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(71) Applicant: **MITSUBISHI HEAVY INDUSTRIES, LTD.**
Tokyo (JP)

(72) Inventors:

- **FUJINO, Tetsuji**
TOKYO (JP)
- **MURAKAMI, Kenichi**
TOKYO (JP)

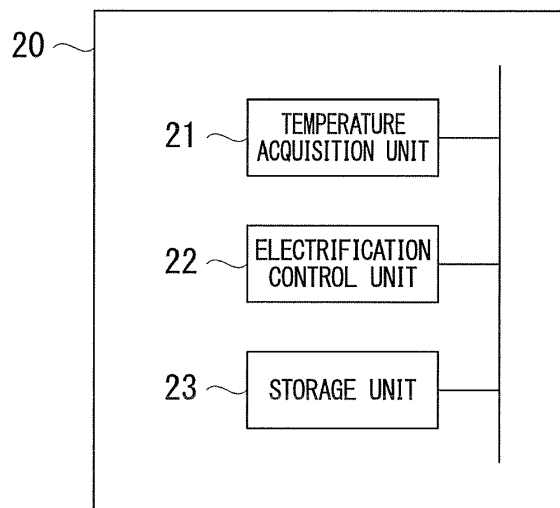
(74) Representative: **Intès, Didier Gérard André et al**
Cabinet Beau de Loménie
158, rue de l'Université
75340 Paris Cedex 07 (FR)

(54) **CONTROL DEVICE, AIR-CONDITIONING DEVICE, AND CONTROL METHOD**

(57) A control device (20) is provided with a temperature acquisition unit (21) which acquires, in a refrigerant circuit which is provided with a heat exchanger (2, 4) and a compressor (1) connected to the heat exchanger (2, 4), a temperature of the compressor (1), a temperature of the heat exchanger (2, 4), and an outside air temperature, and an electrification control unit (22) which performs turn-on control or turn-off control of a crankcase

heater (9) which heats the compressor (1) based on the temperature difference between the temperature of the compressor (1) and the temperature of the heat exchanger (2, 4) when the outside air temperature acquired by the temperature acquisition unit (21) is a temperature included in one range of a plurality of pre-decided temperature zones while the compressor (1) is stopped.

FIG. 2



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a control device of a crankcase heater, an air-conditioning device, and a control method.

[0002] Priority is claimed based on Japanese Patent Application No. 2014-238638, filed November 26, 2014, the content of which is incorporated herein by reference.

Description of Related Art

[0003] A compressor which is provided outside of an air-conditioning facility is cooled by the open air while its operation is stopped. Due to the fact that a refrigerant has a property of moving to a place of a lower temperature in an air-conditioning facility, when a temperature of a compressor is lowered, a phenomenon in which a refrigerant that has been in another device such as an outdoor heat exchanger moves to the compressor and the refrigerant stagnates in the compressor occurs. When the refrigerant becomes stagnant, liquid compression of the refrigerant occurs or a lubricant of the compressor penetrates into the refrigerant and thus a state in which an oil film of the compressor is unformed is created, and thus there are cases in which the compressor malfunctions when the compressor is activated. For this reason, a heater that is called a crankcase heater is provided, and by causing the crankcase heater to operate to heat the stopped compressor, stagnation of the refrigerant in the compressor is prevented.

[0004] For an operation of such a crankcase heater, for example, the crankcase heater is uniformly controlled to be activated while a compressor is stopped, or control of the crankcase heater to be turned on or off based on an outside air temperature has been performed. For example, Patent Literature 1 discloses a control method in which a temperature of a compressor, a temperature of an indoor heat exchanger, and a temperature of an outdoor heat exchanger are acquired, and when the temperature of the compressor reaches a temperature lower than the temperature of the indoor heat exchanger or the temperature of the outdoor heat exchanger by a predetermined temperature or more, a crankcase heater is turned on.

[Prior Art]

[Patent Literature]

[Patent Literature 1]

[0005] Japanese Unexamined Patent Application, First Publication No. 2008-170052

[0006] In the method of Patent Literature 1, however,

control is performed based on a relative relation between a temperature of the compressor and a temperature of the indoor heat exchanger or the outdoor heat exchanger, regardless of an outside air temperature, and thus there is a possibility of, for example, the crankcase heater not operating even when an outside air temperature is low. In this case, there is a possibility of occurrence of stagnation of a refrigerant which is a cause of a malfunction of the compressor. In addition, since there is a possibility of the crankcase heater being turned on even in a temperature zone in which it is not necessary to cause the crankcase heater to operate, problems remain in view of energy saving.

[0007] The present invention provides a control device, an air-conditioning device, and a control method which can solve the above-described problems.

SUMMARY OF THE INVENTION

[0008] According to a first aspect of the present invention, a control device is provided with a temperature acquisition unit which acquires, in a refrigerant circuit which is provided with a heat exchanger and a compressor connected to the heat exchanger, a temperature of the compressor, a temperature of the heat exchanger, and an outside air temperature, and an electrification control unit which performs turn-on control or turn-off control of a crankcase heater which heats the compressor based on the temperature difference between the temperature of the compressor and the temperature of the heat exchanger when the outside air temperature acquired by the temperature acquisition unit is a temperature included in one range of a plurality of pre-decided temperature zones while the compressor stopped.

[0009] According to a second aspect of the present invention, the electrification control unit turns on the crankcase heater when the temperature difference obtained by subtracting the temperature of the heat exchanger from the temperature of the compressor is equal to or greater than a first threshold value, and turns off the crankcase heater when the temperature difference is equal to or smaller than the second threshold value which is a lower temperature than the first threshold value.

[0010] According to a third aspect of the present invention, the electrification control unit turns on the crankcase heater when the acquired outside air temperature continues increasing for a predetermined period of time, regardless of the temperature difference.

[0011] According to a fourth aspect of the present invention, three temperature zones are set as the plurality of pre-decided temperature zones, and one of the plurality of pre-decided temperature zones is the intermediate temperature zone of the three temperature zones, and the electrification control unit turns on the crankcase heater when the acquired outside air temperature is a temperature included in the lowest temperature zone among the three temperature zones, and turns off the crankcase heater when the outside air temperature is a

temperature included in the highest temperature zone.

[0012] According to a fifth aspect of the present invention, the first threshold value is 1.5°C.

[0013] According to a sixth aspect of the present invention, the second threshold value is 0°C.

[0014] According to a seventh aspect of the present invention, the temperature of the compressor is an under-dome temperature of the compressor or a discharge port temperature of the compressor.

[0015] According to an eighth aspect of the present invention, an air-conditioning device having a refrigerant circuit which is provided with a compressor, a crankcase heater provided in the compressor, and an outdoor heat exchanger connected to the compressor includes the control device according to any one of the above-described aspects.

[0016] According to a ninth aspect of the present invention, a control method is a control method of a crankcase heater which heats a compressor in a refrigerant circuit which includes a heat exchanger and the compressor connected to the heat exchanger, in which a temperature of the compressor, a temperature of the heat exchanger, and an outside air temperature are acquired, and turn-on control or turn-off control of the crankcase heater is performed based on the temperature difference between the temperature of the compressor and the temperature of the heat exchanger when the acquired outside air temperature is a temperature included in one range of a plurality of pre-decided temperature zones.

[0017] According to the control device, the air-conditioning device, and the control method described above, energy saving can be achieved by optimizing turn-on/turn-off control of a crankcase heater while a compressor is stopped.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

FIG. 1 is a diagram showing an example of a refrigerant circuit according to an embodiment of the present invention.

FIG. 2 is a schematic block diagram of a control device according to an embodiment of the present invention.

FIG. 3 is a diagram for describing a temperature zone of an outside air temperature to be used in turn-on/turn-off control of a crankcase heater according to an embodiment of the present invention.

FIG. 4 is a flow chart of a process of a control device according to an embodiment of the present invention.

FIG. 5 is a flow chart of a determination process for Condition B1 according to an embodiment of the present invention.

FIG. 6 is a flow chart of a determination process for Condition B2 according to an embodiment of the present invention.

FIG. 7 is diagram for describing an ON area and an OFF area to be used in determination of Condition B2 according to an embodiment of the present invention.

FIG. 8 is a diagram showing an example of behaviors of temperatures of a compressor and an outdoor heat exchanger when an outside air temperature increases.

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DETAILED DESCRIPTION OF THE INVENTION

<First embodiment>

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[0019] Hereinafter, a control device of a crankcase heater according to an embodiment of the present invention will be described with reference to FIGS. 1 to 8.

[0020] FIG. 1 is a diagram showing an example of a refrigerant circuit according to an embodiment of the present invention.

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[0021] The refrigerant circuit shown in FIG. 1 is configured to include a compressor 1, an indoor heat exchanger 2, an expansion valve 3, an outdoor heat exchanger 4, a four-way valve 5, and piping 6 which connects these units to one another.

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[0022] The compressor 1 compresses a refrigerant and supplies the compressed refrigerant to the refrigerant circuit. The indoor heat exchanger 2 performs heat exchange between the refrigerant and the indoor air. The indoor heat exchanger 2 is used as an evaporator to absorb heat from the inside during an air cooling operation, and is used as a condenser to discharge heat to the inside during an air heating operation. The outdoor heat exchanger 4 performs heat exchange between the refrigerant and the outdoor air. The expansion valve 3 lowers pressure of the refrigerant by expanding the high-pressure refrigerant that has undergone heat exchange by the condenser and thereby has been liquefied. The outdoor heat exchanger 4 is used as a condenser to discharge heat to the outside during an air cooling operation, and is used as an evaporator to absorb heat from the outside during an air heating operation. The four-way valve 5 switches directions in which the refrigerant circulates during an air heating operation and an air cooling operation. The refrigerant circulates in the direction of the arrow 7 during an air cooling operation, and circulates in the direction of the arrow 8 during an air heating operation.

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[0023] The compressor 1 is provided with a temperature thermistor in at least one part under a dome (casing) of the compressor 1 and near a discharge port of the compressor 1. A temperature thermistor 11 is provided under the dome of the compressor 1. Another temperature thermistor 12 is provided in the discharge port of the compressor 1. Another temperature thermistor 13 for measuring outside air temperatures is provided outside. The outdoor heat exchanger 4 is provided with temperature thermistors 14A and 14B for measuring a temperature of the outdoor heat exchanger 4 at different posi-

tions of the outdoor heat exchanger 4.

[0024] The compressor 1 is provided with a crankcase heater 9 for heating the compressor 1. A control device 20 controls turn-on/turn-off of the crankcase heater 9. The crankcase heater 9 is provided to prevent a malfunction of the compressor 1 from being caused by liquid compression or an unformed oil film that occurs when the refrigerant stagnates in the compressor 1. Stagnation of the refrigerant in the compressor usually becomes serious when an outside air temperature decreases. When an outside air temperature decreases, temperatures of the compressor 1 and the outdoor heat exchanger 4 also decrease accordingly, with the temperature of the outdoor heat exchanger 4 decreasing first, and thus the refrigerant stagnates in the outdoor heat exchanger 4 first. However, since heat capacity of the compressor 1 is high and thus a temperature increase of the compressor 1 becomes sluggish, when the outside air temperature rises, the refrigerant moves from the outdoor heat exchanger 4 to the compressor 1 and becomes stagnant in the compressor 1. Next, using FIG. 8, changes of a temperature of the compressor 1 and a temperature of the outdoor heat exchanger 4 will be described in detail.

[0025] FIG. 8 is a diagram showing an example of behaviors of temperatures of the compressor and the outdoor heat exchanger at the time of an increase of an outside air temperature.

[0026] The vertical axis of FIG. 8 represents temperature and the horizontal axis represents time. FIG. 8 shows a state in which temperatures of the compressor 1, the outdoor heat exchanger 4, and the like that decreased overnight increase as the sun rises. The graph of FIG. 8 shows the behaviors of the temperatures of the compressor 1 and the like for several hours in the morning before noon.

[0027] A temperature 81 represents the temperature measured by the temperature thermistor 14 (14A or 14B) provided in the vicinity of the outdoor heat exchanger 4. An outside air temperature 82 represents the behavior of the outside air temperature measured by the temperature thermistor 13. A discharge port temperature 83 represents the temperature measured by the temperature thermistor 12 provided in the discharge port of the compressor 1. An oil temperature 84 represents the measured value of the temperature of oil of the compressor 1. An under-dome temperature 85 represents the temperature measured by the temperature thermistor 11 provided under the dome of the compressor 1.

[0028] As shown in FIG. 8, as the outside air temperature 82 increases, the temperature 81 of the outdoor heat exchanger 4, the discharge port temperature 83 of the compressor 1, the oil temperature 84, and the under-dome temperature 85 of the compressor 1 increase as well. Around a time T1, however, a gap of the temperature 81 with the oil temperature 84 and the under-dome temperature 85 start widening, and the difference thereof becomes greater as time elapses. From around a time T2, a gap between the outside air temperature 82 and

the discharge port temperature 83 starts widening, and the difference thereof becomes greater as time elapses. In this manner, when the outside air temperature increases, the temperature of the outdoor heat exchanger 4 increases first and the increase of the temperature of the compressor 1 is slower than that of the outdoor heat exchanger 4. In such a state, a refrigerant moves from the outdoor heat exchanger 4 to the compressor 1, and thus stagnation of the refrigerant in the compressor 1 occurs.

[0029] The control device 20 according to the present embodiment turns on the crankcase heater 9 to heat the compressor 1 in order to prevent such stagnation of the refrigerant in the compressor 1. The control device 20 will be described next using FIG. 2.

[0030] FIG. 2 is a schematic block diagram of the control device according to an embodiment of the present invention.

[0031] The control device 20 is, for example, a micro-computer which performs control of the crankcase heater 9, and is provided at least with a temperature acquisition unit 21, an electrification control unit 22, and a storage unit 23 as shown in FIG. 2.

[0032] The temperature acquisition unit 21 acquires a temperature of the compressor 1 from the temperature thermistor 11 or the temperature thermistor 12, an outside air temperature of the outside from the temperature thermistor 13, and a temperature of the outdoor heat exchanger 4 from the temperature thermistors 14 (14A and 14B).

[0033] The electrification control unit 22 performs turn-on/turn-off control of the crankcase heater 9. Stagnation of the refrigerant in the compressor 1 is a cause of a malfunction of the compressor 1. For this reason, it is necessary to turn on the crankcase heater 9 to heat the compressor 1 in order to prevent stagnation of the refrigerant; however, on the other hand, a reduction of standby power is demanded in view of energy saving. The electrification control unit 22 performs turn-on/turn-off control of the crankcase heater 9 based on each temperature acquired by the temperature acquisition unit 21 so that a turned-off state can last as long as possible while stagnation of the refrigerant in the compressor 1 is prevented. Particularly, when an outside air temperature falls in a predetermined range while the compressor 1 is stopped in the present embodiment, turn-on/turn-off control of the crankcase heater 9 is performed based on the temperature difference between a temperature of the compressor 1 and a temperature of the outdoor heat exchanger 4 or an increase of the outside air temperature.

[0034] The storage unit 23 stores various temperatures acquired by the temperature acquisition unit 21, various parameters used in turn-on/turn-off control by the electrification control unit 22, and the like.

[0035] Next, turn-on/turn-off control of the crankcase heater 9 by the control device 20 will be described using FIGS. 3 to 7.

[0036] FIG. 3 is a diagram for describing a temperature zone of the outside air temperature to be used in turn-

on/turn-off control of the crankcase heater according to an embodiment of the present invention.

[0037] The control device 20 switches a turn-on/turn-off control method of the crankcase heater 9 based on an outside air temperature when the compressor 1 is stopped. To be specific, three temperature zones of A, B, and C are set in increasing order. The "temperature zone A" is the lowest temperature zone (for example, up to -1°C) among the three temperature zones. The "temperature zone B" is the intermediate temperature zone (for example, from -1°C to 30°C) among the three temperature zones. The "temperature zone C" is the highest temperature zone (for example, from 30°C) among the three temperature zones. As shown in FIG. 3, hysteresis widths of 2°C are set for switching temperatures of the "temperature zone A" and the "temperature zone B", and the "temperature zone B" and the "temperature zone C". When an outside air temperature increases from a temperature lower than -1°C, and the outside temperature reaches -1°C, the control device 20 determines that the outside air temperature falls in the "temperature zone B," and conversely, when the outside air temperature that has been in the "temperature zone B" decreases and then the outside air temperature reaches -3°C, the control device determines that the outside air temperature falls in the "temperature zone A". Similarly, when the outside air temperature that has been in the "temperature zone B" increases and then reaches 30°C, the control device 20 determines that the outside air temperature falls in the "temperature zone C", and when the outside air temperature that has been in the "temperature zone C" decreases and then the outside air temperature reaches 28°C, the control device determines that the outside air temperature falls in the "temperature zone B". By setting these hysteresis widths in this manner, it is possible to absorb measurement errors and fluctuation of the temperature thermistor 13, and thus to perform stable control.

[0038] The present embodiment is intended for turn-on/turn-off control of the crankcase heater 9 while the compressor 1 is stopped; however, when an outside air temperature falls in the "temperature zone A", the refrigerant circuit mostly performs an air heating operation. When the outside air temperature falls in the "temperature zone C", the refrigerant circuit mostly performs an air cooling operation. On the other hand, the "temperature zone B" includes normal temperatures, and thus the refrigerant circuit is mostly stopped without performing air cooling or air heating. In the present embodiment, turn-on/turn-off control of the crankcase heater 9 particularly in the "temperature zone B" is optimized and therefore an energy saving effect is improved.

[0039] To be specific, the control device 20 controls the crankcase heater 9 to be turned on when the compressor 1 is stopped and the outside air temperature falls in the "temperature zone A". The control device 20 turns off the crankcase heater 9 when the compressor 1 is stopped and the outside air temperature falls in the "tem-

perature zone C". When the compressor 1 is stopped and the outside air temperature falls in the "temperature zone B", the control devices 20 performs turn-on/turn-off control of the crankcase heater 9 based on the difference between the temperature of the compressor 1 and the temperature of the outdoor heat exchanger 4. Alternatively, when the outside air temperature falls in the "temperature zone B" and the outside air temperature continues increasing for a predetermined period of time, the control device 20 turns on the crankcase heater 9.

[0040] It should be noted that, even when the compressor 1 is not stopped, the control device 20 performs turn-on/turn-off control of the crankcase heater 9, such as turning on the crankcase heater 9 during a defrosting operation based on a predetermined condition; however, description thereof will be omitted because such control is not related to the present embodiment.

[0041] FIG. 4 is a flow chart of a process of the control device according to an embodiment of the present invention.

[0042] The flow of the process in which the control device 20 controls the crankcase heater 9 to turn on/off when the compressor 1 is stopped will be described using FIG. 4.

[0043] As a presumption, the temperature acquisition unit 21 is set to acquire measured temperatures from at least one of the temperature thermistor 11 and the temperature thermistor 12, and the temperature thermistor 13 and the temperature thermistors 14 (14A and 14B) at a predetermined time interval, and each of the acquired temperatures is set to be recorded in the storage unit 23.

[0044] First, the electrification control unit 22 reads an outside air temperature measured by the temperature thermistor 13 from the storage unit 23, and determines which of the "temperature zone A" to the "temperature zone C" the outside air temperature falls in based on the hysteresis diagram of FIG. 3 (Step S11). When the outside air temperature falls in the "temperature zone A", the electrification control unit 22 turns on the crankcase heater 9 (Step S12). When the outside air temperature is sufficiently low, there is a possibility of liquid compression of a refrigerant occurring, regardless of a temperature difference between the outdoor heat exchanger 4 and the compressor 1, and thus the crankcase heater 9 is turned on. When the outside air temperature falls in the "temperature zone C", the electrification control unit 22 turns off the crankcase heater 9 (Step S13). When the outside temperature is sufficiently high, there is no concern of liquid compression of the refrigerant occurring, and thus the crankcase heater 9 is turned off. When the outside air temperature falls in the "temperature zone B", the electrification control unit 22 turns off the crankcase heater 9 after a predetermined period of time (for example, about 10 minutes) elapses (Step S14). Here, in order to reduce standby power, it is preferable to set the crankcase heater 9 to be turned off if possible, and to control the crankcase heater to be turned on only when the necessity arises. The electrification control unit 22

determines whether or not Condition B1 or Condition B2 to be described below has been fulfilled (Step S15), and turns on the crankcase heater 9 only when the necessity arises. Condition B1 and Condition B2 are conditions for determining whether or not activation of the crankcase heater 9 is necessary. When Condition B1 or Condition B2 has been fulfilled, the electrification control unit 22 turns on the crankcase heater 9 (Step S17). When neither Condition B1 nor Condition B2 has been fulfilled, the electrification control unit 22 turns off the crankcase heater 9 (Step S16). Next, whether or not the outside air temperature falls in the "temperature zone B" is determined (Step S18). While the outside air temperature is in the "temperature zone B" (Step S18; Yes), the processes from Step S15 to Step S17 are repeated. When the outside air temperature does not fall in the "temperature zone B" (Step S18; No), the processes from Step S11 are repeated.

[0045] With this control, the crankcase heater 9 can be turned on only when necessary based on a condition of the outside air temperature when the compressor 1 is stopped, and while stagnation of the refrigerant in the compressor 1 is efficiently prevented, standby power can be reduced.

[0046] Next, detailed control performed when the outside air temperature falls in the "temperature zone B" will be described. First, Condition B1 will be described.

[0047] FIG. 5 is a flow chart of a determination process for Condition B1 according to an embodiment of the present invention.

[0048] Condition B1 is one of the conditions for the determination in Step S15 of the flow chart described in FIG. 4. Condition B1 is a condition for controlling the crankcase heater 9 to turn on based on an increase of the outside air temperature.

[0049] First, the electrification control unit 22 substitutes 0 in a counter N for initialization (Step S21). Next, the electrification control unit 22 reads an outside temperature measured by the temperature thermistor 13 from the storage unit 23 and monitors a change of the outside air temperature for 10 minutes (Step S22). Next, the electrification control unit 22 determines whether or not the outside air temperature has increased for the 10 minutes (Step S23). For example, outside air temperatures sampled for the 10 minutes are classified into the first half and the second half of the time period according to their acquired times, the average value of the outside air temperatures acquired in the first half is compared to the average value of the outside air temperatures acquired in the second half, and when the average value of the outside air temperatures of the second half is higher, the outside air temperature is determined to have increased.

[0050] When the outside air temperature is determined to have increased, the electrification control unit 22 adds 1 to the counter N to perform counting-up (Step S24). When the outside air temperature is determined to have not increased, the processes from Step S21 are repeated.

Next, the electrification control unit 22 determines whether or not the value of N counted up has reached 10 (Step S25). When the value of N has not reached 10, the processes from Step S22 are repeated. When the value of N has reached 10, the electrification control unit 22 determines that Condition B1 has been fulfilled (Step S26). When Condition B1 is determined to have been fulfilled, the electrification control unit 22 controls the crankcase heater 9 to be turned on according to the process flow of FIG. 4.

[0051] Here, the example in which the outside air temperature falls in the "temperature zone B" has been described for the sake of convenience of description; however, when the outside air temperature monitored for 10 minutes deviates from the "temperature zone B" in the determination of Step S23, the value of N is set to 0, and execution of the present process flow stops. Since the present embodiment is based on the premise that the compressor 1 is stopped, the value of N is also set to 0 when the compressor 1 starts working, and the execution of the present process flow stops.

[0052] It should be noted that, even when the outside air temperature does not increase and is constant for 10 minutes in Step S23, a modification in which the process of initializing the counter N to 0 is temporarily foregone, N is counted up after the temperature increases for the next 10 minutes, and the determination process of Condition B1 continues without change is also possible. Determination of an increase of an outside air temperature may be possible based on a change rate of temperatures measured by the temperature thermistor 13, not based on the method of FIG. 5, or temperature differences at each predetermined time interval are calculated, and when a temperature acquired at a later time is higher by a predetermined value or more, the outside air temperature may be determined to have increased.

[0053] Next, Condition B2 will be described using FIGS. 6 and 7.

[0054] FIG. 6 is a flow chart of the determination process for Condition B2 according to an embodiment of the present invention.

[0055] First, the electrification control unit 22 reads the temperature of the outdoor heat exchanger 4 and the under-dome temperature of the compressor 1 measured by the temperature thermistor 14A and the temperature thermistor 14B from the storage unit 23. In the case of a refrigerant circuit in which the temperature thermistor 11 is not provided under the dome of the compressor 1, the discharge port temperature of the compressor 1 measured by the temperature thermistor 12 is read. Next, the electrification control unit 22 selects the lower temperature between the temperature measured by the temperature thermistor 14A and the temperature measured by the temperature thermistor 14B, and calculates the temperature difference ΔT obtained by subtracting the under-dome temperature (or the discharge port temperature) from the selected temperature. The electrification control unit 22 determines whether or not the calculated temper-

ature difference ΔT falls in an "ON area" to be described below (Step S31). When the temperature difference falls in the "ON area," the electrification control unit 22 determines that Condition B2 has been fulfilled (Step S32). When the temperature difference falls in an "OFF area" to be described below, the electrification control unit 22 determines that Condition B2 has not been fulfilled (Step S33).

[0056] When Condition B2 is determined to have been fulfilled, the electrification control unit 22 may control the crankcase heater 9 to be turned on according to the process flow of FIG. 4.

[0057] It should be noted that the process flow of FIG. 6 is for control performed while a predetermined period of time (for example, 10 hours) elapses after the compressor 1 stops, and the electrification control unit 22 may control the crankcase heater 9 to be turned on when the predetermined period of time elapses from the stop of the compressor 1, regardless of the amount of the temperature difference ΔT .

[0058] FIG. 7 is diagram for describing the ON area and the OFF area to be used in determination of Condition B2 according to an embodiment of the present invention.

[0059] FIG. 7 shows a graph to be used in determining whether or not the temperature difference ΔT is a temperature difference at which the crankcase heater 9 needs to be turned on based on the temperature difference ΔT obtained by subtracting the under-dome temperature of the compressor 1 (or the discharge port temperature of the compressor 1) from the lower temperature between the temperatures of the outdoor heat exchanger 4 measured by the temperature thermistor 14A and the temperature thermistor 14B. The "ON area" in FIG. 7 indicates an area of the temperature difference at which the crankcase heater 9 needs to be turned on. The "OFF area" indicates an area of the temperature difference at which the crankcase heater 9 can be turned off. When the temperature difference ΔT is 1.5°C, for example, ΔT falls in the "ON area," and when the temperature difference ΔT is 0°C, ΔT falls in the "OFF area." To be specific, when the temperature of the outdoor heat exchanger 4 is higher than the under-dome temperature of the compressor 1 by 1.5°C or more, the electrification control unit 22 turns on the crankcase heater 9. When the temperature of the outdoor heat exchanger 4 is equal to or lower than the under-dome temperature of the compressor 1, the electrification control unit 22 turns off the crankcase heater 9. With this control, a gap between the temperature of the outdoor heat exchanger 4 and the under-dome temperature (or the discharge port temperature) of the compressor 1 is detected even at the time of an increase of the outside air temperature as exemplified in FIG. 8, and the compressor 1 can be warmed up such that the refrigerant does not move to the compressor 1.

[0060] A hysteresis width is also provided in determination of the "ON area" and the "OFF area" as shown in FIG. 7. At the time of an increase of the outside air tem-

perature exemplified in FIG. 8, in a situation in which the temperature difference ΔT gradually increases from a state in which there is little gap between the temperature of the outdoor heat exchanger 4 and the under-dome temperature of the compressor 1, when the temperature difference ΔT is 1.5°C or higher, the electrification control unit 22 determines that the temperature difference ΔT falls in the "ON area." Conversely, in the situation in which the temperature difference ΔT becomes small, when the temperature difference ΔT is 0°C, the electrification control unit 22 determines that the temperature difference ΔT falls in the "OFF area." By providing the hysteresis width, it is possible to prevent unstable control in which a determination of whether the temperature difference ΔT falls in the "ON area" or the "OFF area" is switched over and over again due to fluctuation of the temperature difference ΔT caused by a detection error of the temperature thermistors 11 and 14 and the like.

[0061] When the outside air temperature falls in the "temperature zone B" and the temperature difference ΔT is determined for the first time, if the temperature difference ΔT corresponds to the hysteresis width, the temperature difference ΔT may be determined to fall in the "ON area."

[0062] Reasons for the determination based on both Condition B1 and B2 are as follows. It is desirable to determine the relation between a temperature of the compressor 1 and a temperature of the outdoor heat exchanger 4 based on Condition B2 at all times; however, a situation is possible in which it is difficult for a temperature measured by the temperature thermistor 14 to increase even though the temperature of the outdoor heat exchanger 4 has started increasing due to, for example, influence of an installation place, or a situation in which the temperature of the compressor 1 or the outdoor heat exchanger 4 is not properly obtained due to a malfunction of a temperature thermistor or the like occurring. In such a situation, even though Condition B2 is not fulfilled based on the information of the acquired temperature, there is concern of a temperature difference between the compressor 1 and the outdoor heat exchanger 4 occurring in practice as described in FIG. 8 due to an increase of the outside air temperature, and the refrigerant moving to the compressor 1. Condition B1 is a determination condition prepared for such a situation, and by performing determination of Condition B1 in addition to Condition B2, stagnation of the refrigerant in the compressor 1 caused by a temperature increase as described in FIG. 8 can be reliably prevented.

[0063] According to the present embodiment, the method of turn-on/turn-off control of the crankcase heater 9 when the compressor 1 is stopped can be switched according to a temperature zone of the outside air temperature. Further, when the outside air temperature is in a predetermined range (the "temperature zone B") (for example, -1°C to 30°C), the crankcase heater 9 can be turned on only when a temperature of the outdoor heat exchanger 4 is a predetermined value higher than a tem-

perature of the compressor 1, and the crankcase heater 9 can be turned off when the temperature of the outdoor heat exchanger 4 is lower than the temperature of the compressor 1, and therefore stagnation of the refrigerant in the compressor can be efficiently prevented and energy saving can be achieved. Even when an accurate temperature of the outdoor heat exchanger 4 or the compressor 1 cannot be measured due to an abnormality of the temperature thermistor 11 or 14 or the like, the crankcase heater 9 is turned on if the outside air temperature is monitored to detect an increase in the outside air temperature, and thereby stagnation of the refrigerant in the compressor 1 can be prevented. When the outside air temperature is in the predetermined range (the "temperature zone B"), the crankcase heater 9 can be turned off based on the temperature difference between the temperature of the compressor 1 and the temperature of the outdoor heat exchanger 4, and therefore energy saving can be achieved with turn-off control particularly when the outside air temperature gradually decreases, when no change appears in the outside air temperature, or the like.

[0064] Furthermore, constituent elements in the above-described embodiment can be appropriately replaced with known constituent elements within a scope not deviating from the gist of the present invention. In addition, the technical scope of the invention is not limited to the above-described embodiment, and can be variously modified within a scope not deviating from the gist of the present invention. It should be noted that the temperature difference 1.5°C for determining the "ON area" described in FIG. 7 above is an example of a first threshold value, and the temperature difference 0°C for determining the "OFF area" is an example of a second threshold value.

[0065] According to the control device, the air conditioning device, and the control method described above, by optimizing turn-on/turn-off control of a crankcase heater while a compressor is stopped, energy saving can be achieved.

[Description of Reference Numerals]

[0066]

- 1 Compressor
- 2 Indoor heat exchanger
- 3 Expansion valve
- 4 Outdoor heat exchanger
- 5 Four-way valve
- 6 Piping
- 11, 12, 13, 14 Temperature thermistor
- 20 Control device
- 21 Temperature acquisition unit
- 22 Electrification control unit
- 23 Storage unit

Claims

1. A control device (20) comprising:

5 a temperature acquisition unit (21) configured to acquire, in a refrigerant circuit which includes a heat exchanger (2, 4) and a compressor (1) which is connected to the heat exchanger (2, 4), a temperature of the compressor (1), a temperature of the heat exchanger (2, 4), and an outside air temperature; and
10 an electrification control unit (22) configured to perform, when the outside air temperature acquired by the temperature acquisition unit (21) is included in one range of a plurality of pre-decided temperature zones while the compressor (1) is stopped, turn-on control or turn-off control of a crankcase heater (9) which is configured to heat the compressor (1) based on a temperature difference between the temperature of the compressor and the temperature of the heat exchanger.

25 2. The control device (20) according to claim 1, wherein the electrification control unit (22) is configured to turn on the crankcase heater (9) when the temperature difference obtained by subtracting the temperature of the heat exchanger (2, 4) from the temperature of the compressor (1) is equal to or greater than a first threshold value, and turns off the crankcase heater (9) when the temperature difference is equal to or smaller than a second threshold value which is a lower temperature than the first threshold value.

30 3. The control device (20) according to claim 1 or claim 2, wherein the electrification control unit (22) is configured to turn on the crankcase heater (9) when the acquired outside air temperature continues increasing for a predetermined period of time, regardless of the temperature difference.

35 4. The control device (20) according to any one of claim 1 to claim 3,
40 wherein three temperature zones are set as the plurality of pre-decided temperature zones, and one of the plurality of pre-decided temperature zones is the intermediate temperature zone of the three temperature zones, and
45 wherein the electrification control unit (22) is configured to turn on the crankcase heater (9) when the acquired outside air temperature is a temperature included in the lowest temperature zone among the three temperature zones, and turns off the crankcase heater when the outside air temperature is a temperature included in the highest temperature zone.

50 5. The control device (20) according to claim 2, wherein

the first threshold value is 1.5°C.

6. The control device (20) according to claim 2, wherein the second threshold value is 0°C.
5
7. The control device (20) according to any one of claim 1 to claim 6, wherein the temperature of the compressor (1) is an under-dome temperature of the compressor (1) or a discharge port temperature of the compressor (1).
10
8. An air-conditioning device having a refrigerant circuit which includes a compressor (1), a crankcase heater (9) provided in the compressor (1), and an outdoor heat exchanger (4) connected to the compressor (1), comprising:
15

the control device (20) according to any one of claim 1 to claim 7.
20
9. A control method of a crankcase heater (9) which heats a compressor (1) in a refrigerant circuit which includes a heat exchanger (2, 4) and the compressor (1) connected to the heat exchanger (2, 4), comprising:
25

acquiring a temperature of the compressor (1), a temperature of the heat exchanger (2, 4), and an outside air temperature; and
30
performing turn-on control or turn-off control of the crankcase heater (9) based on the temperature difference between the temperature of the compressor (1) and the temperature of the heat exchanger (2, 4) when the acquired outside air temperature is a temperature included in one
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range of a plurality of pre-decided temperature zones.

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FIG. 1

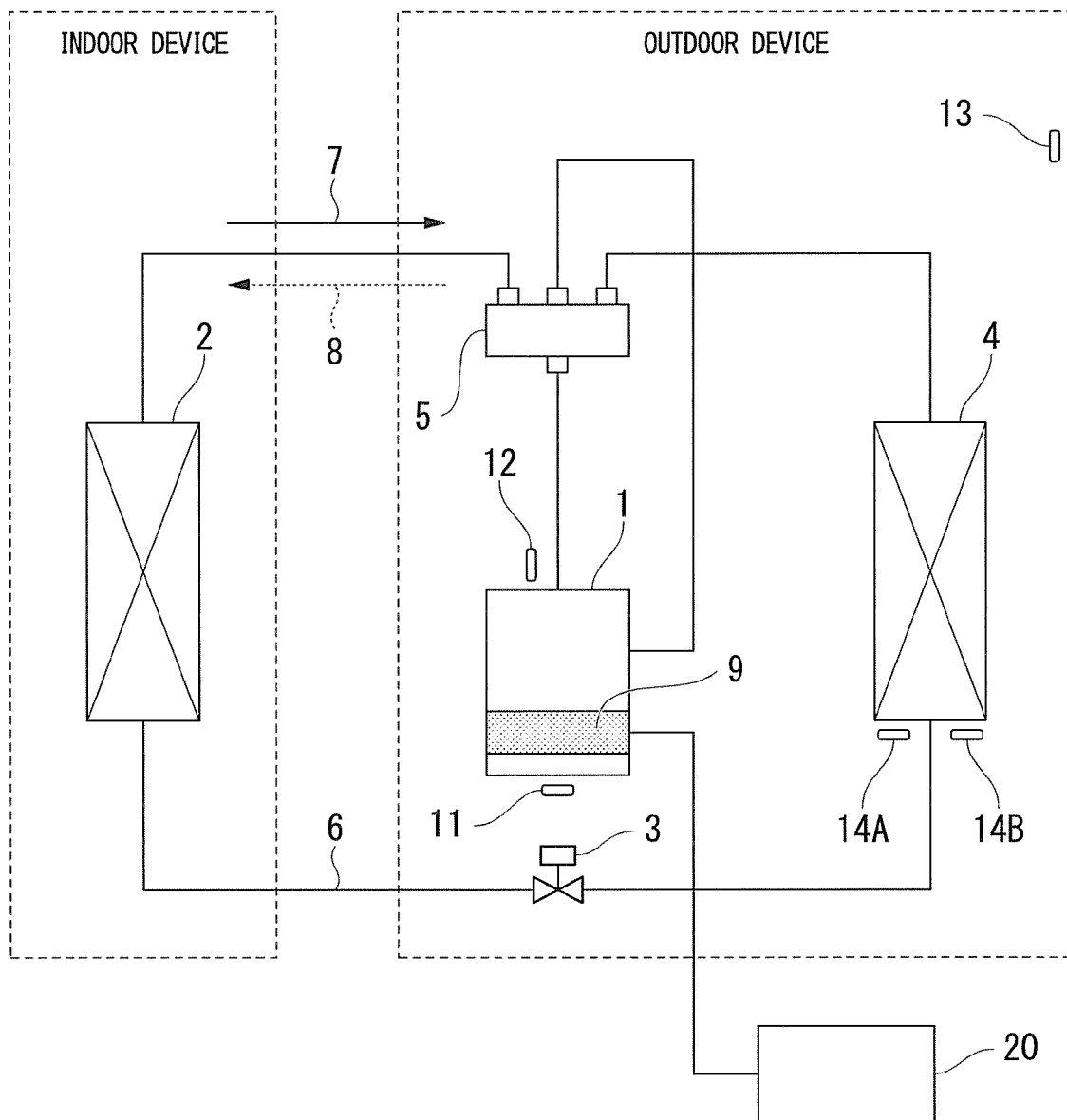


FIG. 2

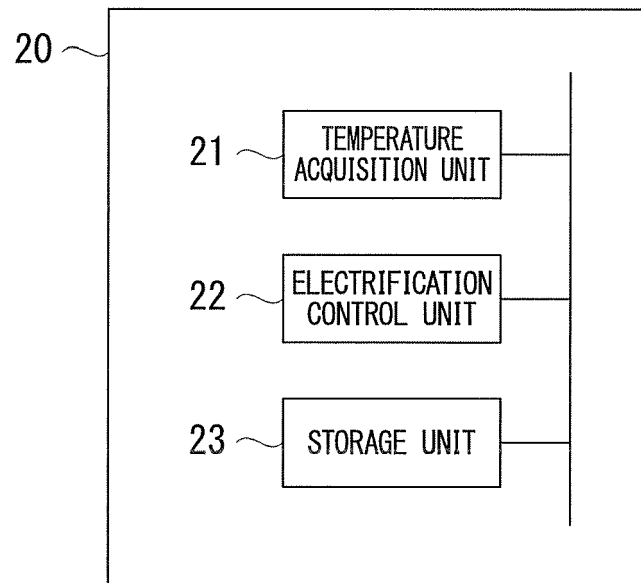


FIG. 3

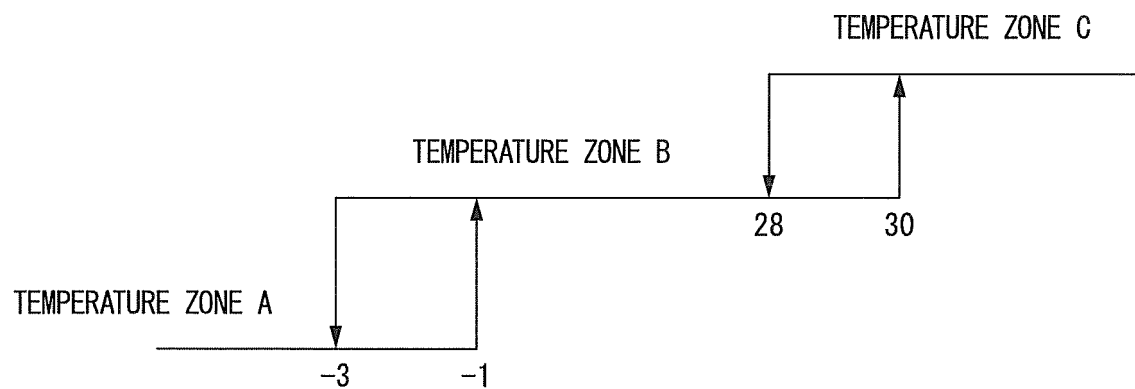


FIG. 4

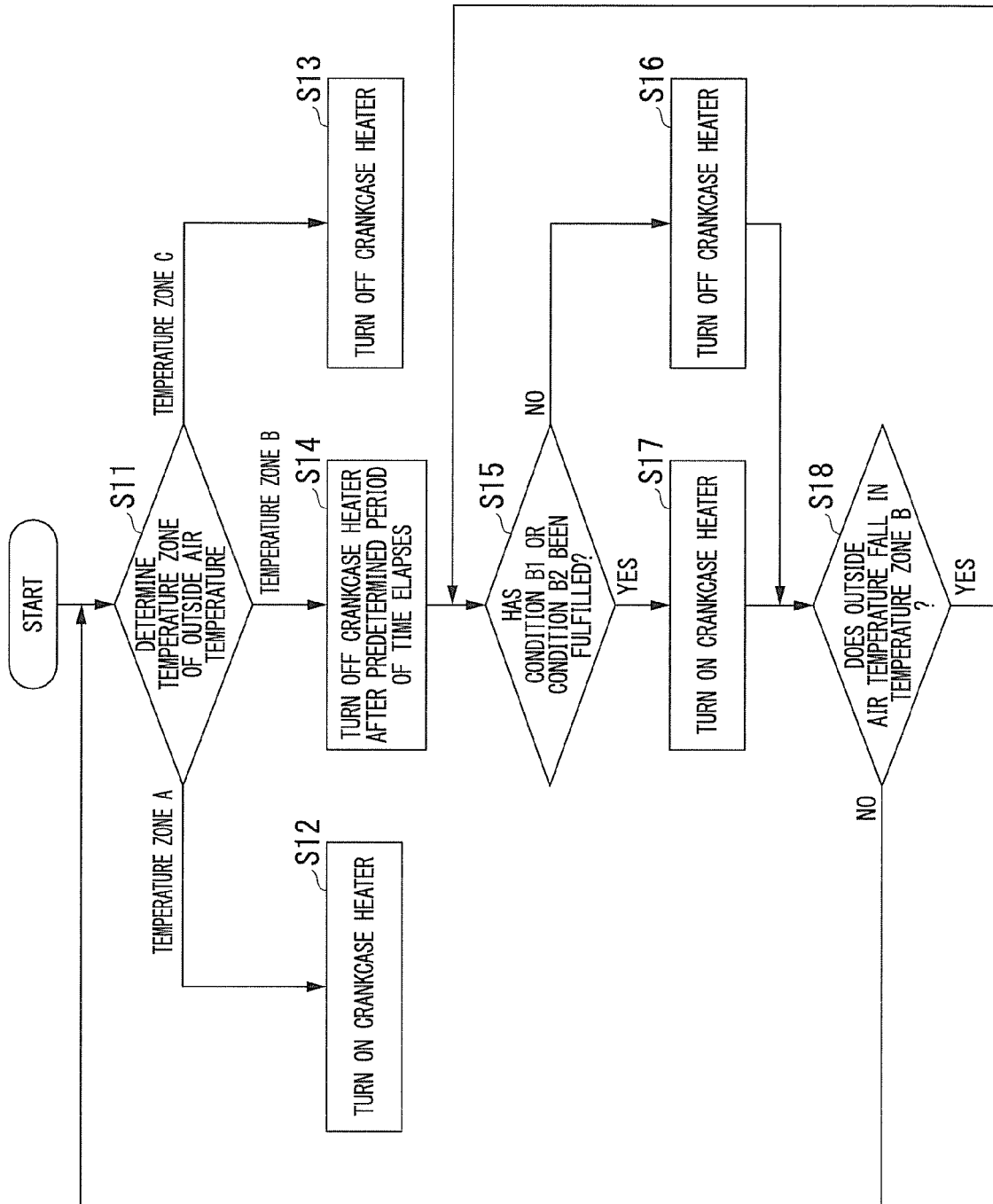


FIG. 5

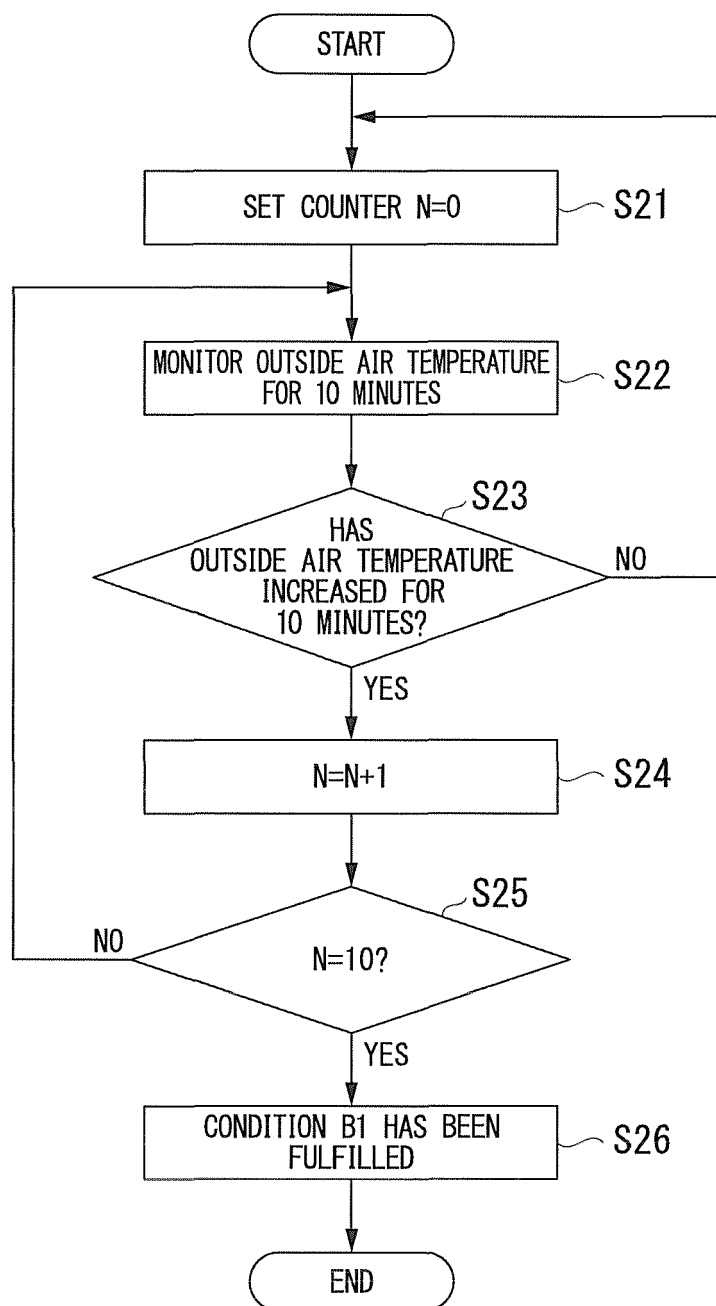


FIG. 6

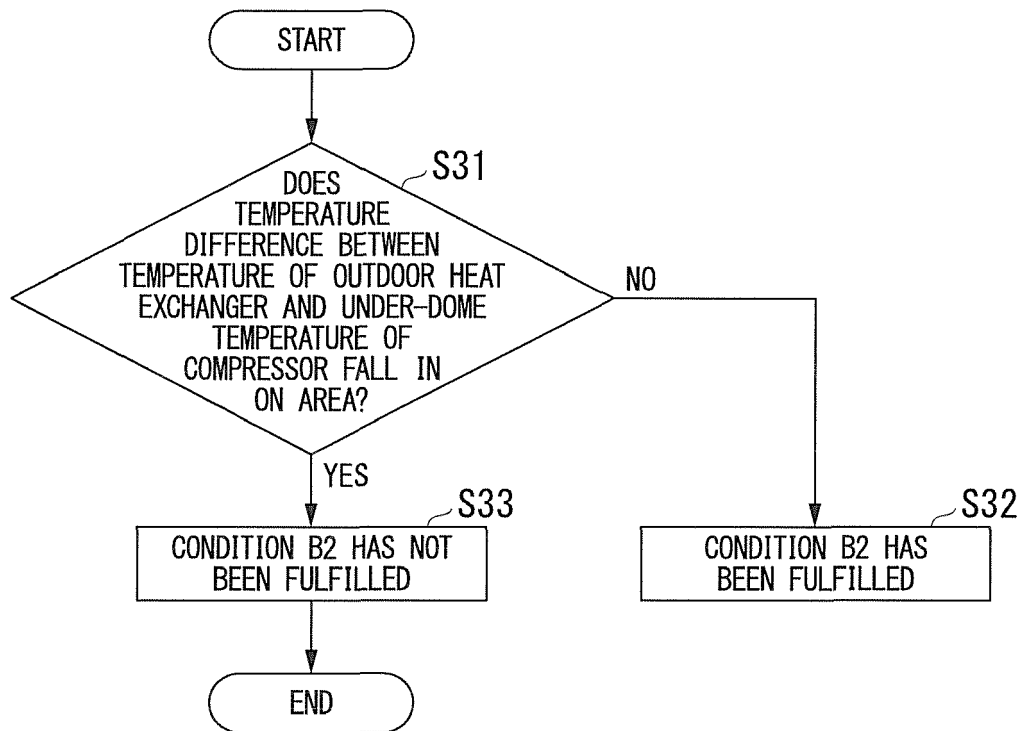


FIG. 7

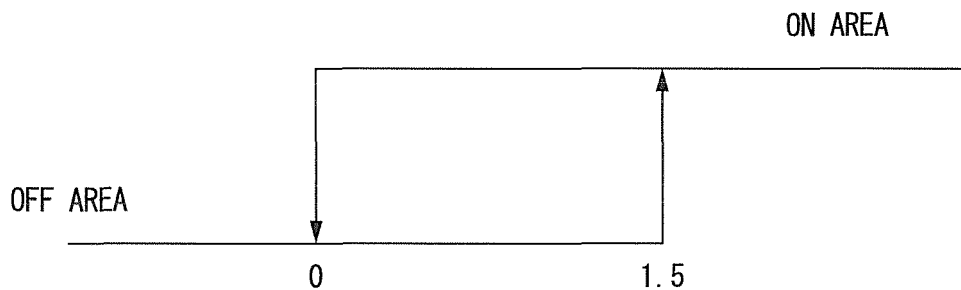
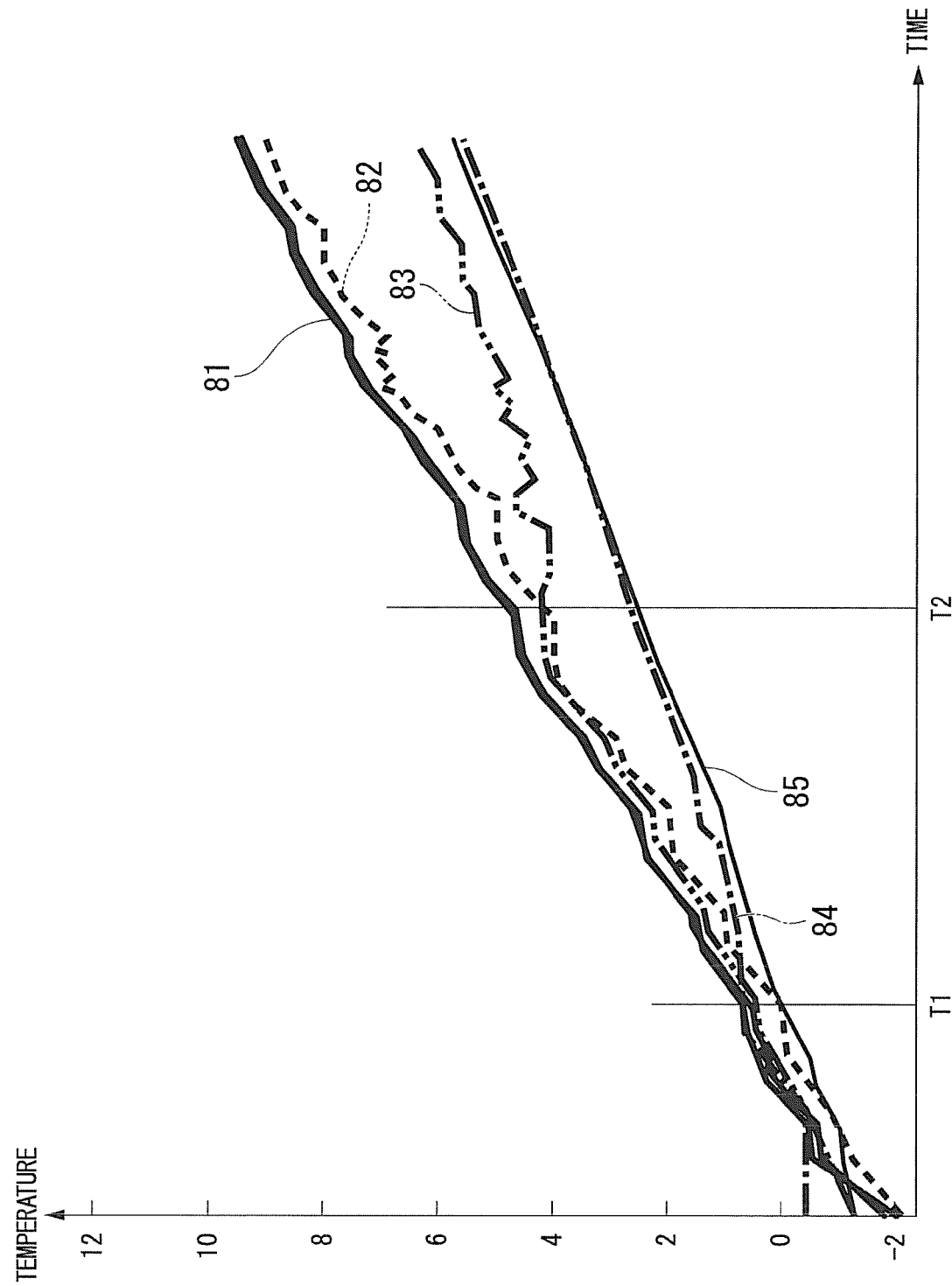


FIG. 8





EUROPEAN SEARCH REPORT

 Application Number
 EP 15 19 5064

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			F25B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 15 April 2016	Examiner Lucic, Anita
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15-04-2016

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