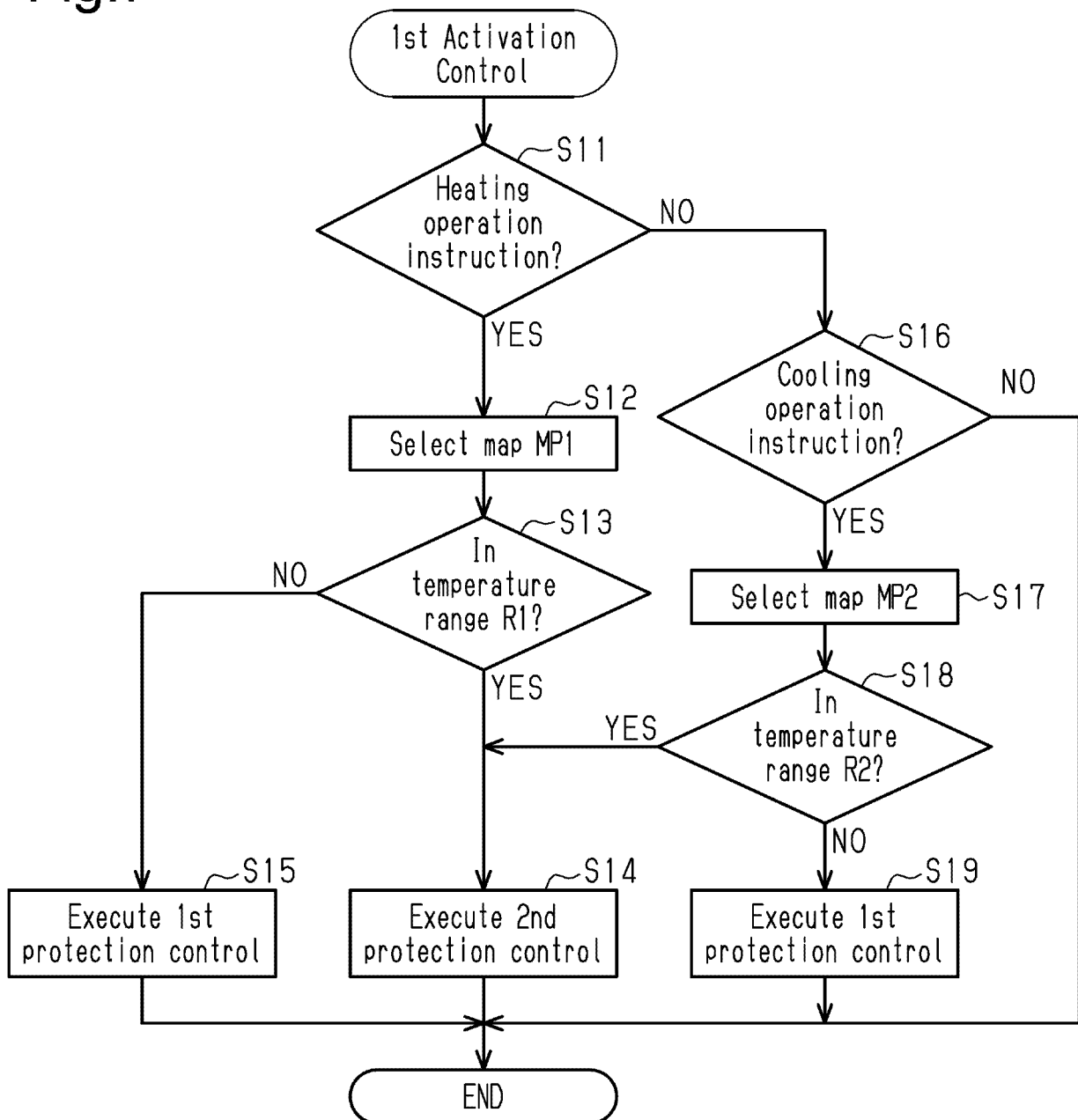


Fig.8

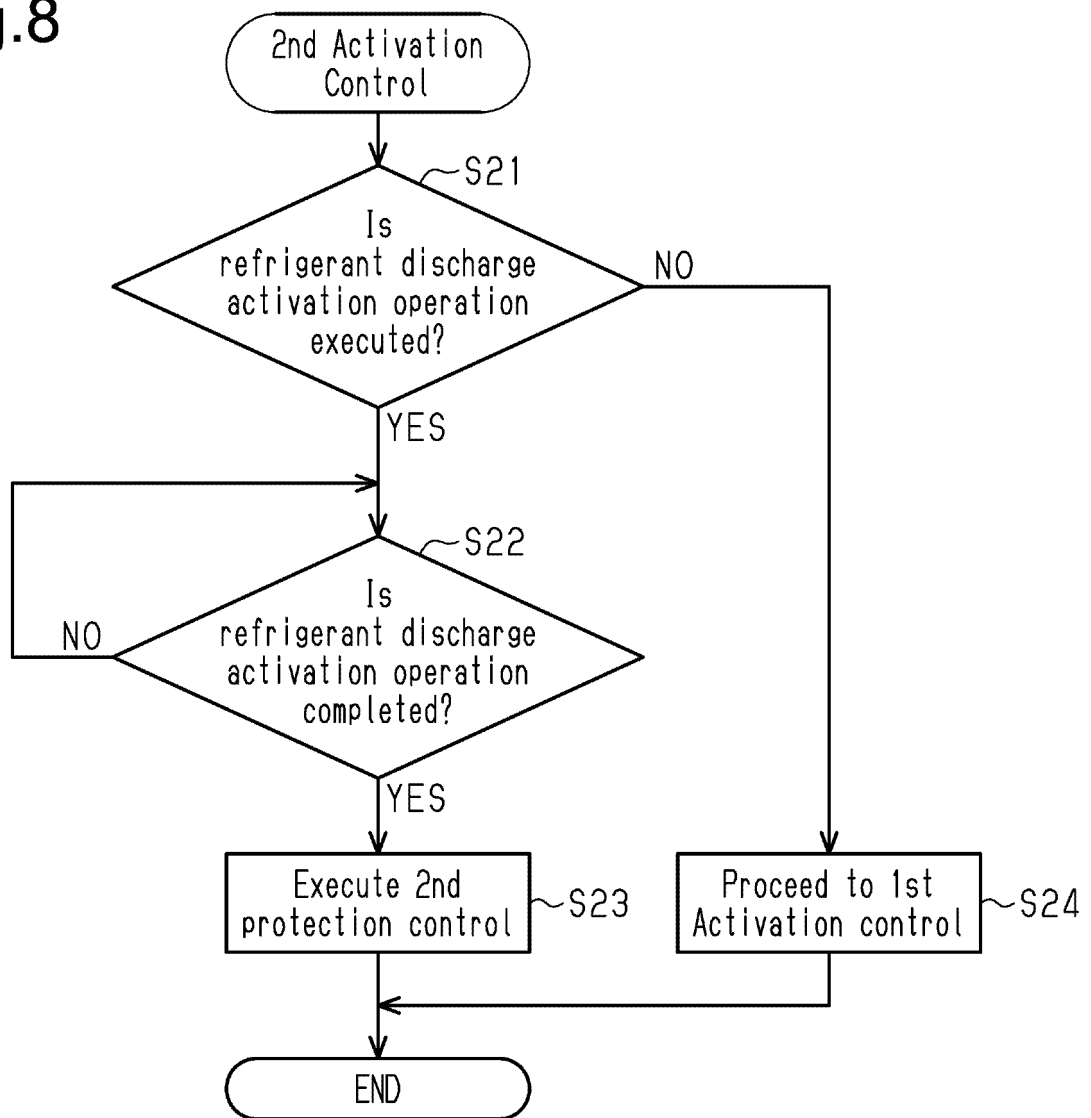
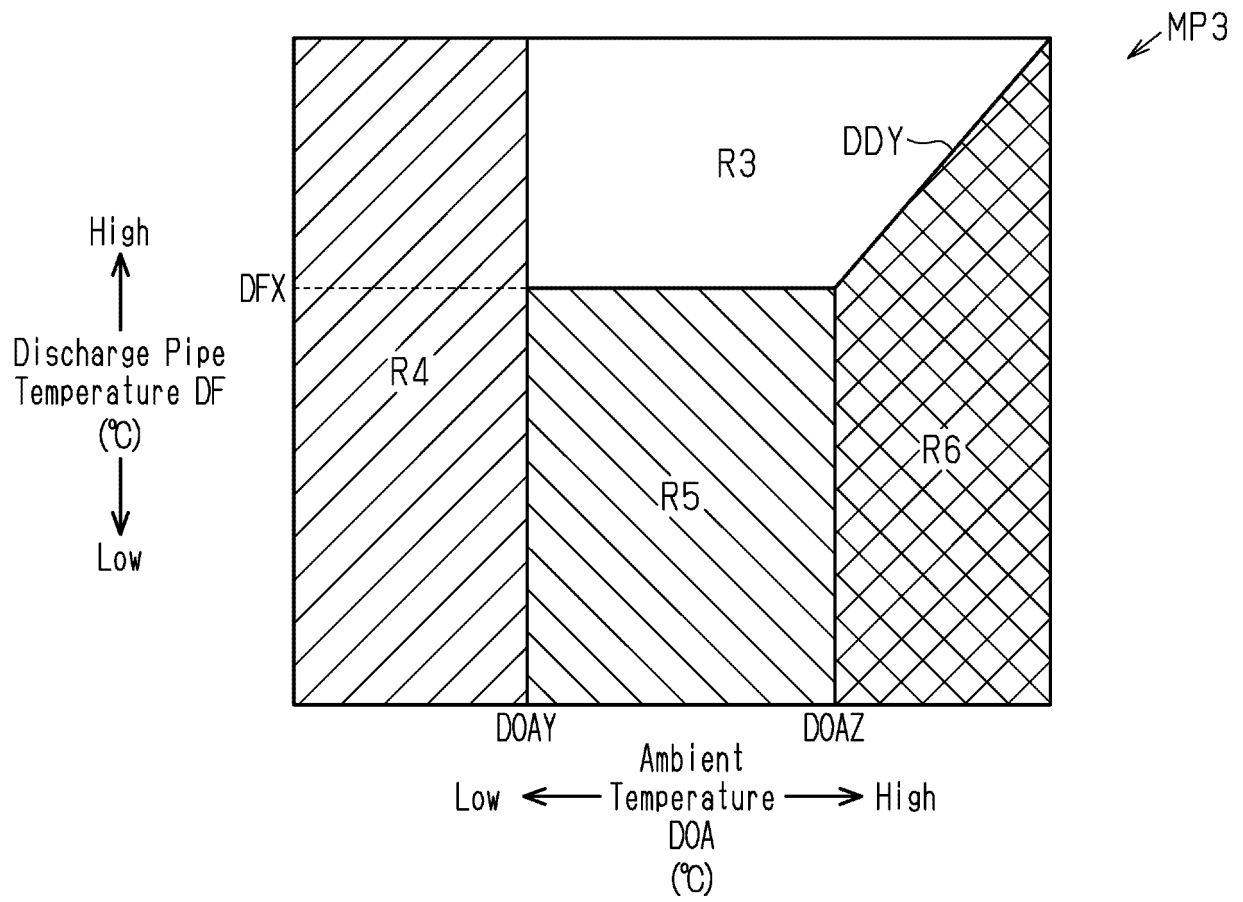


Fig.9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/036016

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. F25B1/00 (2006.01) i, F24F11/86 (2018.01) 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)

Int. Cl. F25B1/00, F24F11/86

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2018

Registered utility model specifications of Japan 1996-2018

Published registered utility model applications of Japan 1994-2018

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.
X	WO 2015/140871 A1 (MITSUBISHI ELECTRIC CORP.) 24	1-2, 4
Y	September 2015, paragraphs [0008], [0042]-[0050], fig. 5, 6 (Family: none)	2-7
X	JP 4-268164 A (SHARP CORP.) 24 September 1992,	1, 3
Y	paragraphs [0002], [0006], [0007], fig. 1-3 (Family: none)	2-7
X	Microfilm of the specification and drawings	1
Y	annexed to the request of Japanese Utility Model Application No. 181104/1986 (Laid-open No. 150258/1988) (MITSUBISHI HEAVY INDUSTRIES, LTD.) 03 October 1988, page 2, line 13 to page 4, line 20, fig. 2, 3 (Family: none)	2-7



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"T"

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2018/036016
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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REFERENCES CITED IN THE DESCRIPTION

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