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(71) Applicant: **Hitachi-Johnson Controls Air Conditioning, Inc.**
Tokyo 105-0022 (JP)

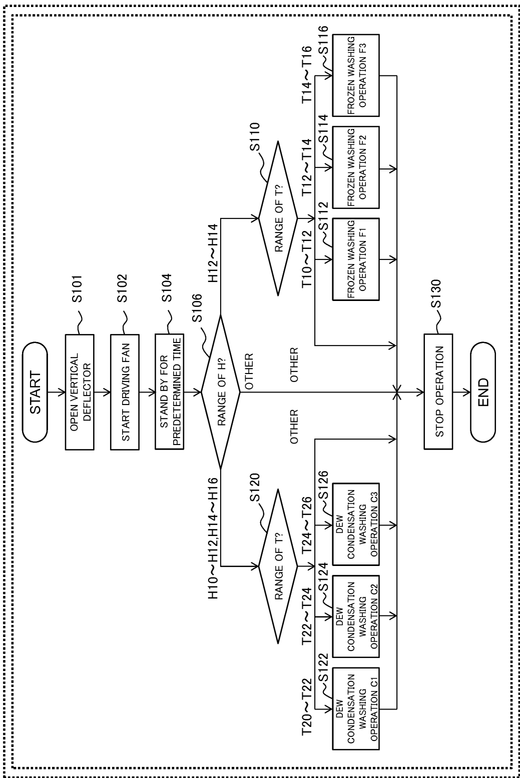
(72) Inventor: **KEZUKA, Yasumasa**
Tokyo 1050022 (JP)

(74) Representative: **MERH-IP Matias Erny Reichl Hoffmann**
Patentanwälte PartG mbB
Paul-Heyse-Strasse 29
80336 München (DE)

(54) AIR CONDITIONER, METHOD FOR CONTROLLING AIR CONDITIONER, AND PROGRAM

(57) In order to make it possible to perform a washing operation appropriately in an air-conditioner, this air-conditioner includes: a refrigeration cycle including a compressor for compressing a refrigerant, and an indoor heat exchanger for cooling or heating air in an air-conditioned room; a control device for controlling the refrigeration cycle to perform a washing operation for washing a surface of the indoor heat exchanger; an indoor fan for delivering air to the indoor heat exchanger; and an air state sensor for detecting a temperature or humidity of air that flows in from the air-conditioned room. The control device includes: a function (S102, S104) of driving the indoor fan for a predetermined time before performing the washing operation; and a function (S10, S120) of allowing the washing operation to be performed on condition that a detection result from the air state sensor after the indoor fan has been driven is within a first predetermined range.

FIG. 3



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Description

TECHNICAL FIELD

[0001] The present invention relates to an air-conditioner, a method of controlling an air-conditioner, and a program.

BACKGROUND ART

[0002] With regard to a washing operation for an air-conditioner, Patent Literature 1 indicated below describes that "An air-conditioner is provided with: a refrigeration cycle including a heat exchanger for cooling or heating ambient air; and a control device 130 that can perform a heating operation, a cooling operation, a dehumidification operation and the like, and controls the refrigeration cycle to perform a washing operation for washing the surface of the heat exchanger. Here, the control device 130 includes a regulating controller 138 that regulates the performing of the washing operation when a predetermined condition arises" (see Abstract).

[0003] Patent Literature 1 also describes that, with respect to the sensing of temperature in an air-conditioned room, i.e., the interior space in which an indoor unit is installed, "the room temperature sensing unit 161 senses the temperature of the inside of an air-conditioned room, and is preferably adapted to detect, using a far-infrared sensor, such as a thermopile, the room temperature of an area equivalent to an area captured by an image capture unit 110" (see the Description, paragraph 0020).

CITATION LIST

PATENT LITERATURE

[0004] Patent Literature 1: JP-A-6296633

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0005] Generally, the indoor unit of an air-conditioner has a plurality of sensors, and, as described in Patent Literature 1, one of the sensors may sometimes be applied as a sensor for detecting the state of the air-conditioned room. However, depending on the status of the indoor unit, the discrepancy between the measurement result from the sensor and the actual state of the air-conditioned room may become large, possibly resulting in an inability to perform the washing operation appropriately.

[0006] The present invention has been made in view of the above circumstances, and an object of the present invention is to provide an air-conditioner that can perform a washing operation appropriately, a method of controlling an air-conditioner, and a program.

SOLUTION TO THE PROBLEMS

[0007] In order to solve the problem, an air-conditioner of the present invention includes: a refrigeration cycle including a compressor for compressing a refrigerant, and an indoor heat exchanger for cooling or heating air in an air-conditioned room; a control device for controlling the refrigeration cycle to perform a washing operation for washing a surface of the indoor heat exchanger; an indoor fan for delivering air to the indoor heat exchanger; and an air state sensor for detecting a temperature or humidity of air that flows in from the air-conditioned room. The control device includes: a function of driving the indoor fan for a predetermined time before performing the washing operation; and a function of allowing the washing operation to be performed on condition that a detection result from the air state sensor after the indoor fan has been driven is within a first predetermined range.

EFFECTS OF THE INVENTION

[0008] According to the present invention, a washing operation can be performed appropriately.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Fig. 1 is a system diagram of an air-conditioner 100 according to a first embodiment of the present invention.
Fig. 2 is a side cross-sectional view of an indoor unit according to the first embodiment.
Fig. 3 is a flowchart of a washing operation process routine in the first embodiment.
Fig. 4 is a flowchart of a washing operation process routine according to a second embodiment.
Fig. 5 is a flowchart of a washing operation process routine according to a third embodiment.

DESCRIPTION OF THE EMBODIMENTS

[First Embodiment]

<Configuration of Air-Conditioner>

[0010] Fig. 1 is a system diagram of an air-conditioner 100 according to a first embodiment of the present invention.

[0011] The air-conditioner 100 is provided with an outdoor unit 30, an indoor unit 60, and a control device 20 for controlling the units. The indoor unit 60 sets an operation mode (such as cooling, heating, dehumidification, or ventilation), an indoor air volume (such as rapid air, strong air, or weak air), a target indoor temperature and the like, in accordance with signals input from a remote controller 90.

(Control Device 20)

[0012] The control device 20 is provided with hardware as a general computer, including a central processing unit (CPU), a digital signal processor (DSP), a random-access memory (RAM), and a read only memory (ROM). In the ROM, a control program executed by the CPU and various data and the like are stored. The control device 20 controls various portions of the outdoor unit 30 and the indoor unit 60 based on the control program. The details thereof will be described later.

(Outdoor Unit 30)

[0013] The outdoor unit 30 is provided with a compressor 32, a four-way switching valve 34, and an outdoor heat exchanger 36. The compressor 32 is provided with a motor 32a, and has the function of compressing a refrigerant that flows in via the four-way switching valve 34. A pipe a1 is installed with a suction-side temperature sensor 41 for detecting the temperature of the refrigerant suctioned into the compressor 32, and a suction-side pressure sensor 45 for detecting the pressure of the refrigerant suctioned into the compressor 32. A pipe a2 is installed with a discharge-side temperature sensor 42 for detecting the temperature of the refrigerant discharged from the compressor 32, and a discharge-side pressure sensor 46 for detecting the pressure of the refrigerant discharged from the compressor 32. The compressor 32 is fitted with a compressor temperature sensor 43 for detecting the temperature of the compressor 32.

[0014] The four-way switching valve 34 has the function of switching the direction of the refrigerant supplied to the indoor unit 60, depending on whether the indoor heat exchanger 64 is caused to function as an evaporator or as a condenser. When the indoor heat exchanger 64 is caused to function as an evaporator, the four-way switching valve 34, during a cooling operation, for example, is turned to connect pipes a2 and a3 and to connect pipes a1 and a6 along the paths of solid lines. In this case, the high-temperature, high-pressure refrigerant discharged from the compressor 32 is cooled by the outdoor heat exchanger 36. The cooled refrigerant is supplied via a pipe a5 to the indoor unit 60.

[0015] When the indoor heat exchanger 64 is caused to function as a condenser, the four-way switching valve 34, during a heating operation, for example, is turned to connect the pipes a2 and a6 and to connect the pipes a1 and a3 along the paths of dashed lines. In this case, the high-temperature, high-pressure refrigerant discharged from the compressor 32 is supplied via the pipes a2 and a6 to the indoor unit 60. An outdoor fan 48 is provided with a motor 48a, and delivers air to the outdoor heat exchanger 36.

[0016] The outdoor heat exchanger 36 is a heat exchanger for exchanging heat between the air delivered from the outdoor fan 48 and the refrigerant, and is connected to the compressor 32 via the four-way switching valve 34. The outdoor unit 30 is fitted with: an outdoor heat exchanger entrance temperature sensor 51 for detecting the temperature of the air that flows into the outdoor heat exchanger 36; an outdoor heat exchanger refrigerant gas temperature sensor 53 for detecting the temperature of gas-side refrigerant of the outdoor heat exchanger 36; and an outdoor heat exchanger refrigerant liquid temperature sensor 55 for detecting the temperature of liquid-side refrigerant of the outdoor heat exchanger 36.

[0017] A power supply unit 54 receives a three-phase alternating-current voltage from a commercial power supply 22. A power measurement unit 58 is connected to the power supply unit 54 to measure power consumption by the air-conditioner 100. The power supply unit 54 outputs a direct-current voltage that is supplied to a motor controller 56. The motor controller 56 is provided with an inverter (not illustrated), and supplies an alternating-current voltage to the motor 32a of the compressor 32 and the motor 48a of the outdoor fan 48. The motor controller 56 also controls the motors 32a and 48a in a sensorless manner to thereby detect the rotating speed of the motors 32a and 48a.

(Indoor Unit 60)

[0018] The indoor unit 60 is provided with: an indoor expansion valve 62; an indoor heat exchanger 64; an indoor fan 66; a motor controller 67; and a remote controller communication unit 68 for performing bi-directional communication with the remote controller 90. The indoor fan 66 is provided with a motor 66a and delivers air to the indoor heat exchanger 64. The motor controller 67 is provided with an inverter (not illustrated) and supplies an alternating-current voltage to the motor 66a. The motor controller 67 also controls the motor 66a in a sensorless manner to thereby detect the rotating speed of the motor 66a.

[0019] The indoor expansion valve 62 is inserted between pipes a5 and a7, and has the function of adjusting the flow volume of the refrigerant flowing through the pipes a5 and a7 and reducing the pressure of the refrigerant on the secondary side of the indoor expansion valve 62. The indoor heat exchanger 64 is a heat exchanger for exchanging heat between indoor air delivered from the indoor fan 66 and the refrigerant, and is connected to the indoor expansion valve 62 via a pipe a7.

[0020] The indoor unit 60 is also provided with: an indoor heat exchanger entry air temperature sensor 70 (air state sensor); an indoor heat exchanger discharge air temperature sensor 72; an indoor heat exchanger entry humidity sensor 74; an indoor heat exchanger refrigerant liquid temperature sensor 25; and an indoor heat exchanger refrigerant gas temperature sensor 26.

[0021] The indoor heat exchanger entry air temperature sensor 70 detects the temperature of the air drawn by the indoor fan 66. The indoor heat exchanger discharge air temperature sensor 72 detects the temperature of the air discharged from the indoor heat exchanger 64.

[0022] The indoor heat exchanger entry humidity sensor 74 (air state sensor) detects the humidity of the air drawn by the indoor fan 66. The indoor heat exchanger refrigerant liquid temperature sensor 25 and the indoor heat exchanger refrigerant gas temperature sensor 26 are disposed where the indoor heat exchanger 64 and the pipe a6 are connected, and detect the temperature of the refrigerant flowing through the connection. Thus, the compressor 32, the four-way switching valve 34, the outdoor heat exchanger 36, the indoor expansion valve 62, the indoor heat exchanger 64, and the pipes a1 to a7 form a refrigeration cycle RC.

[0023] Fig. 2 is a side cross-sectional view of the indoor unit 60. The indoor unit 60 is of a so-called "ceiling cassette-type" that is embedded in a ceiling 130, with a lower surface exposed in the air-conditioned room.

[0024] Referring to Fig. 2, the indoor heat exchanger 64 is formed as a plate bent in substantially V-shape, and is installed in a central part of the indoor unit 60. The indoor fan 66 has fins arranged in a substantially cylindrical shape, and is disposed forwardly of the indoor heat exchanger 64. A drain pan 140 for receiving dew-condensed water is disposed under the indoor heat exchanger 64 and the indoor fan 66.

[0025] To the rear of the indoor heat exchanger 64, an inclined air filter 142 is disposed. The lower surface of the indoor unit 60 is covered with a decorative plate 143. An air intake opening 144 is formed by slitting the decorative plate 143 under the air filter 142. The indoor heat exchanger entry air temperature sensor 70 is disposed between the indoor heat exchanger 64 and the air filter 142.

[0026] To the front of the indoor fan 66, an air blow-out passageway 146 is formed. A horizontal deflector 148 is disposed at a point along the air blow-out passageway 146, and controls the direction of air flow in the horizontal direction (perpendicular to the sheet). A vertical deflector 150 is disposed at the exit portion of the air blow-out passageway 146, and pivots about a support point 150a to control the direction of air flow in the vertical direction. The horizontal deflector 148 and the vertical deflector 150 are pivotally driven by the control device 20 (see Fig. 1). In Fig. 2, the vertical deflector 150 indicated by solid lines indicates its position in fully open state.

[0027] When the air-conditioner 100 is at rest, the vertical deflector 150 is pivoted to a fully closed position 152 indicated by dashed and single-dotted lines. When a washing operation is performed, as will be described later, the vertical deflector 150 is pivoted to a position 156 indicated by dashed and single-dotted line, and is thereafter pivoted to a washing operation position 154. As the degree of opening of the vertical deflector 150 increases, the duct resistance of the air blow-out passageway 146 becomes smaller. However, even when the vertical deflector 150 is closed at the fully closed position 152, there is a gap FS formed between the vertical deflector 150 and the decorative plate 143, so that a small amount of air can flow through the gap FS.

<Operation of Embodiment>

(Outline of Washing Operation)

[0028] The operation of the present embodiment will be described.

[0029] In the present embodiment, a "washing operation" is performed automatically or by a user's instruction. The "washing operation" refers to an operation for causing frost formation or dew condensation on the surface of the indoor heat exchanger 64, and washing the surface of the indoor heat exchanger 64 using water due to the frost formation or condensation. The washing operation is performed automatically when, for example, a setting is made to perform the washing operation periodically at predetermined time intervals. The washing operation is classified into a "frozen washing operation" and a "dew condensation washing operation".

[0030] In the frozen washing operation, the control device 20 (see Fig. 1) turns the four-way switching valve 34 in the direction indicated by solid line so that the indoor heat exchanger 64 becomes an evaporator. Then, the control device 20 sets the state of each of the portions of the air-conditioner 100, such as the rotating speed of the compressor 32, the degree of opening of the indoor expansion valve 62, and the rotating speed of the indoor fan 66 so that the surface temperature of the indoor heat exchanger 64 becomes below zero. As this state is continued, frost forms on the surface of the indoor heat exchanger 64.

[0031] Next, the control device 20 turns the four-way switching valve 34 in the direction indicated by dashed line so that the indoor heat exchanger 64 becomes a condenser, and heats the indoor heat exchanger 64. Thereby, the frost attached to the indoor heat exchanger 64 melts, rinsing the surface of the indoor heat exchanger 64. The control device 20 keeps heating the indoor heat exchanger 64 for a while thereafter, and keeps driving the indoor fan 66. As a result, the surface of the indoor heat exchanger 64 becomes dry. Through the above steps, the frozen washing operation comes to an end.

[0032] During the dew condensation washing operation, the control device 20 (see Fig. 1) also turns the four-way switching valve 34 in the direction indicated by solid line so that the indoor heat exchanger 64 becomes an evaporator. Next, the control device 20 sets the state of each of the various parts of the air-conditioner 100 so that the surface temperature of the indoor heat exchanger 64 becomes lower than a dew-point temperature and higher than zero. As this state is continued, dew condensation occurs on the surface of the indoor heat exchanger 64, and the water due to the condensation rinses the surface of the indoor heat exchanger 64. Thereafter, the control device 20 turns the four-way switching valve 34 in the direction indicated by dashed line so that the indoor heat exchanger 64 becomes a condenser, and keeps heating the indoor heat exchanger 64 and driving the indoor fan 66. In this way, the surface of the indoor heat exchanger 64 becomes dry. Through the above steps, the dew condensation washing operation comes to an end.

(Operation by Washing Operation Process Routine)

[0033] Fig. 3 is a flowchart of a washing operation process routine in the present embodiment.

[0034] The present routine is performed when the user has entered on the remote controller 90 a command for performing the washing operation, or by the user's instruction when it is the time to perform an automatic operation of the washing operation.

[0035] Referring to Fig. 3, as the process proceeds to step S101, the vertical deflector 150 is opened to the position 156 indicated in Fig. 2. As the process proceeds to step S102, rotational driving of the indoor fan 66 is started. As the process proceeds to step S104, the process stands by for a predetermined time. The predetermined time is a time for the temperature and humidity around the indoor heat exchanger entry air temperature sensor 70 (see Fig. 2) and the indoor heat exchanger entry humidity sensor 74 to become close to the temperature and humidity of the air-conditioned room. The predetermined time may be 30 seconds or more and 5 minutes or less, for example.

[0036] After the elapse of the predetermined time, as the process proceeds to step S106, the process diverges based on the range of relative humidity H that is the detection result from the indoor heat exchanger entry humidity sensor 74. More specifically, the process diverges based on the result of comparison between the relative humidity H and constants H10, H12, H14, and H16. The constants have the relationship "H10 < H12 < H14 < H16", wherein the constants H12, H14 are the minimum value and the maximum value of the relative humidity considered to be preferable for the frozen washing operation.

[0037] If the relative humidity H is lower than the constant H12, the relative humidity H is too low so that, even if the frozen washing operation were to be attempted, a sufficient amount of frost would not be formed on the indoor heat exchanger 64 and a sufficient washing effect would not be obtained. If the relative humidity H is too high, if the frozen washing operation were to be attempted, dew condensation may occur at locations other than the indoor heat exchanger 64. For example, if dew condensation occurs on the indoor fan 66 or the air blow-out passageway 146, the problem that the dew-condensed water leaks into the air-conditioned room via the air blow-out passageway 146 may arise.

[0038] The constant H 14 is the value of the relative humidity H such that a dew condensation caused in locations other than the indoor heat exchanger 64 would be less of a problem. In other words, the range in which the relative humidity H is "H12 ≤ H < H14" is a range that is preferable for performing the frozen washing operation. The constant H10 is a relative humidity at which it is considered difficult to produce, by dew condensation on the indoor heat exchanger 64, a sufficient amount of water for performing the dew condensation washing operation. The constant H16 is a relative humidity at which dew condensation may possibly occur at locations other than the indoor heat exchanger 64 when the dew condensation washing operation were to be attempted.

[0039] In step S106, if the relative humidity H is in the range "H12 ≤ H < H14", the process proceeds to step S110. If the relative humidity H is in the range "H10 ≤ H < H12" or "H14 ≤ H < H16", the process proceeds to step S120. If the relative humidity H is in the range "Other", i.e., "H < H10" or "H16 ≤ H", the process proceeds to step S130.

[0040] In step S110, the process diverges based on the range of room temperature T that is the detection result from the indoor heat exchanger entry air temperature sensor 70. More specifically, the process diverges based on the result of comparison between the room temperature T and constants T10, T12, T14, and T16. The constants have the relationship "T10 < T12 < T14 < T16".

[0041] If the room temperature T is in the range "T10 ≤ T < T12", the process proceeds to step S112 in which a "frozen washing operation F1" is performed. If the room temperature T is in the range "T12 ≤ T < T14", the process proceeds to step S114 in which a "frozen washing operation F2" is performed. If the room temperature T is in the range "T14 ≤ T < T16", the process proceeds to step S116 in which a "frozen washing operation F3" is performed. In the other cases, i.e., if the room temperature T is lower than the constant T10 or higher than T16, the process proceeds to step S130.

[0042] The constant T10 is a value in the vicinity of 0°C, such as a value on the order of 1°C to 6°C. The drain pan 140 (see Fig. 2) of the indoor unit 60 is fitted with a drain pipe, a drain pump and the like (not illustrated) for discharging dew condensation water. If a location arises where the temperature of the dew condensation water is 0°C or lower, the drain pipe and the like may become clogged at that location. Accordingly, the constant T10 is set to a value on the order of 1°C to 6°C with some margin with respect to "0°C", so that, when the room temperature T has become lower than the constant T10, the washing operation can be cancelled. If the room temperature T is too high, it may be impossible to ensure cooling capacity to such an extent that sufficient frost formation can be caused on the indoor heat exchanger 64. The constant T16 may be set to a temperature at which sufficient frost formation can be caused on the indoor heat exchanger 64.

[0043] The frozen washing operations F1, F2, and F3 have their operation contents set so that the cooling capacity increases as the range of room temperature T becomes higher. More particularly, when the compressor 32 (see Fig. 1) during the frozen washing operations F1, F2, and F3 respectively has rotating speeds NF1, NF2, and NF3, the rotating speeds have the relationship "NF1 < NF2 < NF3". During each of the frozen washing operations F1, F2, and F3, the control device 20 sets the position of the vertical deflector 150 to the washing operation position 154 (see Fig. 2).

[0044] As the process proceeds from step S106 to step S120, the process diverges based on the range of room temperature T. More specifically, the process diverges based on the result of comparison between the room temperature T and constants T20, T22, T24, and T26. The constants have the relationship "T20 < T22 < T24 < T26".

[0045] If the room temperature T is in the range "T20 ≤ T < T22", the process proceeds to step S122 in which a "dew condensation washing operation C1" is performed. If the room temperature T is in the range "T22 ≤ T < T24", the process proceeds to step S124 in which a "dew condensation washing operation C2" is performed. If the room temperature T is in the range "T24 ≤ T < T26", the process proceeds to step S126 in which a "dew condensation washing operation C3" is performed. In the other cases, i.e., if the room temperature T is lower than the constant T20 or higher than T26, the process proceeds to step S130.

[0046] Here, the constant T20, similarly to the constant T10 described above, is a value on the order of 1°C to 6°C, for example. The constant T20 may be the same as constant T10. The constant T26 may be set to a temperature such that sufficient dew condensation can be caused on the indoor heat exchanger 64. Accordingly, the constant T26 may preferably be higher than the constant T16 described above.

[0047] The dew condensation washing operations C1, C2, and C3 have their operation contents set so that the cooling capacity increases as the range of room temperature T becomes higher. More particularly, when the compressor 32 (see Fig. 1) during the dew condensation washing operations C1, C2, and C3 respectively has rotating speeds NC1, NC2, and NC3, the rotating speeds have the relationship "NC1 < NC2 < NC3". Further, because the dew condensation washing operation lowers the cooling capacity compared to the frozen washing operation, the rotating speeds, when combined with the rotating speeds NF1, NF2, and NF3 during the frozen washing operation described above, have the relationship "NC1 < NC2 < NC3 < NF1 < NF2 < NF3". In each of the dew condensation washing operations C1, C2, and C3, the control device 20 sets the position of the vertical deflector 150 to the washing operation position 154 (see Fig. 2).

[0048] As any of the processes of steps S112 to S116 and S122 to S126 described above comes to an end, the process proceeds to step S130 in which the control device 20 performs a washing operation shut-down process. That is, the control device 20 shuts down the refrigeration cycle RC, shuts down the indoor fan 66, and causes the vertical deflector 150 to pivot to the fully closed position 152 (see Fig. 2). If "Other" has been determined in any of the steps S106, S110, and S120, neither the frozen washing operation nor the dew condensation washing operation are performed, and the shut-down process of step S130 is performed. Thus, the process of the present routine ends.

(Operation of Watch-Over Operation)

[0049] In the present embodiment, an operation called "watch-over operation" is also performed. In general, a "watch-over operation" refers to performing a cooling operation automatically when the temperature of the air-conditioned room has become a predetermined temperature or above. In the present embodiment, upon instruction from the user via the remote controller 90 to perform the "watch-over operation", the control device 20, in the period in which the refrigeration cycle RC is shut down, performs a "room temperature acquisition process" at predetermined monitoring periodic intervals. The "room temperature acquisition process" refers to taking the air in the air-conditioned room into the indoor unit 60 by driving the indoor fan 66 for a predetermined time, and acquiring the detection result from the indoor heat exchanger entry air temperature sensor 70 as the room temperature T. Next, the control device 20 determines whether the acquired room temperature T is higher than or equal to a predetermined temperature and, if the determination result is "Yes", performs cooling operation.

[0050] Thus, the "room temperature acquisition process" during the "watch-over operation" is similar to the process of steps S101, S102, S104, and S106 of the washing operation (see Fig. 3) in that the indoor fan 66 is driven to take the air in the air-conditioned room into the indoor unit 60 and the room temperature T is acquired.

[0051] However, as described above, in step S101 of the washing operation, the vertical deflector 150 is opened to the position 156 (see Fig. 2). The "room temperature acquisition process" during the "watch-over operation" differs in that the vertical deflector 150 remains at the fully closed position 152.

[0052] Also, the drive time of the indoor fan 66 (standby time in step S104) during the washing operation is longer than the drive time of the indoor fan 66 during the room temperature acquisition process of the watch-over operation. In addition, the rotating speed of the indoor fan 66 (rotating speed in step S104) during the washing operation is higher than the rotating speed of the indoor fan 66 during the room temperature acquisition process of the watch-over operation.

[0053] Thus, the process of steps S101 to S106 during the washing operation differs from the room temperature acquisition process of the watch-over operation in that the degree of opening of the vertical deflector 150 is greater, the drive time of the indoor fan 66 is longer, and the rotating speed of the indoor fan 66 is higher. One of the reasons for such differences is that during the room temperature acquisition process of the watch-over operation, only the room temperature T needs to be acquired, and it is not necessary to measure the relative humidity H. Particularly, when the inside of the indoor unit 60 is dry, in order to match the relative humidity in the indoor unit 60 with the relative humidity of the air-conditioned room, it is preferable to increase the drive time of the indoor fan 66 compared to when only the temperature is matched.

<Effects of First Embodiment>

[0054] Thus, according to the present embodiment, the control device (20) has the function (S102, S104) of driving the indoor fan (66) for a predetermined time before performing the washing operation, and the function (S110, S120) of performing the washing operation on condition that the detection result from the air state sensor (70, 74) after the indoor fan (66) has been driven is within a first predetermined range.

[0055] In this way, according to the present embodiment, the detection result from the air state sensor (70, 74) can be made accurate, and the washing operation can be performed appropriately.

[0056] Further, the predetermined time is a time greater than or equal to 30 seconds, and, even when it is being determined whether the detection result from the air state sensor (70, 74) is within the first predetermined range, the driving of the indoor fan (66) is continued. This makes it possible to make the detection result from the air state sensor (70, 74) even more accurate, and the washing operation can be performed even more appropriately.

[0057] The control device (20) further has the function (S101) of placing the vertical deflector (150) in a state more open than the closed state in a predetermined period of time. This makes it possible to promote the flow of air through the air-conditioner (100), make the detection result from the air state sensor (70, 74) even more accurate, and perform the washing operation even more appropriately.

[0058] The control device (20) has the watch-over operation function of performing cooling operation automatically in accordance with the detection result from the air state sensor (70, 74) after the indoor fan (66) has been rotated, wherein the rotating speed at which the indoor fan (66) is rotated before the washing operation is performed is higher than the rotating speed at which the indoor fan (66) is rotated before the watch-over operation function is performed. Thus, compared to when the watch-over operation is performed, it is possible to make the detection result from the air state sensor (70, 74) even more accurate, so that the washing operation can be performed even more appropriately.

[0059] The control device (20) further has the function (S10, S120) of setting the rotating speed of the compressor (32) based on the detection result from the air state sensor (70, 74) after the indoor fan (66) has been driven. Thus, depending on the situation, it is possible to provide the air-conditioner (100) with an appropriate cooling capacity.

[0060] The control device (20) further has the function (S106) of selecting, based on the detection result from the air state sensor (70, 74) after the indoor fan (66) has been driven, the frozen washing operation for causing frost formation on the indoor heat exchanger (64), or the dew condensation washing operation for causing dew condensation without causing frost formation on the indoor heat exchanger (64). Thus, depending on the situation, it is possible to select the proper side as appropriate: the frozen washing operation or the dew condensation washing operation.

[Second Embodiment]

<Configuration and Operation of Second Embodiment>

[0061] A second embodiment of the present invention will be described.

[0062] The hardware configuration of the second embodiment is similar to that of the first embodiment (see Fig. 1 and Fig. 2). However, in the present embodiment, instead of the washing operation process routine depicted in Fig. 3, a washing operation process routine depicted in Fig. 4 is performed.

[0063] The present routine is also performed when the user has entered on the remote controller 90 a command for performing the washing operation (see Fig. 1), or when it is the time to perform an automatic operation of the washing operation.

[0064] Referring to Fig. 4, as the process proceeds to step S12, it is determined whether the relative humidity H that is the detection result from the indoor heat exchanger entry humidity sensor 74 satisfies the condition "$H60 \leq H < H62$". However, at this point in time, the indoor fan 66 is not being driven, and therefore the relative humidity H may possibly be far from the actual relative humidity in the air-conditioned room. Here, H60 and H62 are predetermined constants. The constant H60 is a value slightly lower than the constant H10 discussed in step S106 of Fig. 3. The constant H62 is a value slightly higher than the constant H16 discussed in step S106. That is, the range of the constants H60 to H62 is wider than the range of the constants H10 to H16.

[0065] If it is determined "Yes" in step S12, the process proceeds to step S14 in which it is determined whether an outside air temperature TD that is the detection result from the outdoor heat exchanger entrance temperature sensor 51 satisfies the condition "$TD0 \leq TD < TD2$". Here, TD0 and TD2 are predetermined constants. The constant TD0, similarly to the constants T10 and T20 discussed in steps S110 and S120, is a value in the vicinity of 0°C, such as a value on the order of 1 °C to 6°C. If the outside air temperature is too high, it may be impossible to ensure cooling capacity to such an extent that sufficient frost formation or dew condensation can be caused on the indoor heat exchanger 64. The constant TD2 may be set to a temperature at which sufficient frost formation or dew condensation can be caused on the indoor heat exchanger 64.

[0066] If it is determined "Yes" in step S14, the process proceeds to step S16 in which it is determined whether the room temperature T that is the detection result from the indoor heat exchanger entry air temperature sensor 70 satisfies the condition "T80 ≤ T < T82". However, at this point in time, the indoor fan 66 is not being driven. Therefore, as in the case of the relative humidity H described above, the room temperature T may also possibly be far from the actual room temperature in the air-conditioned room. Here T80 and T82 are predetermined constants. The constant T80 is a value in the vicinity of 0°C; the constant T80, however, is set to a value lower than the constants T10 and T20 discussed in steps S110 and S120. The constant T82 is set to a value higher than the constant T26 discussed in step S120. That is, the range of the constants T80 to T82 is wider than the range of the constants T10 to T20.

[0067] If it is determined "Yes" in step S16, the same process as that from step S100 of Fig. 3 is performed. On the other hand, if it is determined "No" in any of steps S12, S14, and S16, the process proceeds to step S20 in which the control device 20 performs the washing operation shut-down process, and the process of the present routine ends.

<Effects of Second Embodiment>

[0068] Thus, the present embodiment further has the function (S12 to S16) of driving the indoor fan (66) on condition that, before driving the indoor fan (66), the detection result from the air state sensor (70, 74) is within a second predetermined range. Further, the second predetermined range is wider than the first predetermined range. Thus, if the detection result from the air state sensor (70, 74) is not within the second predetermined range, no electric power for moving the indoor fan (66) is required, thereby achieving energy conservation.

[0069] Once the indoor fan (66) is driven, the user tends to recognize that "the washing operation has been started". However, if it is determined "Other" in step S106, S110, or S120 (see Fig. 3), the shut-down process of step S130 is performed while performing neither the frozen washing operation nor the dew condensation washing operation. In this case, the user might suspect that "a failure has occurred in the air-conditioner (100)". According to the present embodiment, it is possible to increase the probability that the frozen washing operation or the dew condensation washing operation will be performed once the indoor fan (66) has been driven, thus decreasing the frequency with which the user may have a suspicion.

[Third Embodiment]

[0070] A third embodiment of the present invention will be described.

[0071] The hardware configuration of the third embodiment is similar to that of the first embodiment (see Fig. 1 and Fig. 2). However, in the present embodiment, instead of the washing operation process routine depicted in Fig. 3, a washing operation process routine depicted in Fig. 5 is performed. The present routine is also performed when the user has entered on the remote controller 90 a command for performing the washing operation (see Fig. 1), or when it is the time to perform an automatic operation of the washing operation.

[0072] As the routine of Fig. 5 is started, the control device 20 performs the process of steps S140, S142, and S144. The contents of the steps are the same as those of steps S101, S102, and S104 (see Fig. 3) in the first embodiment. Then, as the process proceeds to step S150, the process diverges based on the range of room temperature T that is the detection result from the indoor heat exchanger entry air temperature sensor 70. More specifically, the process diverges based on the result of comparison between the room temperature T and constants T50, T52, T54, T56, T58, T60, and T62. The constants have the relationship "T50 < T52 < T54 < T56 < T58 < T60 < T62".

[0073] If the room temperature T is in the range "T50 ≤ T < T52", the process proceeds to step S152 in which a "dew condensation washing operation C1" is performed. If the room temperature T is in the range "T52 ≤ T < T54", the process proceeds to step S154 in which a "dew condensation washing operation C2" is performed. If the room temperature T is in the range "T54 ≤ T < T56", the process proceeds to step S156 in which a "frozen washing operation F1" is performed.

[0074] If the room temperature T is in the range "T56 ≤ T < T58", the process proceeds to step S158 in which a "frozen washing operation F2" is performed. If the room temperature T is in the range "T58 ≤ T < T60", the process proceeds to step S160 in which a "frozen washing operation F3" is performed. If the room temperature T is in the range "T60 ≤ T < T62", the process proceeds to step S162 in which a "dew condensation washing operation C3" is performed. In the other cases, i.e., if the room temperature T is lower than the constant T50 or higher than T62, the process proceeds to step S170.

[0075] The contents of the dew condensation washing operations C1 to C3 and the frozen washing operations F1 to F3 performed in steps S152 to S162 are the same as those of the first embodiment. As any of the process of steps S1 52 to S162 ends, the process proceeds to step S170 in which the control device 20 performs the washing operation shut-down process. The content of the shut-down process is the same as that of step S130 (see Fig. 3) of the first embodiment wherein the control device 20 shuts down the refrigeration cycle RC, also shuts down the indoor fan 66, and causes the vertical deflector 150 to pivot to the fully closed position 152 (see Fig. 2). If it is determined "Other" in step S150 described above, the frozen washing operation or the dew condensation washing operation is not performed, and the shutdown process of step S170 is performed. Thus, the process of the present routine ends.

[0076] In the process of steps S140 to S170 described above, the determination based on relative humidity is not made. This is because temperature and relative humidity have a correlation depending on the region in which the air-conditioner 100 is installed. For example, assume that the air-conditioner 100 is set for Japan. The climate of Japan in such that the temperature tends to become low in winter and high in summer. At the same time, the relative humidity tends to become low in winter and high in summer. This means that the relative humidity has a monotonically increasing correlation with respect to the temperature.

[0077] In the example depicted in Fig. 5, if the room temperature T is in the range "T54 ≤ T < T60", it can be inferred that the relative humidity H will also be in a preferable range for the frozen washing operation, and so the control device 20 performs the frozen washing operations F1 to F3. If the room temperature T is in the lower or upper ranges "T50 ≤ T < T54" or "T60 ≤ T < T62", it can be inferred that the relative humidity H will also be in a preferable range for the dew condensation washing operation, and so the control device 20 performs the dew condensation washing operations C1 to C3.

[0078] Thus, according to the present embodiment, as in the first embodiment, it is possible to make the detection result from the indoor heat exchanger entry air temperature sensor 70 accurate, and the washing operation can be performed appropriately. Further, in the process of steps S1 40 to S170 in the present embodiment, the determination based on relative humidity is not performed. Accordingly, it is possible to omit the indoor heat exchanger entry humidity sensor 74 depicted in Fig. 1 and Fig. 2, and to reduce costs for the air-conditioner 100.

[0079] In the present embodiment, before the process of step S140 is performed, the same process as that of steps S14, S16, and S20 may be performed. That is, if it is determined "Yes" in both steps S14 and S16, the process of step S140 and the subsequent steps may be performed. If it is determined "No" in step S14 or S16, the shut-down process of step S20 may be performed.

[0080] Thus, as in the second embodiment, it is possible to reduce electric power for moving the indoor fan 66 and achieve energy conservation. It is also possible to increase the probability that the frozen washing operation or the dew condensation washing operation will be performed once the indoor fan 66 has been driven, thus decreasing the frequency with which the user may have a suspicion.

[Modifications]

[0081] The present invention is not limited to the foregoing embodiments and may include various modifications. The foregoing embodiments have been described by way of example to facilitate an understanding of the present invention, and are not necessarily limited to those provided with all of the configurations described. Some of the configurations of one embodiment may be substituted by a configuration of another embodiment, or a configuration of the other embodiment may be incorporated into a configuration of one embodiment. With respect to some of the configurations of each of the embodiments, deletion, addition, or substitution of other configurations may be made. The control lines or information lines depicted in the drawings are those considered necessary for illustrative purposes, and do not necessarily represent all of the control lines or information lines required in a product. It may be considered that in practice, most of the configurations are interconnected. Modifications that may be made with respect to the foregoing embodiments include the following.

(1) In the embodiments, cooling capacity, i.e., the rotating speed of the compressor 32, is set in accordance with the room temperature T. However, the rotating speed of the compressor 32 may be feedback-controlled based on the detection value from the indoor heat exchanger refrigerant liquid temperature sensor 25 or the indoor heat exchanger refrigerant gas temperature sensor 26 so that an appropriate refrigerant temperature can be obtained.

(2) In the embodiments, various determinations are made based on relative humidity H. However, various determinations may be made based on absolute humidity rather than relative humidity H.

(3) The hardware of the control device 20 in the embodiments may be implemented using a general computer. Accordingly, a program or the like relating to the flowcharts of Fig. 3 to Fig. 5 may be stored in a storage medium or distributed via a transmission path.

(4) The processes depicted in Fig. 3 to Fig. 5 have been described as software processes using a program in the embodiment. However, the processes may be partly or entirely substituted by hardware processes using an application specific integrated circuit (ASIC) or a field programmable gate array (FPGA), for example.

(5) The present invention may be used preferably for a ceiling cassette-type indoor unit in which differences tend to occur between the environment of the air-conditioned room and the environment in the indoor unit. However, the present invention is not limited by the type of indoor unit. For example, the present invention may be applied to a wall-hanging indoor unit or a window-type air-conditioner in which an indoor unit and an outdoor unit are integrated.

DESCRIPTION OF REFERENCE SIGNS

[0082]

20 Control device

30 Outdoor unit
32 Compressor
64 Indoor heat exchanger
66 Indoor fan
70 Indoor heat exchanger entry air temperature sensor (Air state sensor)
74 Indoor heat exchanger entry humidity sensor (Air state sensor)
100 Air-conditioner
150 Vertical deflector
RC Refrigeration cycle

Claims

1. An air-conditioner comprising:

a refrigeration cycle including a compressor for compressing a refrigerant, and an indoor heat exchanger for cooling or heating air in an air-conditioned room;
a control device for controlling the refrigeration cycle to perform a washing operation for washing a surface of the indoor heat exchanger;
an indoor fan for delivering air to the indoor heat exchanger; and
an air state sensor for detecting a temperature or humidity of air that flows in from the air-conditioned room,
wherein the control device includes:

a function of driving the indoor fan for a predetermined time before performing the washing operation; and
a function of allowing the washing operation to be performed on condition that a detection result from the air state sensor after the indoor fan has been driven is within a first predetermined range.

2. The air-conditioner according to claim 1, further comprising a function of driving the indoor fan on condition that the detection result from the air state sensor before the indoor fan is driven is within a second predetermined range.

3. The air-conditioner according to claim 2, wherein the second predetermined range is wider than the first predetermined range.

4. The air-conditioner according to claim 3, wherein:

the predetermined time is a time greater than or equal to 30 seconds; and
when it is being determined whether the detection result from the air state sensor is within the first predetermined range, the driving of the indoor fan is continued.

5. The air-conditioner according to claim 4, further comprising a vertical deflector that changes, in a vertical direction, an air flow discharged into the air-conditioned room, and is placed in closed state during a shut-down of the refrigeration cycle, wherein
the control device further has a function of placing the vertical deflector in a state more open than the closed state during a period of the predetermined time.

6. The air-conditioner according to claim 5, wherein:

the control device has a watch-over operation function of performing a cooling operation automatically in accordance with the detection result from the air state sensor after the indoor fan has been rotated; and
before the washing operation is performed, the indoor fan is rotated at a rotating speed higher than a rotating speed at which the indoor fan is rotated before the watch-over operation function is performed.

7. The air-conditioner according to claim 6, wherein
the control device further has a function of setting a rotating speed of the compressor based on the detection result from the air state sensor after the indoor fan has been driven.

8. The air-conditioner according to claim 7, wherein
the control device further has a function of selecting, based on the detection result from the air state sensor after the indoor fan has been driven, a frozen washing operation for causing frost formation on the indoor heat exchanger or a dew condensation washing operation for causing dew condensation without causing frost formation on the indoor heat exchanger.

9. A method of controlling an air-conditioner comprising:

a refrigeration cycle including a compressor for compressing a refrigerant, and an indoor heat exchanger for cooling or heating air in an air-conditioned room;
a control device for controlling the refrigeration cycle to perform a washing operation for washing a surface of the indoor heat exchanger;
an indoor fan for delivering air to the indoor heat exchanger; and
an air state sensor for detecting a temperature or humidity of air that flows in from the air-conditioned room,
the method comprising:

a step of driving the indoor fan for a predetermined time before performing the wash-

ing operation; and
a step of allowing the washing operation to be performed on condition that a detection result from the air state sensor after the indoor fan has been driven is within a first predetermined range.

10. A program for application in an air-conditioner comprising:

a refrigeration cycle including a compressor for compressing a refrigerant, and an indoor heat exchanger for cooling or heating air in an air-conditioned room;
a computer for controlling the refrigeration cycle to perform a washing operation for washing a surface of the indoor heat exchanger;
an indoor fan for delivering air to the indoor heat exchanger; and
an air state sensor for detecting a temperature or humidity of air that flows in from the air-conditioned room,
the program causing the computer to function as:

a means of driving the indoor fan for a predetermined time before performing the washing operation; and
a means of allowing the washing operation to be performed on condition that a detection result from the air state sensor after the indoor fan has been driven is within a first predetermined range.

Amended claims under Art. 19.1 PCT

1. (Amended) An air-conditioner comprising:

a refrigeration cycle including a compressor for compressing a refrigerant, and an indoor heat exchanger for cooling or heating air in an air-conditioned room;
a control device for controlling the refrigeration cycle to perform a freezing operation for making a surface temperature of the indoor heat exchanger below zero;
an indoor fan for delivering air to the indoor heat exchanger;
a temperature sensor for detecting a temperature of air that flows in from the air-conditioned room; and
a humidity sensor for detecting a humidity of the air that flows in from the air-conditioned room,
wherein the control device has
both of:

a first function of not allowing the freezing operation to be performed when a relative humidity of the air is lower than a third predetermined value and the temperature of the air is higher than a first predetermined value, and
a second function of not allowing the freezing operation to be performed when the relative humidity of the air is higher than or equal to the third predetermined value; or

both of:

a third function of not allowing the freezing operation to be performed when the absolute humidity of the air is lower than a fourth predetermined value and the temperature of the air is higher than the first predetermined value, and
a fourth function of not allowing the freezing operation to be performed when the absolute humidity of the air is higher than or equal to the fourth predetermined value.

2. (Amended) The air-conditioner according to claim 1, further comprising a function of driving the indoor fan on condition that the temperature of the air before the indoor fan is driven is within a second predetermined range.

3. The air-conditioner according to claim 2, wherein the second predetermined range is wider than the first predetermined range.

4. (Amended) The air-conditioner according to claim 1, wherein:

the control device
further has a function of driving the indoor fan for a predetermined time of 30 seconds or more before performing the freezing operation; and
is continuing the driving of the indoor fan when it is being determined whether the temperature of the air is within the first predetermined range.

5. (Amended) The air-conditioner according to claim 1, further comprising a vertical deflector that changes, in a vertical direction, an air flow discharged into the air-conditioned room, and is placed in closed state during a shut-down of the refrigeration cycle, wherein

the control device further has
both of:

a function of driving the indoor fan for a predetermined time before performing the freezing operation; and
a function of placing the vertical deflector in a state more open than the closed state during a period of the predetermined time.

6. (Amended) The air-conditioner according to claim 1, wherein:

the control device has a watch-over operation function of performing a cooling operation automatically in accordance with the detection result from the temperature sensor after the indoor fan has been rotated; and
before the freezing operation is performed, the indoor fan is rotated at a rotating speed higher than a rotating speed at which the indoor fan is rotated before the watch-over operation function is performed.

7. (Amended) The air-conditioner according to claim 1, wherein
the control device further has a function of setting a rotating speed of the compressor based on the detection result from the temperature sensor after the indoor fan has been driven.

8. (Amended) The air-conditioner according to claim 1, wherein
the control device further has a function of selecting, based on the detection result from the humidity sensor after the indoor fan has been driven, the freezing operation for causing frost formation on the indoor heat exchanger or a dew condensation washing operation for causing dew condensation without causing frost formation on the indoor heat exchanger.

9. (Deleted)

10. (Deleted)

FIG. 1

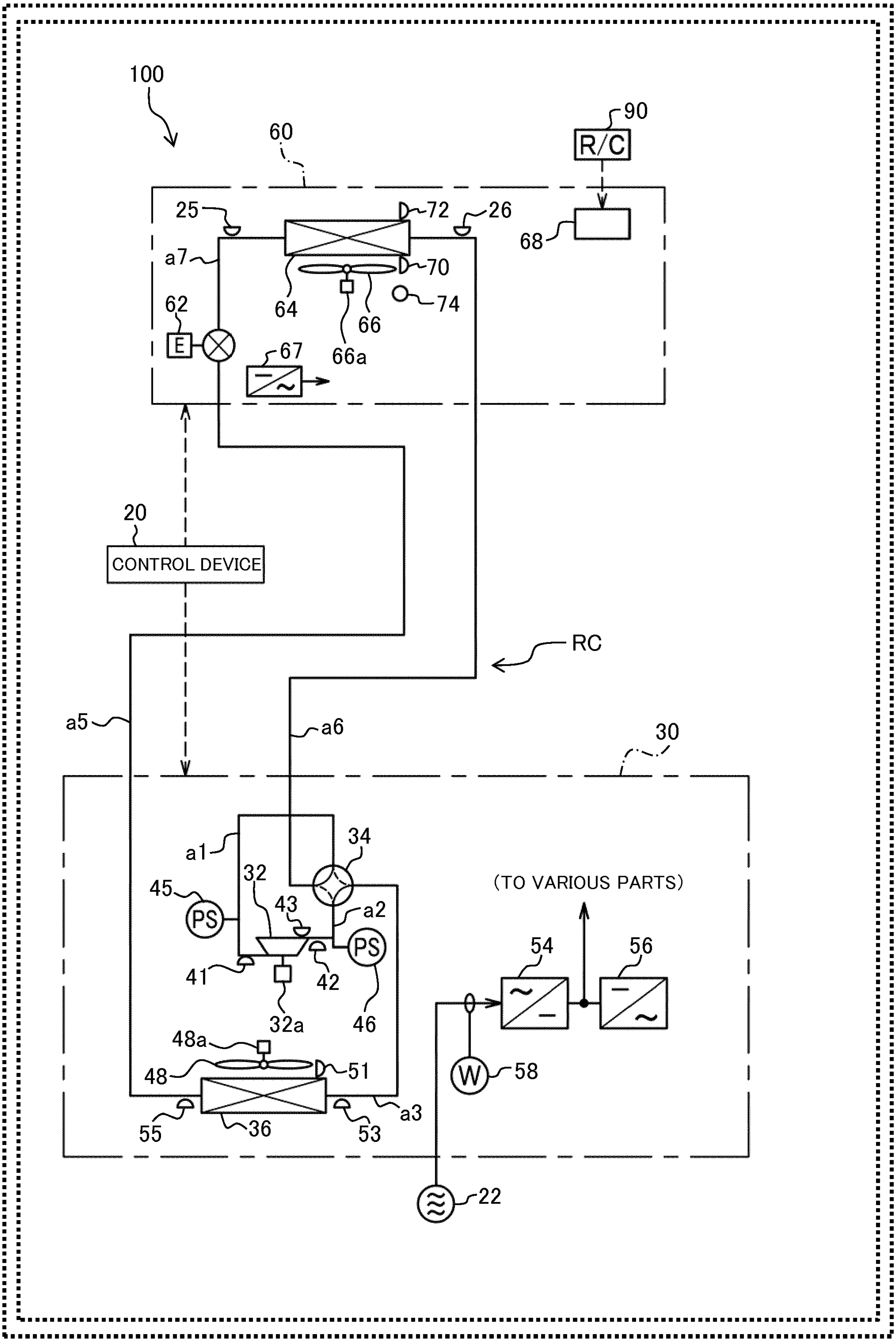

100
60
90
R/C
25
72
26
a7
70
68
64
66
74
62
E
67
66a
20
CONTROL DEVICE
RC
a5
a6
30
a1
34
32
45
PS
43
a2
(TO VARIOUS PARTS)
41
42
PS
54
56
32a
46
48a
51
58
48
W
55
36
53
a3
22

FIG. 2

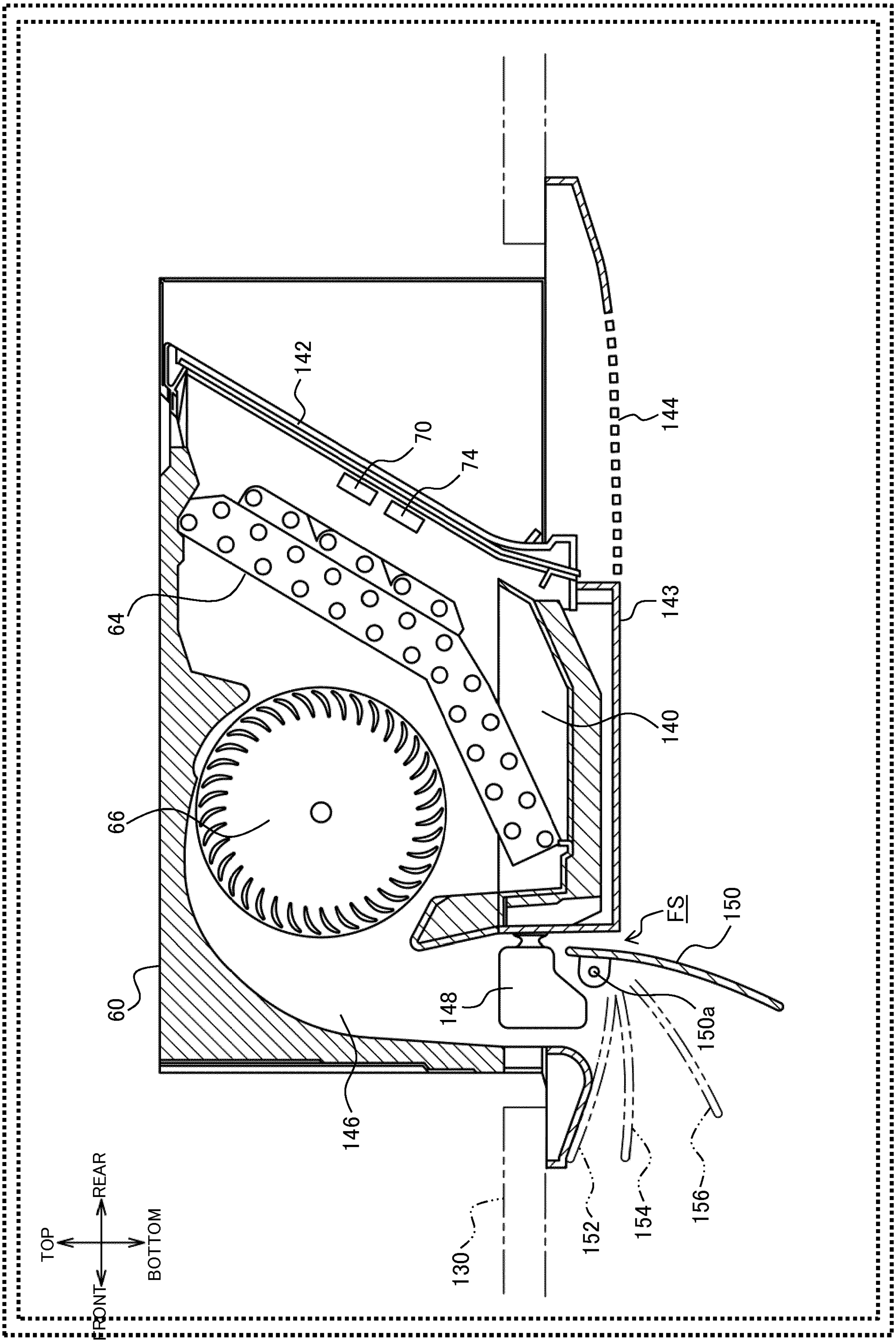

142
70
74
144
64
143
66
140
FS
150
60
148
150a
146
TOP
REAR
BOTTOM
FRONT
130
152
154
156

FIG. 3

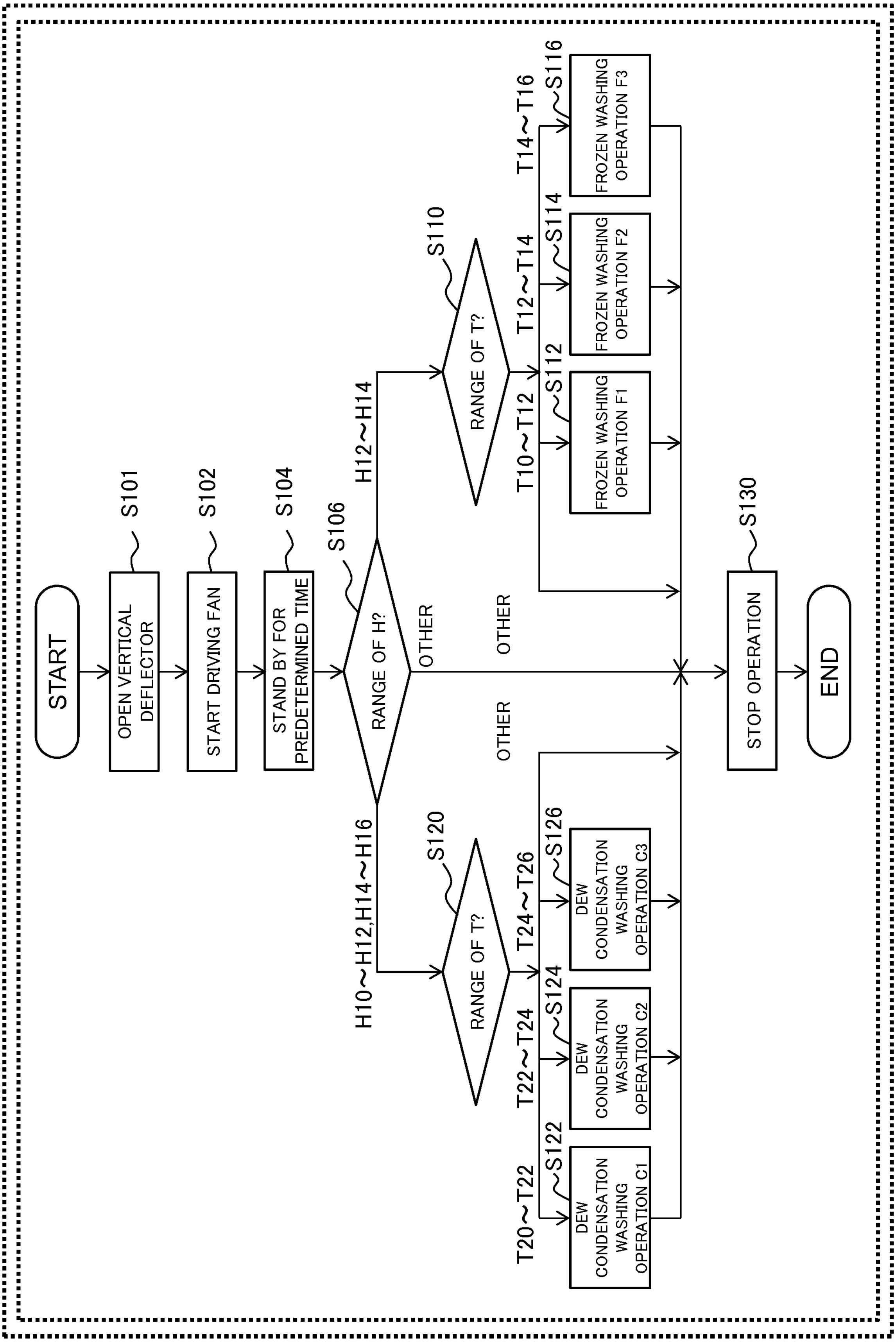

START
OPEN VERTICAL DEFLECTOR
S101
START DRIVING FAN
S102
STAND BY FOR PREDETERMINED TIME
S104
RANGE OF H?
S106
H12~H14
OTHER
H10~H12,H14~H16
RANGE OF T?
S110
T10~T12
T12~T14
T14~T16
OTHER
FROZEN WASHING OPERATION F1
S112
FROZEN WASHING OPERATION F2
S114
FROZEN WASHING OPERATION F3
S116
OTHER
RANGE OF T?
S120
T20~T22
T22~T24
T24~T26
OTHER
DEW CONDENSATION WASHING OPERATION C1
S122
DEW CONDENSATION WASHING OPERATION C2
S124
DEW CONDENSATION WASHING OPERATION C3
S126
STOP OPERATION
S130
END

FIG. 4

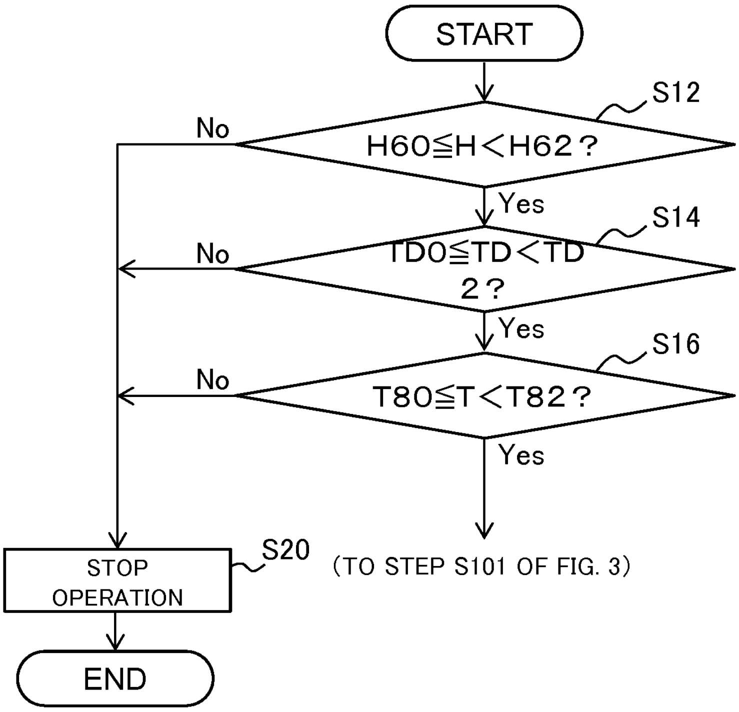
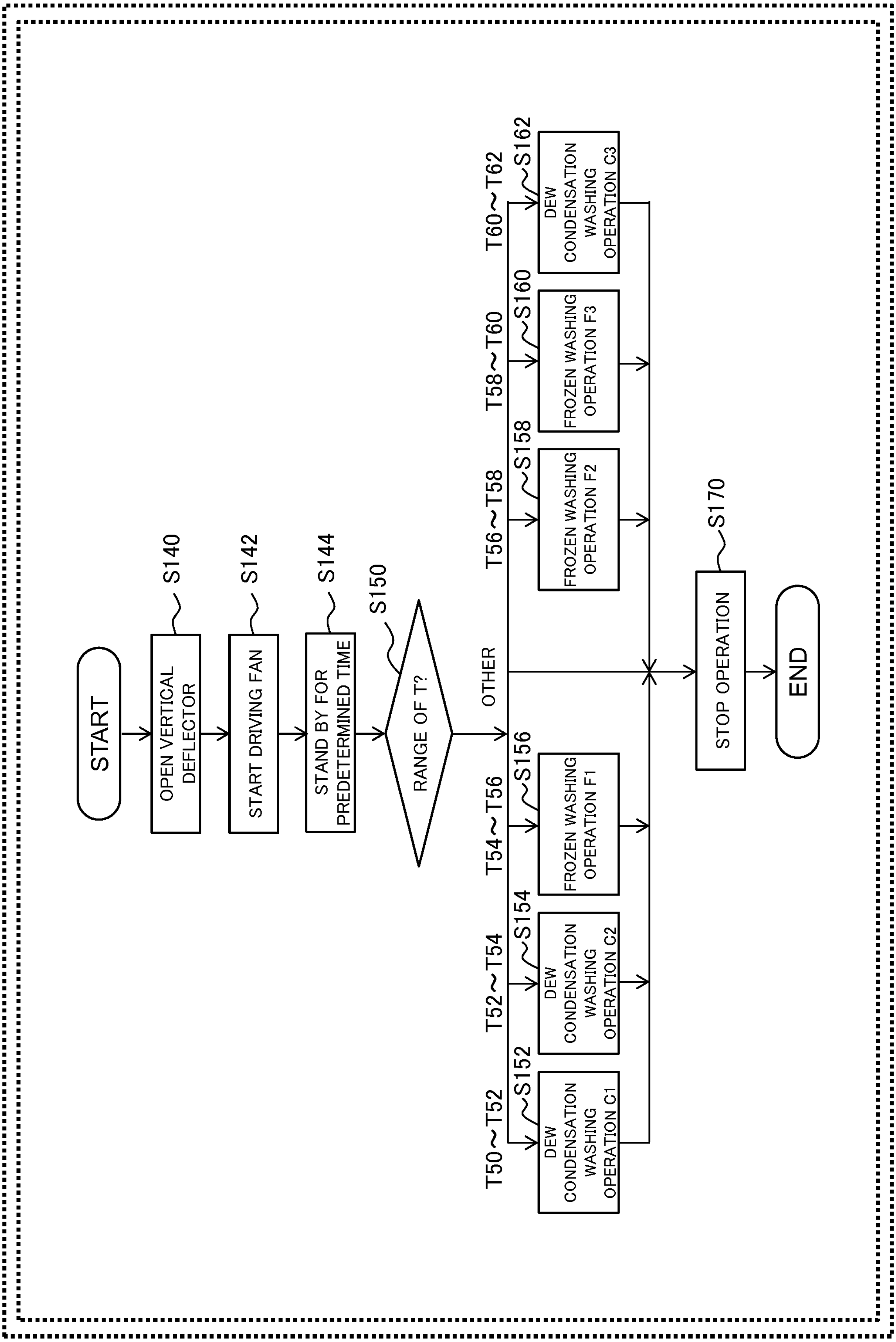

START
S12
No
H60≦H＜H62？
Yes
S14
No
TD0≦TD＜TD2？
Yes
S16
No
T80≦T＜T82？
Yes
S20
STOP OPERATION
(TO STEP S101 OF FIG. 3)
END

FIG. 5



START
OPEN VERTICAL DEFLECTOR
S140
START DRIVING FAN
S142
STAND BY FOR PREDETERMINED TIME
S144
RANGE OF T?
S150
T50～T52
S152
DEW CONDENSATION WASHING OPERATION C1
T52～T54
S154
DEW CONDENSATION WASHING OPERATION C2
T54～T56
S156
FROZEN WASHING OPERATION F1
OTHER
T56～T58
S158
FROZEN WASHING OPERATION F2
T58～T60
S160
FROZEN WASHING OPERATION F3
T60～T62
S162
DEW CONDENSATION WASHING OPERATION C3
STOP OPERATION
S170
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/037443

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F24F11/48(2018.01)i, F24F11/43(2018.01)i, F24F11/74(2018.01)i, F24F110/10(2018.01)n, F24F110/20(2018.01)n

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. F24F11/48, F24F11/43, F24F11/74, F24F110/10, F24F110/20

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2009-52844 A (TOSHIBA CARRIER CORP.) 12 March 2009, paragraphs [0010]-[0012], [0020], [0022], [0035]-[0040], fig. 1, 5, 7 (Family: none)	1-5, 9-10 6-8
Y	JP 50-141845 A (MITSUBISHI ELECTRIC CORP.) 14 November 1975, page 2, upper left column, line 12 to page 3, upper left column, line 15, fig. 2, 3 (Family: none)	1-5, 9-10
A	CN 107514683 A (QINGDAO HAIER AIR CONDITIONER) 26 December 2017, entire text, all drawings (Family: none)	1-10

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

* Special categories of cited documents:
“A” document defining the general state of the art which is not considered to be of particular relevance
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“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
“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
“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
“&” document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03.12.2018	11.12.2018

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 6296633 A **[0004]**