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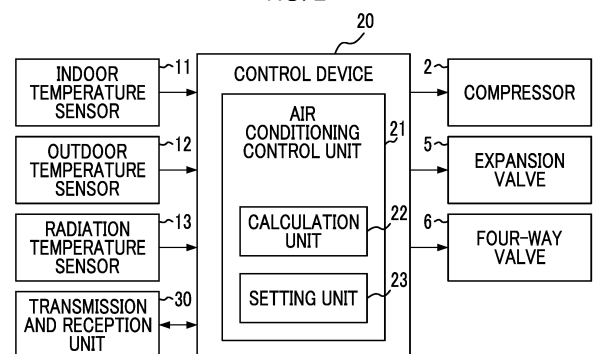
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Remarks:

(54) **CONTROL DEVICE, CONTROL METHOD, AND AIR CONDITIONER**

(57) This control device controls an air conditioner so that a first deviation, which is a deviation of an indoor temperature with respect to a setting temperature, decreases, the air conditioner including a refrigerant circuit through which a refrigerant that has been compressed by a compressor is circulated between an indoor heat exchanger and an outdoor heat exchanger. The control device controls the maximum rotation speed of the compressor on the basis of a prescribed setting value. The control device comprises: a calculation unit for calculating a first time which is the time until the first deviation reaches no more than a first prescribed setting value; and a setting unit that sets a setting value on the basis of the first time period.

FIG. 2



Description

Technical Field

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

[0002] Priority is claimed on Japanese Patent Application No. 2022-134898 filed on August 26, 2022, the content of which is incorporated herein by reference.

Background Art

[0003] PTL 1 describes an air conditioner as follows. That is, the air conditioner described in PTL 1 detects a size, air tightness, and heat insulating properties of a room and regulates a wind direction, a wind amount, and a temperature correction amount at the start of an operation or every predetermined time according to the detection results. In the air conditioner described in PTL 1, for example, the air tightness and the heat insulating properties of the room are detected based on the detected size of the room and a temperature difference between a detected temperature after the start of the operation and a detected temperature after a predetermined time from the start of the operation. In addition, in the air conditioner described in PTL 1, a temperature correction amount is regulated by regulating a detected value of a room temperature sensor or a correction amount of a set temperature. With the air conditioner described in PTL 1, for example, it is possible to prevent a temperature of the room when a thermostat is turned off from becoming too low so that the room is cold during heating or becoming too low so that the room is hot during cooling or to suppress non-uniformity of an indoor temperature in a wide room.

Citation List

Patent Literature

[0004] [PTL 1] Japanese Unexamined Patent Application Publication No. 2017-203581

Summary of Invention

Technical Problem

[0005] However, since the air conditioner described in PTL 1 is intended to maintain comfort, there is a problem in which appropriate air conditioning control is not always performed in some cases in order to improve energy saving performance.

[0006] The present disclosure has been made in order to solve the above problem, and an object of thereof is to provide a control device, a control method, and an air conditioner that can achieve both maintenance of comfort and reduction in power consumption.

Solution to Problem

[0007] According to an aspect of the present disclosure, in order to solve the above problem, there is provided a control device that controls an air conditioner having a refrigerant circuit which circulates a refrigerant compressed by a compressor between an indoor heat exchanger and an outdoor heat exchanger such that a first deviation, which is a deviation of an indoor temperature from a set temperature, is small and that controls a maximum rotation speed of the compressor based on a predetermined set value, the control device including a calculation unit that calculates a first time until the first deviation becomes equal to or smaller than a first predetermined value and a setting unit that sets the set value based on the first time.

[0008] According to another aspect of the present disclosure, there is provided a control method of controlling an air conditioner having a refrigerant circuit which circulates a refrigerant compressed by a compressor between an indoor heat exchanger and an outdoor heat exchanger such that a first deviation, which is a deviation of an indoor temperature from a set temperature, is small and controlling a maximum rotation speed of the compressor based on a predetermined set value, the control method including a step of calculating a first time until the first deviation becomes equal to or smaller than a first predetermined value and a step of setting the set value based on the first time.

[0009] According to still another aspect of the present disclosure, there is provided an air conditioner including a refrigerant circuit that circulates a refrigerant compressed by a compressor between an indoor heat exchanger and an outdoor heat exchanger and a control device that controls a rotation speed of the compressor such that a first deviation, which is a deviation of an indoor temperature from a set temperature, is small, that controls a maximum rotation speed of the compressor based on a predetermined set value, and that has a calculation unit which calculates a first time until the first deviation becomes equal to or smaller than a first predetermined value and a setting unit which sets the set value based on the first time.

Advantageous Effects of Invention

[0010] With the control device, the control method, and the air conditioner of the present disclosure, both maintenance of comfort and reduction in power consumption can be achieved.

Brief Description of Drawings

[0011]

Fig. 1 is a diagram showing an outline of an air conditioner according to a first embodiment of the present disclosure.

Fig. 2 is a diagram showing a configuration example of a control device according to the first embodiment of the present disclosure.

Fig. 3 is a schematic diagram for describing the control device according to the first embodiment of the present disclosure.

Fig. 4 is a schematic diagram for describing the control device according to the first embodiment of the present disclosure.

Fig. 5 is a flowchart showing an operation example of the control device according to the first embodiment of the present disclosure.

Fig. 6 is a schematic diagram for describing the control device according to the first embodiment of the present disclosure.

Fig. 7 is a schematic diagram for describing the control device according to the first embodiment of the present disclosure.

Fig. 8 is a schematic diagram for describing a control device according to a second embodiment of the present disclosure.

Fig. 9 is a flowchart showing an operation example of a control device according to a third embodiment of the present disclosure.

Fig. 10 is a schematic diagram for describing the control device according to the third embodiment of the present disclosure.

Fig. 11 is a flowchart showing an operation example of a control device according to a fourth embodiment of the present disclosure.

Fig. 12 is a schematic diagram for describing the control device according to the fourth embodiment of the present disclosure.

Fig. 13 is a schematic block diagram showing a configuration of a computer according to at least one embodiment.

Description of Embodiments

[0012] Hereinafter, a control device, a control method, and an air conditioner according to an embodiment of the present disclosure will be described with reference to the drawings. In each drawing, the same reference signs will be assigned to the same or corresponding configurations, and description thereof will be omitted as appropriate.

<First Embodiment>

(Configuration of Air Conditioner)

[0013] Fig. 1 is a diagram showing an outline of an air conditioner according to a first embodiment of the present disclosure. As shown in Fig. 1, an air conditioner 100 according to the present embodiment includes a refrigerant circuit 1, including a compressor 2, an indoor heat exchanger 3, an outdoor heat exchanger 4, an expansion valve 5, a four-way valve 6, and a refrigerant pipe 7

connecting these, and a control device 20 that controls the refrigerant circuit 1. For example, an indoor unit 8 is provided with the indoor heat exchanger 3, and an outdoor unit 9 is provided with the compressor 2, the outdoor heat exchanger 4, the expansion valve 5, and the four-way valve 6. In addition, the indoor unit 8 is provided with an indoor temperature sensor 11 that detects an indoor temperature of a room where the indoor unit 8 is installed and a radiation temperature sensor 13 that detects a radiation temperature from a wall or a floor of the room. In addition, the outdoor unit 9 is provided with an outdoor temperature sensor 12 that detects an outdoor temperature. In addition, in the control device 20, for example, a set temperature and an operation mode of the air conditioner 100 are set by a transmission and reception unit 30 such as a remote control operated by a user and a smartphone. The indoor temperature sensor 11 detects, for example, a temperature of air sucked by the indoor heat exchanger 3. In addition, the radiation temperature sensor 13 is, for example, a thermopile sensor and includes a thermopile (infrared sensor), an optical system that focuses infrared rays radiated from an object on the thermopile, and a signal processing circuit that processes an output signal of the thermopile. The set temperature is a target temperature for room temperature control. The operation mode is an operation method such as a heating operation and a cooling operation.

[0014] The compressor 2 compresses a refrigerant and discharges and supplies the high-temperature and high-pressure refrigerant after compression to the refrigerant pipe 7. The high-pressure refrigerant compressed by the compressor 2 flows into a port 6a of the four-way valve 6 via the refrigerant pipe 7.

[0015] In the heating operation, the control device 20 controls the four-way valve 6 such that the port 6a and a port 6b of the four-way valve 6 are connected to each other and a port 6c and a port 6d are connected to each other. Accordingly, in the heating operation, the refrigerant flows in a direction of an arrow A1. That is, the high-temperature and high-pressure refrigerant is supplied to the indoor heat exchanger 3 via the four-way valve 6. The refrigerant radiates heat and is condensed and liquefied in the indoor heat exchanger 3. In addition, the refrigerant condensed in the indoor heat exchanger 3 is depressurized by the expansion valve 5 to become a low-pressure refrigerant. The low-pressure refrigerant is supplied to the outdoor heat exchanger 4 and vaporizes due to, for example, heat absorption from outside air. That is, in the heating operation, the indoor heat exchanger 3 functions as a condenser, and the outdoor heat exchanger 4 functions as an evaporator. In addition, the vaporized refrigerant is sucked by the compressor 2 via the four-way valve 6. The compressor compresses the low-pressure refrigerant again and discharges the high-temperature and high-pressure refrigerant.

[0016] On the other hand, in the cooling operation, the control device 20 controls the four-way valve 6 such that the port 6a and the port 6d of the four-way valve 6 are

connected to each other and the port 6b and the port 6c are connected to each other. Accordingly, in the cooling operation, the refrigerant flows in a direction of an arrow A2. That is, the high-temperature and high-pressure refrigerant is supplied to the outdoor heat exchanger 4 via the four-way valve 6, radiates heat to the outside air, and is condensed. In addition, the refrigerant condensed in the outdoor heat exchanger 4 is depressurized by the expansion valve 5 and is supplied to the indoor heat exchanger 3. In the indoor heat exchanger 3, the refrigerant is vaporized by, for example, heat absorption from indoor air. That is, in the cooling operation, the outdoor heat exchanger 4 functions as a condenser, and the indoor heat exchanger 3 functions as an evaporator. In addition, the vaporized refrigerant is sucked by the compressor 2 via the four-way valve 6. The compressor compresses the low-pressure refrigerant again and discharges the high-temperature and high-pressure refrigerant.

[0017] The air conditioner 100 performs heating or cooling by repeating the above process to circulate the refrigerant. The control device 20 switches between the heating operation and the cooling operation by controlling the four-way valve 6. In addition, the control device 20 executes the heating operation or the cooling operation by adjusting a rotation speed of the compressor 2 such that the room temperature is the set temperature, based on a difference between the indoor temperature measured by the indoor temperature sensor 11 of the indoor heat exchanger 3 and the set temperature set by the user. In this case, the control device 20 according to the present embodiment controls the air conditioner 100 having the refrigerant circuit 1 that circulates the refrigerant compressed by the compressor 2 between the indoor heat exchanger 3 and the outdoor heat exchanger 4 such that a first deviation, which is a deviation of the indoor temperature from the set temperature, is small.

[0018] In addition, when the heating operation is performed in an environment where an outside air temperature is low, frost adheres to the outdoor heat exchanger 4 in some cases. In order to prevent a decrease in a heating capacity caused by frosting, the air conditioner 100 performs a defrosting operation of removing frost on the outdoor unit 9. In the defrosting operation, the control device 20 switches the four-way valve 6 such that a circulation direction of the refrigerant is the same direction as in the cooling operation (the arrow A2 in Fig. 1). Accordingly, the outdoor unit 9 is defrosted by supplying the high-temperature and high-pressure refrigerant to the outdoor heat exchanger 4.

(Configuration of Control Device)

[0019] Fig. 2 is a diagram showing a configuration example of the control device 20 according to the first embodiment of the present disclosure. Figs. 3, 4, 6, and 7 are schematic diagrams for describing the control device 20 according to the first embodiment of the present

disclosure. Fig. 5 is a flowchart showing an operation example of the control device 20 according to the first embodiment of the present disclosure.

[0020] The control device 20 of the present embodiment includes an air conditioning control unit 21 as a functional configuration that can be configured by using a computer such as a microcomputer and that is configured by a combination of hardware, such as the computer, a peripheral circuit, and a peripheral device, and software, such as a program executed by the computer. In addition, the air conditioning control unit 21 includes a calculation unit 22 and a setting unit 23.

[0021] The air conditioning control unit 21 inputs output signals of various types of sensors such as the indoor temperature sensor 11, the outdoor temperature sensor 12, the radiation temperature sensor 13, and a humidity sensor (not shown), transmits and receives a predetermined signal to and from the transmission and reception unit 30, and controls the compressor 2, the expansion valve 5, the four-way valve 6, a fan and a wind direction plate in the indoor unit 8 (not shown), a fan in the outdoor unit 9, and the like (hereinafter, referred to as the compressor 2 and the like) based on a set operation mode, the set temperature, and the like.

[0022] In addition, in the present embodiment, the air conditioning control unit 21 controls the compressor 2 and the like such that the first deviation, which is the deviation of the indoor temperature from the set temperature, is small as described above. In this case, the air conditioning control unit 21 controls a maximum rotation speed of the compressor 2 based on a "set value" set by the setting unit 23 as will be described later. The maximum rotation speed of the compressor 2 is a maximum value (upper limit value) of the rotation speed when controlling the rotation speed of the compressor 2. In addition, the "set value" that is used as reference when controlling the maximum rotation speed of the compressor 2 may be, for example, a value of the maximum rotation speed itself or may be a predetermined reference value (for example, a value of a rotation speed that is lower than the maximum rotation speed by a predetermined rotation speed, a value that represents a range of a rotation speed having a predetermined width above and below the maximum rotation speed, and the like) that is used in a case where the rotation speed is controlled to be equal to or lower than the maximum rotation speed. Hereinafter, the "set value" will also be referred to as a "compressor maximum rotation speed set value".

[0023] In addition, the calculation unit 22 according to the present embodiment calculates a first time until the first deviation becomes equal to or smaller than a first predetermined value. Herein, the "first deviation", the "first predetermined value", and the "first time" will be described with reference to Fig. 3. Fig. 3 shows, with a solid line, an example of a change in the indoor temperature over time in a case where the air conditioner 100 is in the cooling operation. As shown in Fig. 3, the "first deviation" is a deviation of the indoor temperature from the set

temperature (a temperature difference between the set temperature and the indoor temperature) as described above. The "first deviation" is calculated by, for example, a calculation equation "(indoor temperature) - (set temperature)". In addition, the "first predetermined value" is a determination value corresponding to the first deviation in a case where it can be determined that the indoor temperature has almost reached the set temperature. The first predetermined value may be positive, negative, or zero. In the example shown in Fig. 3, at time point t1, the first deviation is equal to or smaller than the first predetermined value. In addition, the "first time" is a time from when the air conditioner 100 starts the room temperature control (or changes control content) to when the indoor temperature reaches (or almost reaches) the set temperature, and in the example shown in Fig. 3, is a time from time point t0 to time point t1. The time point t0 is, for example, an operation start time point of operating of the air conditioner 100, a time point of change of the set temperature, a time point of change of the operation mode, and the like. The "first time" is affected by an installation environment of the air conditioner 100 and is changed by, for example, a difference in heat insulating properties or air tightness of the room. In a case where the "first time" is relatively short, it can be said that, for example, the heat insulating properties are good, and in a case where the "first time" is relatively long, it can be said that, for example, the heat insulating properties are poor.

[0024] In addition, the setting unit 23 sets the "set value" (compressor maximum rotation speed set value) based on the "first time" calculated by the calculation unit 22. Fig. 4 shows table T1 in which a setting example of the set value in the present embodiment is defined. According to table T1 shown in Fig. 4, for example, in a case where the first time is within a first threshold value, the setting unit 23 decreases the set value from the current set value. In a case where the first time is larger than the first threshold value and is smaller than a second threshold value, the setting unit 23 does not change the set value from the current set value. However, the second threshold value is a value larger than the first threshold value. In a case where the first time is equal to or larger than the second threshold value, the setting unit 23 increases the set value from the current set value. The first threshold value is, for example, a determination value with which it can be determined that the heat insulating properties are good. In addition, the second threshold value is, for example, a determination value with which it can be determined that the heat insulating properties are poor. In addition, in the present embodiment, the setting of the "set value" by the setting unit 23 includes a case where the "set value" is changed and a case where the "set value" is not changed. The setting unit 23 increases or decreases the set value within a range of a limit on the upper limit value of the rotation speed, such as a maximum rated rotation speed, or a limit on a lower limit value of the predetermined rotation

speed.

[0025] For example, once the set temperature is reached within A minutes (for example, 10 minutes) from the start of the cooling operation, the setting unit 23 determines that the heat insulating properties are good and lowers the set value (for example, 100 rps to 95 rps). In addition, in the next operation, once the set temperature is reached within A minutes from the start of the cooling operation, the setting unit 23 lowers the set value again (for example, 95 rps to 90 rps). In addition, in a case where the set temperature is not reached for B minutes (for example, 20 minutes) or more from the start of the operation, the setting unit 23 raises the set value (for example, 90 to 95 rps). In addition, the setting unit 23 does not change the set value in a case where the time taken to reach the set temperature is A to B minutes. The setting unit 23 automatically adjusts the set value (maximum rotation speed) of the compressor 2 to be suitable for the room where the air conditioner 100 is used by repeating this setting operation of the set value. In this example, the first threshold value shown in Fig. 4 corresponds to A minutes, and the second threshold value corresponds to B minutes. In addition, in a case of lowering or raising the rotation speed, the rotation speed is changed by a predetermined rotation speed (for example, 5 rps). However, an increase/decrease amount is not limited to a constant and may be changed by, for example, a variable or a predetermined ratio with respect to the current set value.

(Operation Example of Air Conditioner)

[0026] Fig. 5 shows an example of the setting operation of a set value by the control device 20. The processing shown in Fig. 5 is executed, for example, at the start of the operation of the air conditioner 100. In the processing shown in Fig. 5, first, the calculation unit 22 calculates the first time for which the first deviation, which is the deviation of the indoor temperature from the set temperature, becomes equal to or smaller than the first predetermined value (step S11). Next, the setting unit 23 sets the set value of the maximum rotation speed of the compressor 2 based on the first time (step S12).

[0027] Fig. 6 shows an example of a change in the rotation speed of the compressor 2 and the indoor temperature in the cooling operation of the air conditioner 100 over time. In the example shown in Fig. 6, the operation is started at time point t0, and the rotation speed of the compressor 2 increases at a predetermined rate of change. Then, the rotation speed is controlled in the vicinity of the set value from time point t02 to time point t03 in a range that does not exceed the "set value" (compressor maximum rotation speed set value (before change)) at the start of the operation. Then, after time point t03, the rotation speed gradually decreases, the first deviation is equal to or smaller than the first predetermined value at time point t1, and the set value is changed (decreased) from the compressor maximum rotation

speed set value (before change) to the compressor maximum rotation speed set value (after change). In the example shown in Fig. 6, the set value is changed after the rotation speed of the compressor 2 reaches around the maximum rotation speed and is further decreased. Therefore, the changed set value is valid from the next operation. Fig. 7 shows an example of a change in the rotation speed of the compressor 2 before and after the change over time. In an operating example after the change, the operation time in the vicinity of the set value is extended compared to before the change, but an increase in the maximum rotation speed is suppressed.

(Operational Effects of Present Embodiment)

[0028] Basically, the higher the rotation speed of the compressor, the larger the power consumption. According to the present embodiment, it is possible to suppress an increase in power consumption without impairing comfort by adjusting the maximum rotation speed according to the room. That is, according to the present embodiment, both maintenance of comfort and reduction in power consumption can be achieved.

<Second Embodiment>

[0029] Fig. 8 is a schematic diagram for describing a control device according to a second embodiment of the present disclosure. Fig. 8 shows an example of a change in the rotation speed of the compressor 2 and the indoor temperature in the cooling operation of the air conditioner 100 in the second embodiment over time. The configuration and the operation of the air conditioner 100 and the control device 20 described with reference to Figs. 1 to 5 are the same between the first embodiment and the second embodiment except for the following points. That is, in the first embodiment, as shown in Fig. 6, the set value is changed in a case where the first time for which the first deviation becomes equal to or smaller than the first predetermined value has elapsed. On the other hand, in the second embodiment, as shown in Fig. 8, the first time is predicted, and the set value is changed before the first time elapses. In this case, the calculation unit 22 of the second embodiment calculates the first time through prediction before the first time elapses.

[0030] The calculation unit 22 of the second embodiment creates a regression model based on each of actual values, such as the set temperature, the indoor temperature, the outdoor temperature, the rotation speed of the compressor 2, and the first time, and predicts the first time using the created regression model. For example, the calculation unit 22 of the second embodiment creates a trained machine learning model that is trained through machine learning based on at least each of actual values, such as the set temperature, the indoor temperature, the rotation speed of the compressor 2, and the first time, and predicts the first time using the created trained machine learning model. In this case, the indoor temperature may

be only a value at the start of the operation or may include a plurality of time-series values before reaching the set temperature. In addition, the rotation speed may be only a value of the maximum rotation speed (set value) or may include the plurality of time-series values before reaching the set temperature.

[0031] Until the regression model can be created by acquiring a plurality of actual values, the calculation unit 22 of the second embodiment can change the set value in a case where the first time elapses, for example, like the calculation unit 22 of the first embodiment.

[0032] According to the second embodiment, for example, as shown in Fig. 8, when the first time can be predicted before the rotation speed approaches around the maximum rotation speed (set value) (before time point t02) (time point t01 before time point t02), the set value can be changed (time point t01), and the change in the set value can be reflected (made valid) in the current operation.

<Third Embodiment>

[0033] Fig. 9 is a flowchart showing an operation example of a control device according to a third embodiment of the present disclosure. Fig. 10 is a schematic diagram for describing the control device according to the third embodiment of the present disclosure. The configuration and the operation of the air conditioner 100 and the control device 20 described with reference to Figs. 1 to 3 are the same between the first embodiment and the third embodiment except for the following points. That is, the calculation unit 22 of the first embodiment calculates the first time until the first deviation becomes equal to or smaller than the first predetermined value. In addition, the setting unit 23 of the first embodiment sets the set value based on the first time. On the other hand, the calculation unit 22 of the third embodiment further calculates a second time until a second deviation, which is a deviation of the radiation temperature measured by the radiation temperature sensor 13 indoors from the set temperature, becomes equal to or smaller than a second predetermined value. In addition, the setting unit 23 of the third embodiment sets the set value based on the first time and the second time. The second deviation, the second predetermined value, and the second time correspond to a case where the indoor temperature in the first deviation, the first predetermined value, and the first time is replaced with the radiation temperature.

[0034] As shown in Fig. 9, in the control device 20 of the third embodiment, first, the calculation unit 22 of the third embodiment calculates the first time for which the first deviation, which is the deviation of the indoor temperature from the set temperature, becomes equal to or smaller than the first predetermined value (step S31) and calculates the second time for which the second deviation, which is the deviation of the radiation temperature from the set temperature, becomes equal to or smaller than the second predetermined value (step

S32). Next, the setting unit 23 of the third embodiment sets the set value of the maximum rotation speed of the compressor 2 based on the first time and the second time (step S33).

[0035] Fig. 10 shows table T3 in which a setting example of the set value in the present embodiment is defined. According to table T3 shown in Fig. 10, for example, in a case where the first time is within the first threshold value, the setting unit 23 decreases the set value from the current set value when the second time is within a third threshold value and does not change the set value from the current set value when the second time is larger than the third threshold value. Herein, the third threshold value is a determination value for determining, for example, whether the heat insulating properties of the room are good or poor from a temperature change of the wall or the floor detected by the radiation temperature sensor. In addition, in a case where the first time is larger than the first threshold value and is smaller than the second threshold value, the setting unit 23 does not change the set value from the current set value when the second time is within the third threshold value and increases the set value from the current set value when the second time is larger than the third threshold value. In addition, in a case where the first time is equal to or larger than the second threshold value, the setting unit 23 increases the set value from the current set value.

[0036] According to the present embodiment, the maximum rotation speed can be adjusted according to the room in consideration of the temperature change of the floor or the wall in addition to the indoor temperature.

<Fourth Embodiment>

[0037] Fig. 11 is a flowchart showing an operation example of a control device according to a fourth embodiment of the present disclosure. Fig. 12 is a schematic diagram for describing the control device according to the fourth embodiment of the present disclosure. The configuration and the operation of the air conditioner 100 and the control device 20 described with reference to Figs. 1 to 3 are the same between the first embodiment and the fourth embodiment except for the following points. That is, the calculation unit 22 of the first embodiment calculates the first time until the first deviation becomes equal to or smaller than the first predetermined value. In addition, the setting unit 23 of the first embodiment sets the set value based on the first time. On the other hand, the calculation unit 22 of the fourth embodiment further calculates a temperature difference between the set temperature and the indoor temperature at the start of the operation (however, the setting unit 23 may calculate the temperature difference, for example). In addition, the setting unit 23 of the third embodiment sets the set value based on the temperature difference between the set temperature and the indoor temperature at the start of the operation and the first time.

[0038] As shown in Fig. 12, in the control device 20 of

the fourth embodiment, first, the calculation unit 22 of the fourth embodiment calculates a temperature difference between the set temperature and the indoor temperature at the start of the operation (step S41) and calculates the first time for which the first deviation, which is the deviation of the indoor temperature from the set temperature, becomes equal to or smaller than the first predetermined value (step S42). Next, the setting unit 23 of the fourth embodiment sets the set value of the maximum rotation speed of the compressor 2 based on the first time and the calculated temperature difference (step S43).

[0039] Fig. 12 shows table T4 in which a setting example of the set value in the present embodiment is defined. According to table T4 shown in Fig. 12, for example, in a case where the first time is within the first threshold value, the setting unit 23 does not change the set value when the temperature difference is within a fourth threshold value, decreases the set value by a change amount $\Delta 1$ when the temperature difference is larger than the fourth threshold value and is smaller than a fifth threshold value, and decreases the set value by a change amount $\Delta 2$ when the temperature difference is equal to or larger than the fifth threshold value. The change amount $\Delta 1$ is smaller than the change amount $\Delta 2$. In addition, the fourth threshold value is smaller than the fifth threshold value. In addition, in a case where the first time is larger than the first threshold value and is smaller than the second threshold value, the setting unit 23 does not change the set value. In addition, in a case where the first time is equal to or larger than the second threshold value, the setting unit 23 does not change the set value when the temperature difference is within the fourth threshold value, increases the set value by the change amount $\Delta 2$ when the temperature difference is larger than the fourth threshold value and is smaller than the fifth threshold value, and increases the set value by the change amount $\Delta 1$ when the temperature difference is equal to or larger than the fifth threshold value.

[0040] According to the present embodiment, for example, in a case where the temperature difference between the set temperature and the indoor temperature at the start of the operation is small (in a case where the temperature difference is within the fourth threshold value), it is possible to not change the set value without determining the heat insulating properties of the room or the like. In addition, for example, in a case where the temperature difference is large (in a case where the temperature difference is equal to or larger than the fifth threshold value), a decrease amount when the maximum rotation speed is decreased can be made large, and an increase amount when the maximum rotation speed is increased can be made small, compared to a case where the temperature difference is not large (in a case where the temperature difference is smaller than the fifth threshold value). According to the present embodiment, the maximum rotation speed can be adjusted according to the room in consideration of the temperature difference at the start of the operation in addition to the indoor tem-

perature.

(Operational Effects)

[0041] In the control device, the control method, and the air conditioner having the above configuration, in the control of decreasing the first deviation, which is the deviation of the indoor temperature from the set temperature, the maximum rotation speed of the compressor is controlled based on the set value, which is set based on the first time until the first deviation becomes equal to or smaller than the first predetermined value. The first time is an element that is affected by the heat insulating properties of the room and the like, and the maximum rotation speed of the compressor is an element that affects power consumption. For this reason, adjusting the maximum rotation speed according to the first time is adjusting a degree of reduction in power consumption according to the heat insulating properties of the room or the like. Therefore, with the control device, the control method, and the air conditioner of the embodiment, both maintenance of comfort and reduction in power consumption can be achieved by adjusting the maximum rotation speed according to the first time.

(Other Embodiments)

[0042] Although the embodiments of the present disclosure have been described in detail with reference to the drawings hereinbefore, a specific configuration is not limited to the embodiments, and design changes or the like are also included without departing from the gist of the present disclosure. For example, configurations and operations of respective embodiments can be combined as appropriate. Although the maximum rotation speed is, for example, increased or decreased according to comparison results between the first time and a predetermined threshold value (the first threshold value and the second threshold value) in the above embodiments, a raising width or a lowering width may be changed, for example, according to the magnitude of a difference between the first time and the predetermined threshold value, that is, the length of time until the set temperature is reached. In addition, when creating the regression model, actual values such as the outdoor temperature and humidity can be further used. In addition, in a case where the indoor temperature and the radiation temperature are considered, a change in both temperatures may be considered, or one of the temperatures (for example, a temperature with a slower change) may be selectively considered.

<Computer Configuration>

[0043] Fig. 13 is a schematic block diagram showing a configuration of a computer according to at least one embodiment.

[0044] A computer 90 includes a processor 91, a main

memory 92, a storage 93, and an interface 94.

[0045] The control device 20 described above is mounted on the computer 90. An operation of each processing unit described above is stored in a form of a program in the storage 93. The processor 91 reads the program from the storage 93, deploys the program in the main memory 92, and executes the processing in accordance with the program. In addition, the processor 91 secures a storage area, which corresponds to each storage unit described above, in the main memory 92 in accordance with the program.

[0046] The program may be a program for realizing some of the functions performed by the computer 90. For example, the program may be a program that performs the functions in combination with other programs already stored in the storage or in combination with other programs installed in other devices. In other embodiments, the computer may include a custom large scale integrated (LSI) circuit such as a programmable logic device (PLD) in addition to the above configuration or instead of the above configuration. Examples of the PLD include a programmable array logic (PAL), a generic array logic (GAL), a complex programmable logic device (CPLD), and a field programmable gate array (FPGA). In this case, some or all of the functions realized by the processor may be realized by the integrated circuit.

[0047] Examples of the storage 93 include a hard disk drive (HDD), a solid state drive (SSD), a magnetic disk, a magneto-optical disk, a compact disc read only memory (CD-ROM), a digital versatile disc read only memory (DVD-ROM), and a semiconductor memory. The storage 93 may be an internal medium directly connected to a bus of the computer 90 or may be an external medium connected to the computer 90 via the interface 94 or a communication line. In addition, in a case where the program is distributed to the computer 90 via the communication line, the computer 90 that has received the distribution may deploy the program in the main memory 92 and execute the processing. In at least one embodiment, the storage 93 is a non-transitory tangible storage medium.

<Appendix>

[0048] The control device 20 described in each of the embodiments is understood as follows, for example.

(1) The control device 20 according to a first aspect is the control device 20 that controls the air conditioner 100 having the refrigerant circuit 1 which circulates a refrigerant compressed by the compressor 2 between the indoor heat exchanger 3 and the outdoor heat exchanger 4 such that a first deviation, which is a deviation of an indoor temperature from a set temperature, is small and that controls a maximum rotation speed of the compressor 2 based on a predetermined set value and includes the calculation unit 22 that calculates a first time until the first deviation

tion becomes equal to or smaller than a first predetermined value and the setting unit 23 that sets the set value based on the first time. According to the present aspect and each of the following aspects, both maintenance of comfort and reduction in power consumption can be achieved.

(2) The control device 20 according to a second aspect is the control device 20 of (1). The setting unit 23 decreases the set value in a case where the first time is equal to or smaller than the first threshold value, does not change the set value in a case where the first time is smaller than a second threshold value, which is larger than the first threshold value, and is larger than the first threshold value, and increases the set value in a case where the first time is equal to or larger than the second threshold value.

(3) The control device 20 according to a third aspect is the control device 20 of (1) or (2). The calculation unit 22 calculates the first time through prediction before the first time elapses.

(4) The control device 20 according to a fourth aspect is the control device 20 of (1) to (3). The calculation unit 22 predicts the first time using a trained machine learning model that is trained through machine learning based on at least each of actual values of the set temperature, the indoor temperature, the rotation speed, and the first time.

(5) The control device 20 according to a fifth aspect is the control device 20 of (1) to (4). The calculation unit 22 further calculates a second time until a second deviation, which is a deviation of a radiation temperature measured by a radiation temperature sensor indoors from the set temperature, becomes equal to or smaller than a second predetermined value, and the setting unit 23 sets the set value based on the first time and the second time. According to the present aspect, the maximum rotation speed can be set in consideration of the temperature change of the wall or the floor of the room.

(6) The control device 20 according to a sixth aspect is the control device 20 of (1) to (5). The setting unit sets the set value based on a temperature difference between the set temperature and the indoor temperature at start of an operation and the first time.

Industrial Applicability

[0049] According to the aspect described above, both maintenance of comfort and reduction in power consumption can be achieved.

Reference Signs List

[0050]

100 air conditioner
1 refrigerant circuit
2 compressor

3 indoor heat exchanger
4 outdoor heat exchanger
5 expansion valve
6 four-way valve
7 refrigerant pipe
8 indoor unit
9 outdoor unit
11 indoor temperature sensor
12 outdoor temperature sensor
10 13 radiation temperature sensor
20 control device
21 air conditioning control unit
22 calculation unit
23 setting unit

Claims

1. A control device that controls an air conditioner having a refrigerant circuit which circulates a refrigerant compressed by a compressor between an indoor heat exchanger and an outdoor heat exchanger such that a first deviation, which is a deviation of an indoor temperature from a set temperature, is small and that controls a maximum rotation speed of the compressor based on a predetermined set value, the control device comprising:

a calculation unit that calculates a first time until the first deviation becomes equal to or smaller than a first predetermined value; and
a setting unit that sets the set value based on the first time.

2. The control device according to Claim 1, wherein the setting unit decreases the set value in a case where the first time is equal to or smaller than the first threshold value, does not change the set value in a case where the first time is smaller than a second threshold value, which is larger than the first threshold value, and is larger than the first threshold value, and increases the set value in a case where the first time is equal to or larger than the second threshold value.

3. The control device according to Claim 2, wherein the calculation unit calculates the first time through prediction before the first time elapses.

4. The control device according to Claim 3, wherein the calculation unit predicts the first time using a trained machine learning model that is trained through machine learning based on at least each of actual values of the set temperature, the indoor temperature, the maximum rotation speed, and the first time.

5. The control device according to Claim 4,

wherein the calculation unit further calculates a second time until a second deviation, which is a deviation of a radiation temperature measured by a radiation temperature sensor indoors from the set temperature, becomes equal to or smaller than a second predetermined value, and the setting unit sets the set value based on the first time and the second time. 5

6. The control device according to Claim 5, wherein the setting unit sets the set value based on a temperature difference between the set temperature and the indoor temperature at start of an operation and the first time. 10

7. A control method of controlling an air conditioner having a refrigerant circuit which circulates a refrigerant compressed by a compressor between an indoor heat exchanger and an outdoor heat exchanger such that a first deviation, which is a deviation of an indoor temperature from a set temperature, is small and controlling a maximum rotation speed of the compressor based on a predetermined set value, the control method comprising: 15 20

a step of calculating a first time until the first deviation becomes equal to or smaller than a first predetermined value; and
a step of setting the set value based on the first time. 25 30

8. An air conditioner comprising:

a refrigerant circuit that circulates a refrigerant compressed by a compressor between an indoor heat exchanger and an outdoor heat exchanger; and
a control device that controls a rotation speed of the compressor such that a first deviation, which is a deviation of an indoor temperature from a set temperature, is small, that controls a maximum rotation speed of the compressor based on a predetermined set value, and that has a calculation unit which calculates a first time until the first deviation becomes equal to or smaller than a first predetermined value and a setting unit which sets the set value based on the first time. 35 40 45

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FIG. 1

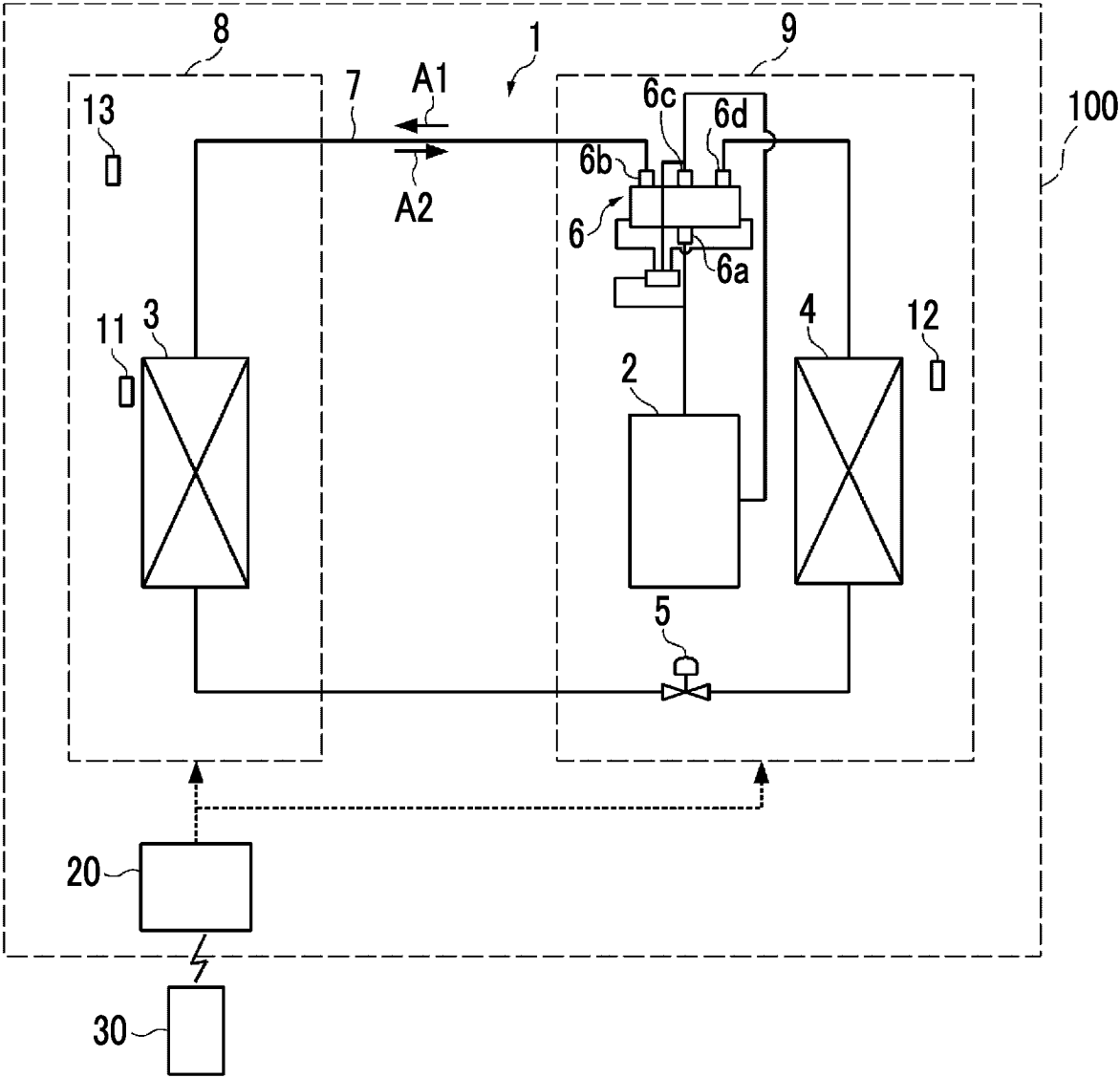


FIG. 2

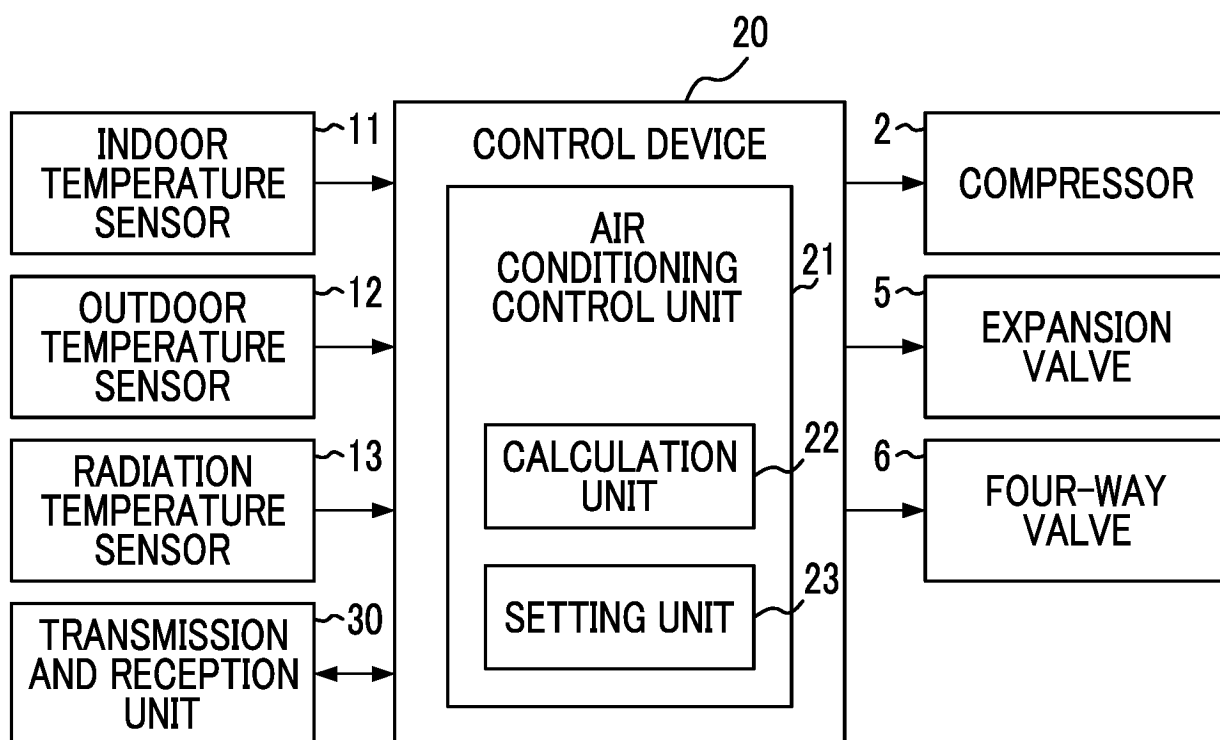


FIG. 3

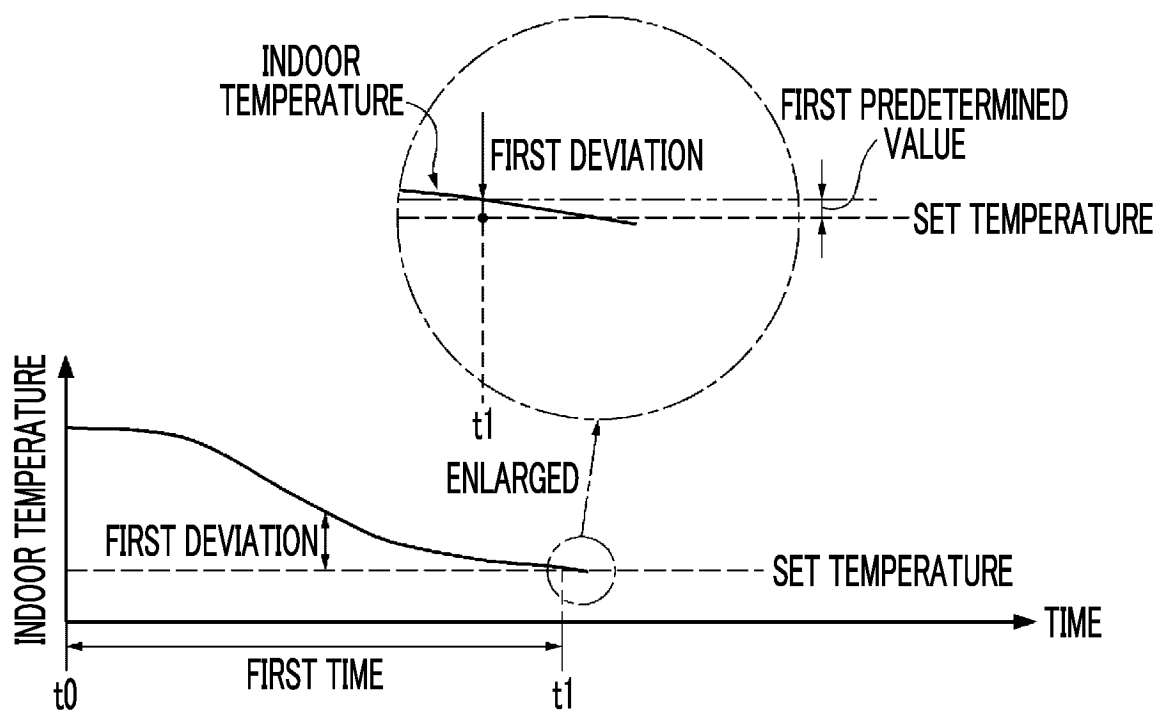


FIG. 4

T1

	FIRST TIME		
	WITHIN FIRST THRESHOLD VALUE	LARGER THAN FIRST THRESHOLD VALUE AND SMALLER THAN SECOND THRESHOLD VALUE	EQUAL TO OR LARGER THAN SECOND THRESHOLD VALUE
SET VALUE	DECREASE	DOES NOT CHANGE	INCREASE

FIG. 5

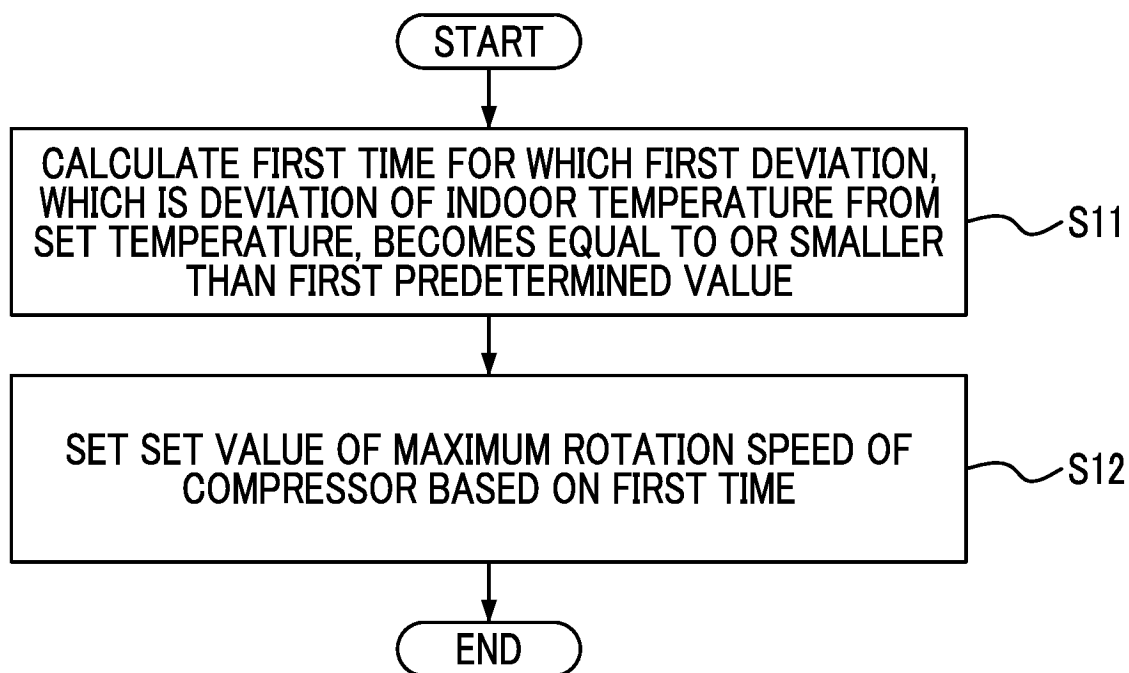


FIG. 6

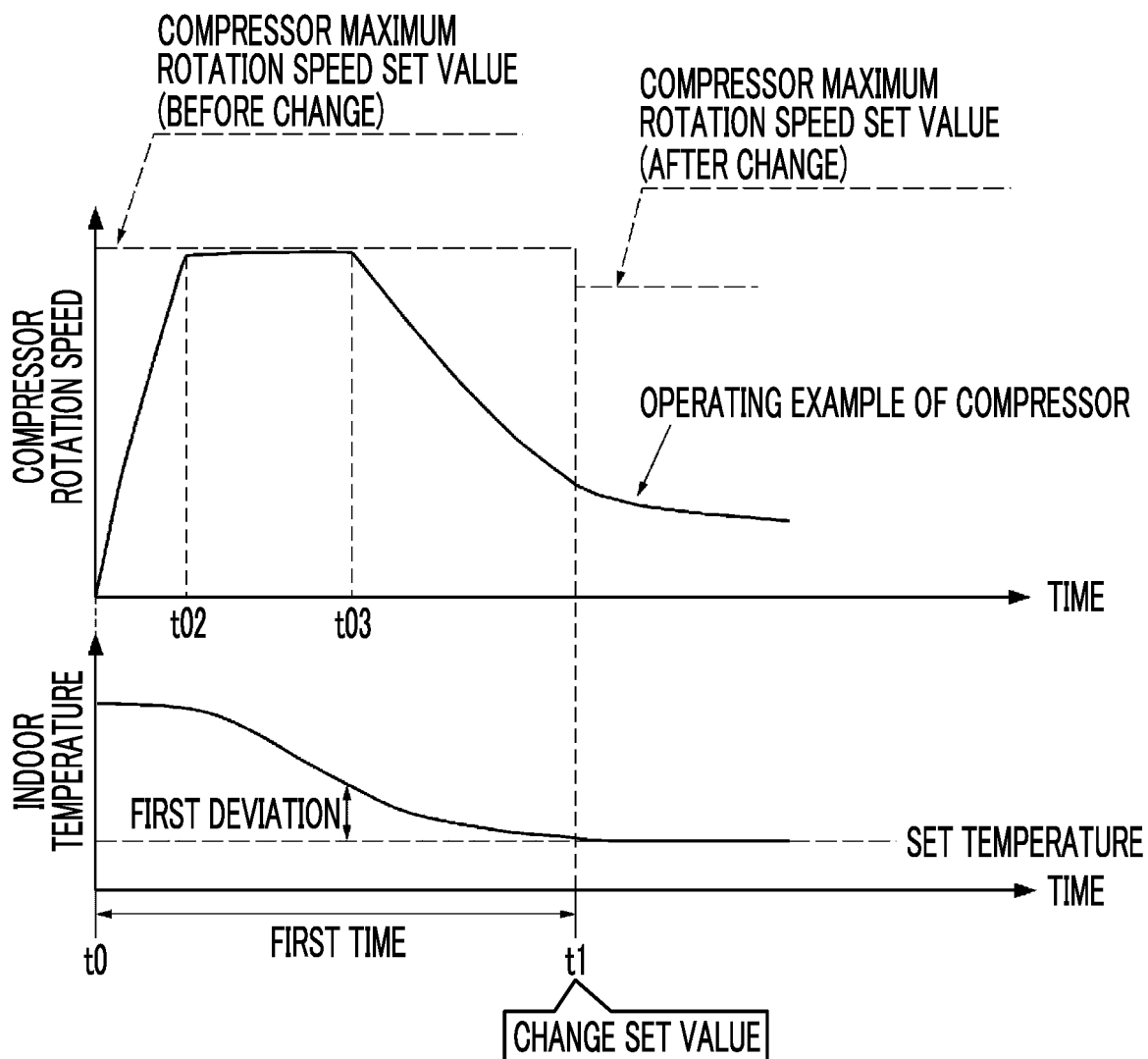


FIG. 7

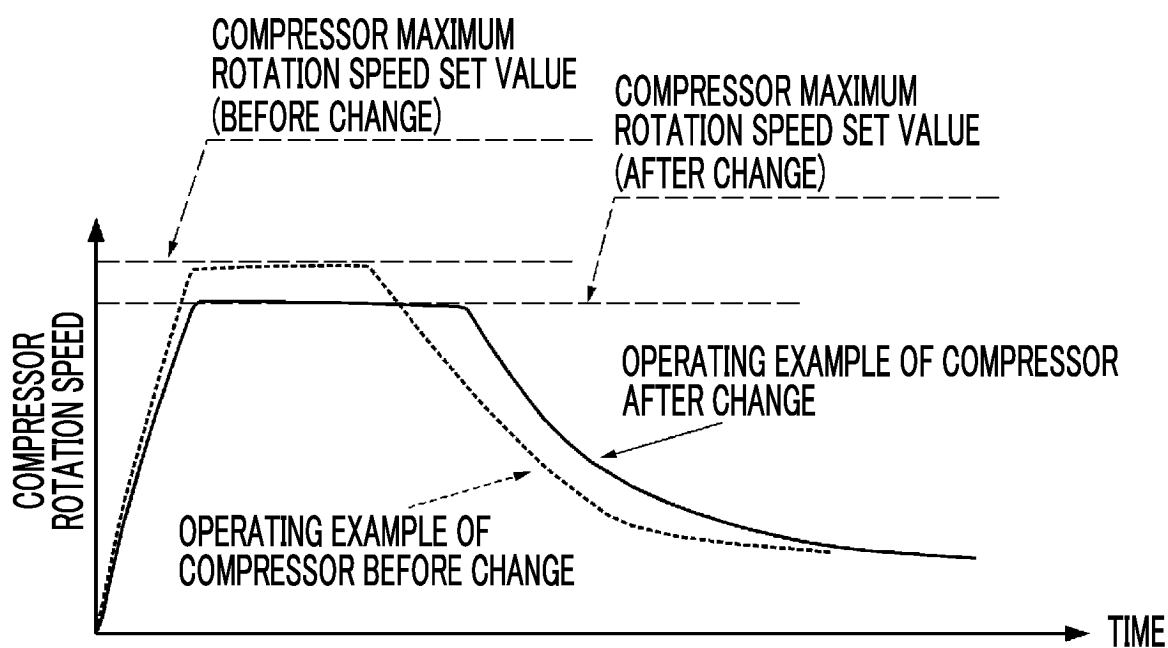


FIG. 8

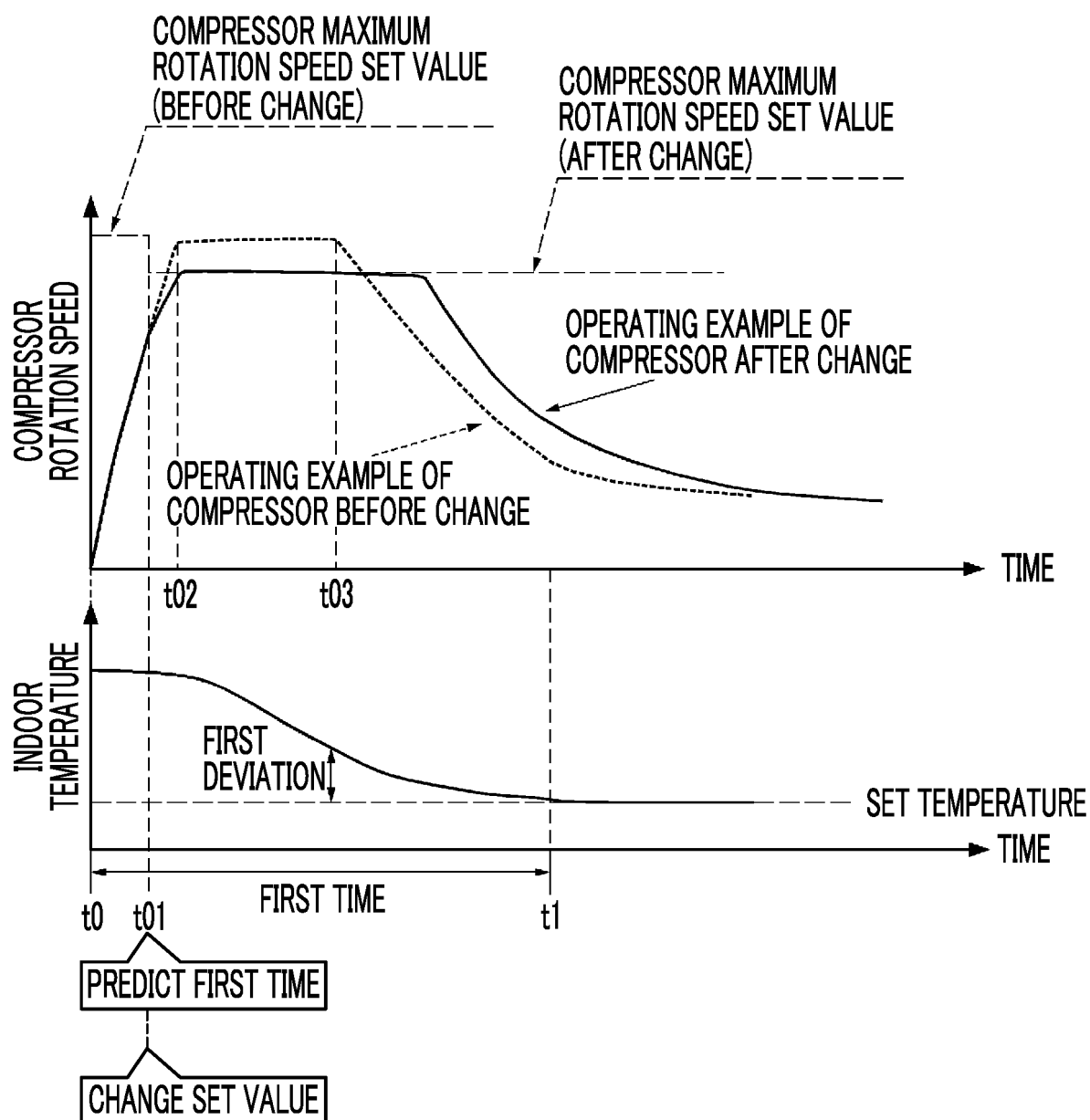


FIG. 9

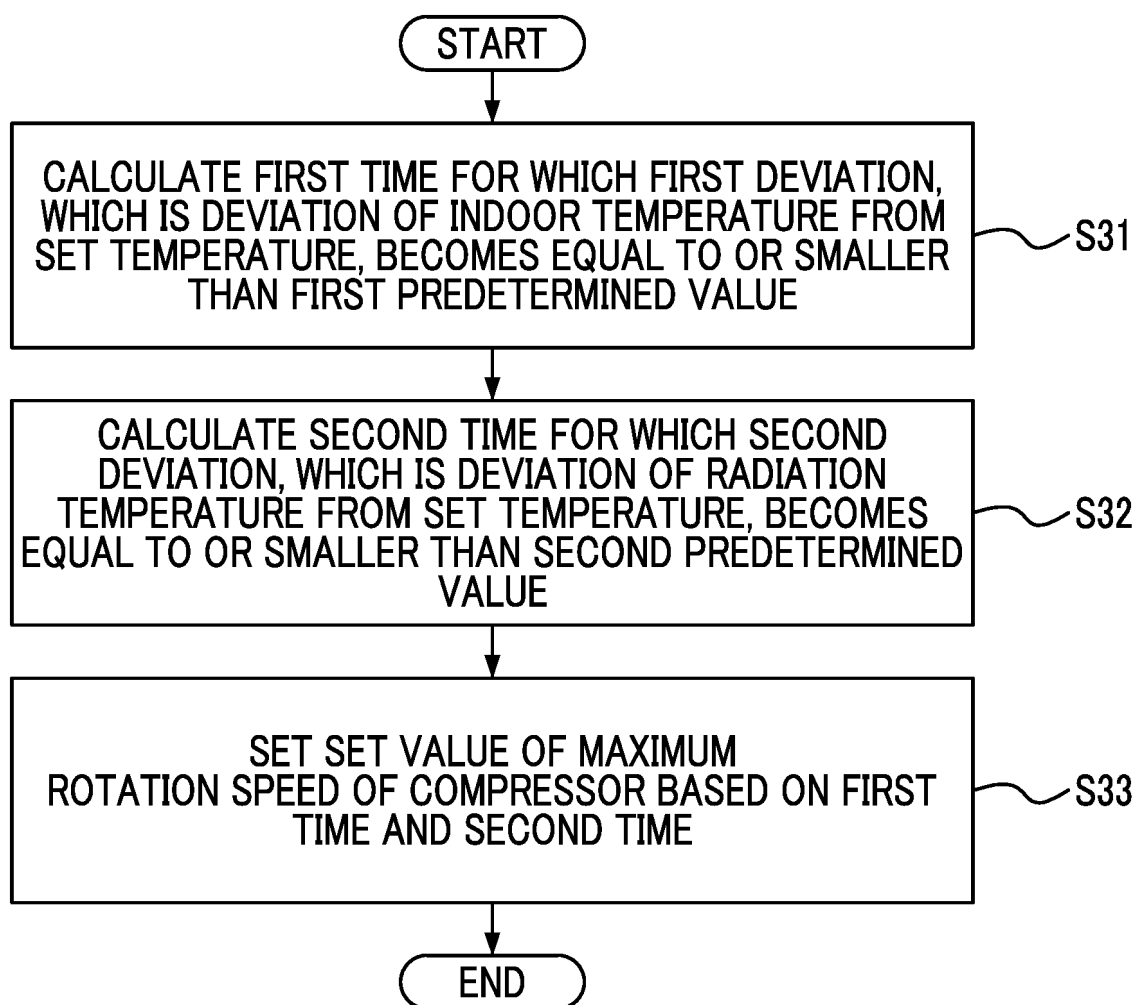


FIG. 10

T3

		MAXIMUM ROTATION SPEED SET VALUE		
		FIRST TIME		
		WITHIN FIRST THRESHOLD VALUE	LARGER THAN FIRST THRESHOLD VALUE AND SMALLER THAN SECOND THRESHOLD VALUE	EQUAL TO OR LARGER THAN SECOND THRESHOLD VALUE
SECOND TIME	WITHIN THIRD THRESHOLD VALUE	DECREASE	DOES NOT CHANGE	INCREASE
	LARGER THAN THIRD THRESHOLD VALUE	DOES NOT CHANGE	INCREASE	INCREASE

FIG. 11

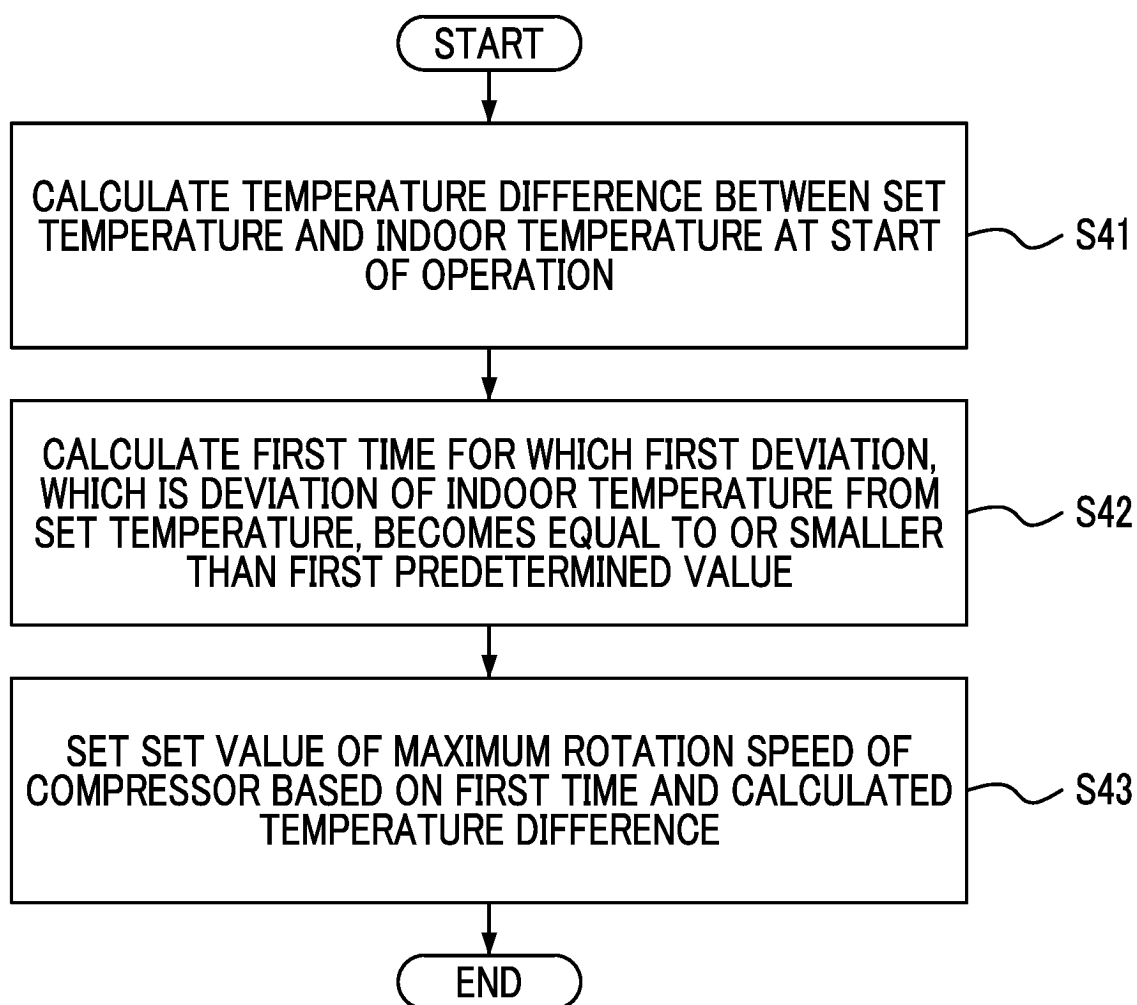
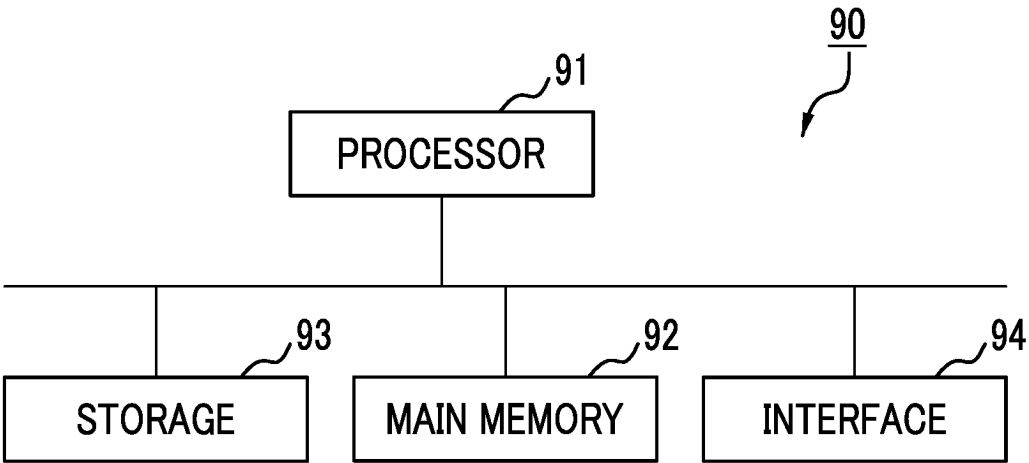


FIG. 12

T4

		MAXIMUM ROTATION SPEED SET VALUE ($\Delta 1 < \Delta 2$)		
		FIRST TIME		
		WITHIN FIRST THRESHOLD VALUE	LARGER THAN FIRST THRESHOLD VALUE AND SMALLER THAN SECOND THRESHOLD VALUE	EQUAL TO OR LARGER THAN SECOND THRESHOLD VALUE
TEMPERATURE DIFFERENCE	WITHIN FOURTH THRESHOLD VALUE	DOES NOT CHANGE	DOES NOT CHANGE	DOES NOT CHANGE
	LARGER THAN FOURTH THRESHOLD VALUE AND SMALLER THAN FIFTH THRESHOLD VALUE	DECREASE BY $\Delta 1$	DOES NOT CHANGE	INCREASE BY $\Delta 2$
	EQUAL TO OR LARGER THAN FIFTH THRESHOLD VALUE	DECREASE BY $\Delta 2$	DOES NOT CHANGE	INCREASE BY $\Delta 1$

FIG. 13



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2023/029993

A. CLASSIFICATION OF SUBJECT MATTER

F24F 11/46(2018.01)i; *F24F 11/64*(2018.01)i; *F24F 11/86*(2018.01)i

FI: F24F11/86; F24F11/46; F24F11/64

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)

F24F11/00-11/89

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 1971-2023

Registered utility model specifications of Japan 1996-2023

Published registered utility model applications of Japan 1994-2023

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	JP 2021-050853 A (PANASONIC IP MANAGEMENT CORP.) 01 April 2021 (2021-04-01) paragraphs [0026]-[0057], fig. 1-3	1-2, 7-8
Y		3-6
Y	WO 2021/117234 A1 (MITSUBISHI ELECTRIC CORP.) 17 June 2021 (2021-06-17) paragraphs [0042]-[0078], fig. 4-10	3-6
Y	JP 11-173633 A (SANYO ELECTRIC CO., LTD.) 02 July 1999 (1999-07-02) paragraph [0080]	5-6

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

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

24 October 2023

Date of mailing of the international search report

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Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/029993

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Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2021-050853 A	01 April 2021	(Family: none)	
WO 2021/117234 A1	17 June 2021	US 2022/0333810 A1 paragraphs [0057]-[0099], fig. 4-10 CN 114761732 A	
JP 11-173633 A	02 July 1999	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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