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(54) **Air conditioner**

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Description**TECHNICAL FIELD**

[0001] The present invention relates to an air conditioner capable of improving user's comfort.

BACKGROUND ART

[0002] Conventional air conditioners are so designed that during its heating operation, as the indoor temperature becomes stabilized, the compressor is stopped (thermo-off) so that low-power consumption control is executed (see, e.g., PTL1).

[0003] JP 2011-153736 A discloses a refrigerating cycle device in which the compressor, an indoor heat exchanger, an expansion valve, and an outdoor heat exchanger are connected to each other by refrigerant piping. The refrigerating cycle device is provided with a heat storage device having a heat storage material disposed in a state of surrounding the compressor and storing the heat generated in the compressor, and a heat storage heat exchanger exchanging heat between the heat stored in the heat storage material and the refrigerant. Further it includes piping for guiding a part of the refrigerant discharged from the compressor to the outdoor heat exchanger, and piping for guiding the refrigerant from the indoor heat exchanger to the heat storage heat exchanger in a defrosting operation, and the refrigerant from the heat storage heat exchanger is joined with the refrigerant from the outdoor heat exchanger.

CITATION LIST**Patent Literature**

[0004] PTL1: JP H6-249542 A

SUMMARY OF INVENTION**Technical Problem**

[0005] However, stopping the operation of the compressor causes indoor air conditioning to be stopped, and therefore comfort of users present in the room may be impaired.

[0006] Accordingly, an object of the present invention is to provide an air conditioner capable of executing the heating operation while indoor users' comfort is maintained.

Solution to Problem

[0007] In order to achieve the object, according to one aspect of the present invention, there is provided an air conditioner as defined in claim 1.

Advantageous Effects of Invention

[0008] According to the present invention, there can be provided an air conditioner capable of executing the heating operation while indoor users' comfort is maintained.

BRIEF DESCRIPTION OF DRAWINGS**[0009]**

Fig. 1 is a schematic constructional view of a refrigerating cycle in an air conditioner according to Embodiment 1 of the invention;

Fig. 2 is a flowchart for a transition to thermo-off operation delay control in Embodiment 1;

Fig. 3 is a flowchart of the thermo-off operation delay control in Embodiment 1;

Fig. 4 is a schematic constructional view of a refrigerating cycle in an air conditioner according to Embodiment 2 of the invention; and

Fig. 5 is a flowchart for a transition to thermo-off operation delay control in Embodiment 2.

DESCRIPTION OF EMBODIMENTS

[0010] A first invention provides an air conditioner comprising: a refrigerating cycle which comprises a compressor, a four-way valve, an indoor heat exchanger, a pressure reducer, and an outdoor heat exchanger and in which during heating operation a refrigerant flows in an order of the compressor, the four-way valve, the indoor heat exchanger, the pressure reducer, the outdoor heat exchanger, the four-way valve, and the compressor; an indoor temperature detection means for detecting an indoor temperature; and a target temperature setting means for setting a target temperature, wherein a specified compressor-stop condition is previously set, the specified compressor-stop condition is satisfied when a state, which the indoor temperature is higher than the target temperature by a specified temperature difference, has lasted for a specified duration time, and the compressor is stopped when, after the indoor temperature has exceeded the target temperature, the specified compressor-stop condition is satisfied, the air conditioner further comprising: a bypass circuit for connecting one point between the indoor heat exchanger and the pressure reducer and another point between the four-way valve and an inlet port of the compressor; and a bypass-use two-way valve provided in the bypass circuit, wherein after the indoor temperature has exceeded the target temperature and before the specified compressor-stop condition is satisfied, the bypass-use two-way valve is opened.

[0011] Therefore, after the indoor temperature has exceeded the target temperature, the refrigerant flowing from the compressor toward the indoor heat exchanger lowers in pressure, so that the temperature of the indoor heat exchanger can be lowered. As a result, the specified

compressor-stop condition becomes less likely to be satisfied, i.e., the compressor is less likely to be stopped, so that the indoor user's comfort can be maintained.

[0012] In a second invention, the air conditioner of the first invention further comprises a heat storage unit which is provided in the bypass circuit and which conducts exhaust heat of the compressor to the refrigerant.

[0013] Therefore, the heating operation can be continued while the defrosting operation is performed securely, and moreover the thermo-off operation delay control is executed when the defrosting operation is less likely to be executed. Thus, the heating operation can be executed while the user's comfort is maintained.

[0014] In a third invention, the air conditioner of the second invention further comprises a defrosting-use bypass circuit for merging a refrigerant discharged from a discharge port of the compressor with a refrigerant flowing between the pressure reducer and the outdoor heat exchanger; and a defrosting-use two-way valve provided in the defrosting-use bypass circuit, wherein during defrosting operation for defrosting the outdoor heat exchanger, the defrosting-use two-way valve and the bypass-use two-way valve are opened while heating operation is kept ongoing.

[0015] Thus, the heating operation can be continued even during defrosting operation.

[0016] In a fourth invention, the air conditioner of the second or third invention is configured so that the heat storage unit has a heat storage material for storing exhaust heat of the compressor, and a heat-storage heat exchanger for conducting heat of the heat storage material to the refrigerant flowing through the bypass circuit, and a heat-storage-material temperature detection means for detecting a temperature of the heat storage material is further included, and wherein while the temperature of the heat storage material is lower than a specified heat-storage-material temperature, the bypass-use two-way valve is kept closed.

[0017] Thus, extreme lowering of the indoor heat exchanger temperature is suppressed.

[0018] In a fifth invention, the air conditioner of any one of the second to fourth invention is configured so that during a period from an end of defrosting operation till an elapse of a specified defrosting non-execution period, the bypass-use two-way valve is kept closed.

[0019] Therefore, when the defrosting operation is highly likely to be executed, temperature decreases of the heat storage material due to the refrigerant flowing through the bypass circuit, which may make it impossible to execute the defrosting operation, are suppressed. Thus, the defrosting operation can be executed while the heating operation is continued.

[0020] In a sixth invention, the air conditioner of any one of the second to fifth invention further comprises an outside-air temperature detection means for detecting an outside air temperature, wherein when an outside air temperature detected by the outside-air temperature detection means is lower than a specified outside air tem-

perature, the bypass-use two-way valve is kept closed.

[0021] Therefore, when the defrosting operation is highly likely to be executed, temperature decreases of the heat storage material due to the refrigerant flowing through the bypass circuit, which may make it impossible to execute the defrosting operation, are suppressed. Thus, the defrosting operation can be executed while the heating operation is continued.

[0022] In a seventh invention, the air conditioner of any one of the second to sixth invention further comprises an outdoor-heat-exchanger temperature detection means for detecting a temperature of the outdoor heat exchanger, wherein while the temperature of the outdoor heat exchanger is lower than a specified outdoor-heat-exchanger temperature, the bypass-use two-way valve is kept closed.

[0023] Therefore, when the defrosting operation is highly likely to be executed, temperature decreases of the heat storage material due to the refrigerant flowing through the bypass circuit, which may make it impossible to execute the defrosting operation, are suppressed. Thus, the defrosting operation can be executed while the heating operation is continued.

[0024] According to the invention, the air conditioner is configured so that after the indoor temperature has exceeded the target temperature and when a specified valve-opening time has elapsed since an opening of the bypass-use two-way valve, the bypass-use two-way valve is closed.

[0025] Therefore, the occurrence that the pressure difference between upstream-side refrigerant and downstream-side refrigerant becomes zero so as to make it impossible to continue the heating operation can be avoided.

[0026] According to the invention, the air conditioner is configured so that after the indoor temperature has exceeded the target temperature, opening and closing of the bypass-use two-way valve is repeated to a plurality of times.

[0027] Therefore, it can be made less likely that the specified compressor-stop condition is satisfied while extreme temperature decreases of the indoor heat exchanger are suppressed.

[0028] In an eighth invention, the air conditioner is configured so that an upper limit is provided for a number of opening and closing times of the bypass-use two-way valve.

[0029] Therefore, the temperature decreasing extent of the indoor heat exchanger can be reduced smaller, and extreme temperature decreases of the indoor heat exchanger can be suppressed.

[0030] In a ninth invention, the air conditioner further comprises an indoor-heat-exchanger temperature detection means for detecting a temperature of the indoor heat exchanger, wherein when the temperature of the indoor heat exchanger is lower than a specified indoor heat exchanger temperature, the bypass-use two-way valve is closed.

[0031] Therefore, the air conditioning can be executed at a certain temperature or higher, so that impairment of the indoor user's comfort can be avoided.

[0032] In a tenth invention, the air conditioner is configured so that during a period from a closing of the bypass-use two-way valve till an elapse of a specified closure time, the bypass-use two-way valve is kept closed.

[0033] Therefore, frequent repetitions of the opening and closing of the bypass-use two-way valve are suppressed, so that earlier decline of the service life of the bypass-use two-way valve can be avoided.

[0034] Hereinbelow, embodiments of the present invention will be described with reference to the accompanying drawings. It is noted that the present invention is not limited by these embodiments.

(Embodiment 1)

[0035] Fig. 1 is a schematic constructional view of a refrigerating cycle in an air conditioner according to this Embodiment 1.

[0036] The air conditioner in this embodiment has an indoor unit 1 to be installed indoors, an outdoor unit 2 to be installed outdoors, and refrigerant piping 3 for connecting the indoor unit 1 and the outdoor unit 2 to each other.

[0037] The indoor unit 1 includes an indoor heat exchanger 5 for performing heat exchange between indoor air and a refrigerant, and an indoor blower fan 6 for accelerating heat exchange between air and refrigerant via the indoor heat exchanger 5 and moreover blowing air into the room. The indoor unit 1 also includes a temperature sensor 7 which is an indoor temperature detection means for detecting an indoor temperature, and a temperature sensor 8 which is an indoor-heat-exchanger temperature detection means for detecting a temperature of the indoor heat exchanger.

[0038] The outdoor unit 2 includes: an outdoor heat exchanger 9 for performing heat exchange between outdoor air and refrigerant; an outdoor fan 10 for blowing air to the outdoor heat exchanger 9 to accelerate the heat exchange between air and refrigerant via the outdoor heat exchanger 9; a compressor 11 for compressing a refrigerant to discharge a high-temperature gas state refrigerant; a four-way valve 12 for switching a flow direction of the refrigerant; a pressure reducer 13 for reducing the pressure of the refrigerant; a temperature sensor 14 which is an outdoor-heat-exchanger temperature detection means for detecting a temperature of the outdoor heat exchanger 9; and a temperature sensor 15 which is an outside-air temperature detection means for detecting a temperature of outside air.

[0039] The compressor 11, the four-way valve 12, the indoor heat exchanger 5, the pressure reducer 13, and the outdoor heat exchanger 9 constitute a refrigerating cycle of the air conditioner.

[0040] During cooling operation, the refrigerant flows in an order of the compressor 11, the four-way valve 12,

the outdoor heat exchanger 9, the pressure reducer 13, the indoor heat exchanger 5, the four-way valve 12, and the compressor 11. During heating operation, on the other hand, the refrigerant flows in an order of the compressor 11, the four-way valve 12, the indoor heat exchanger 5, the pressure reducer 13, the outdoor heat exchanger 9, the four-way valve 12, and the compressor 11. It is noted that Fig. 2 shows a refrigerating cycle for the heating operation.

[0041] Further, a bypass circuit 16 for connecting one point between the pressure reducer 13 and the indoor heat exchanger 5 with another point between the four-way valve 12 and the compressor 11 is provided in the outdoor unit 2. This bypass circuit 16 is provided with a bypass-use two-way valve 17 for opening and closing the bypass circuit 16.

[0042] The air conditioner is equipped with a remote control unit (not shown) for giving an operation instruction to the indoor unit 1. The remote control unit is enabled to issue an instruction for cooling operation or heating operation and to set an indoor set temperature (target temperature). In normal air-conditioning operation, air-conditioning operation is executed so that the indoor temperature becomes an indoor set temperature.

[0043] The air conditioner is so designed that during heating operation, after an indoor temperature detected by the temperature sensor 7 has exceeded the indoor set temperature set by the remote control unit and when a specified compressor-stop condition is satisfied, the compressor 11 is stopped from operating (hereinafter, referred to as 'thermo-off operation'). By this thermo-off operation, i.e. by the stop of the compressor 11, power consumption of the air conditioner is suppressed.

[0044] Now given below is a description of the specified compressor-stop condition previously set for a start of the thermo-off operation. In this Embodiment 1, during heating operation, when a state that the indoor temperature is higher than an indoor set temperature by a specified temperature difference (e.g., 3°C) has lasted for a specified duration time (e.g., 3 min.), a specified compressor-stop condition is satisfied, so that the compressor 11 is stopped. It is noted that the stop condition for the compressor 11 has only to be a condition for stopping the compressor 11 while the indoor temperature keeps stable, and therefore other conditions such as time elapsed since an operation start may also be combined in addition to the above-described specified temperature and specified duration time.

[0045] However, executing the thermo-off operation, i.e. stopping the compressor 11, involves a stop of the indoor air conditioning, giving rise to a possibility that indoor user's comfort may be impaired.

[0046] After execution of the thermo-off operation, when the operation of the compressor 11 is resumed, the compressor 11 is operated in a high operating-frequency state until the refrigerating cycle is stabilized. In this case, power consumption used for restart of the compressor 11 surpasses the electric energy suppressed by

the thermo-off operation. Therefore, although the power consumption of the air conditioner is lowered by the thermo-off operation, yet the power consumption is increased eventually.

[0047] Accordingly, the air conditioner of Embodiment 1 is so designed that before the condition for execution of the thermo-off operation is satisfied, more specifically, after the indoor temperature has exceeded the indoor set temperature and before a specified stop condition for the compressor 11 is satisfied, the high-pressure liquid state refrigerant that has passed through the indoor heat exchanger 5 is made to flow via the bypass circuit 16 to an inlet port of the compressor 11 (hereinafter, referred to as 'thermo-off operation delay control'). By this thermo-off operation delay control, the refrigerant gas outputted from the compressor 11 and directed toward the indoor heat exchanger 5 is decreased in pressure, so that the temperature of the indoor heat exchanger 5 is lowered. Lowering of the temperature of the indoor heat exchanger 5 causes the temperature of the air blown into the room by the blower fan 6 to be lowered, so that the specified compressor stop condition becomes less likely to be satisfied, that is, a start of the thermo-off operation is delayed.

[0048] Next described is a transition to the thermo-off operation delay control. Fig. 2 is a flowchart for the transition to the thermo-off operation delay control.

[0049] First, at Step 21, it is decided whether the compressor 11 is in operation or not (ON or OFF). If the compressor 11 is in operation, the program goes to Step 22, and if the compressor 11 is at an operation stop, the program returns to the start.

[0050] Next, at Step 22, it is decided whether or not a condition for execution of the thermo-off operation delay control for the compressor 11 is satisfied. The condition for execution of the thermo-off operation delay control is a condition which is relaxed gentler than the condition for execution of the thermo-off operation (specified compressor-stop condition) and which is a condition that necessarily needs to be satisfied before the condition for execution of the thermo-off operation is satisfied.

[0051] In Embodiment 1, during heating operation, the condition for execution of the thermo-off operation (specified compressor-stop condition) is satisfied when a state that the indoor temperature is higher than an indoor set temperature by a first temperature difference (e.g., 3°C) has lasted for a first duration time (e.g., 3 min.), so that the compressor 11 is stopped from operation. Meanwhile, the condition for execution of the thermo-off operation delay control is satisfied when a state that the indoor temperature is higher than the indoor set temperature by a second temperature difference (e.g., 2°C) has lasted for a second duration time (e.g., 2 min.). In this case, the first temperature difference is higher than the second temperature difference and the first duration time is longer than the second duration time, but these are not limitative. The first temperature difference may be set lower than the second temperature difference or the first dura-

tion time may be set shorter than the second duration time. That is, it is essential only that the condition for execution of the thermo-off operation delay control is necessarily satisfied before the condition for execution of the thermo-off operation is satisfied.

[0052] If it is decided at Step 22 that the condition for execution of the thermo-off operation delay control is satisfied, the program goes to Step 23. On the other hand, if the condition for execution of the thermo-off operation delay control is not satisfied, the program returns to step 21.

[0053] Next, at Step 23, it is decided whether a temperature of the indoor heat exchanger 5 is not lower than a specified indoor heat exchanger temperature. The reason of providing this Step 23 is that a flow of the refrigerant into the bypass circuit 16 in a low-temperature state of the indoor heat exchanger 5 may cause the indoor heat exchanger 5 to extremely lower in temperature, so that the indoor user's comfort may be impaired. If the temperature of the indoor heat exchanger 5 is not lower than the specified indoor heat exchanger temperature, the program goes to Step 24. If the temperature of the indoor heat exchanger 5 is lower than the specified indoor heat exchanger temperature, the program returns to Step 21.

[0054] Next, at Step 24, it is decided whether or not a specified closure time has elapsed since a last-time closure of the bypass-use two-way valve 17. This Step 24 makes it possible to avoid the occurrence that frequent repetitions of opening and closing of the bypass-use two-way valve 17 cause the bypass-use two-way valve 17 to come earlier to a limit number of its opening and closing times (i.e., its service life is shortened).

[0055] If the specified closure time (e.g., 20 min.) has elapsed since the last-time closure of the bypass-use two-way valve 17, the program goes to Step 25, where the thermo-off operation delay control is executed. On the other hand, if the specified closure time has not elapsed, the program returns to Step 21.

[0056] Based on the steps shown above, the thermo-off operation delay control is executed. Subsequently, the thermo-off operation delay control will be described in detail. Fig. 3 is a flowchart of the thermo-off operation delay control.

[0057] First, at Step 31, the bypass-use two-way valve 17 is opened. As a result of this, the refrigerant in a high-pressure liquid state flows via the bypass circuit 16 to the inlet port of the compressor 11, so that the refrigerant gas outputted from the compressor 11 is lowered in pressure and, resultantly, the temperature of the indoor heat exchanger 5 is lowered. Therefore, the temperature difference between indoor temperature and indoor set temperature becomes smaller, so that the condition for execution of the thermo-off operation (specified compressor-stop condition) becomes less likely to be satisfied. As a consequence, the possibility that the thermo-off operation is executed (the compressor 11 is stopped with the indoor air conditioning stopped) is reduced, so that the user's comfort can be maintained. Moreover, increas-

es in power consumption due to restarts of the compressor 11 can be avoided.

[0058] However, when the bypass-use two-way valve 17 is kept in an opened state, the pressure difference between upstream-side refrigerant and downstream-side refrigerant becomes zero, making it impossible to continue the heating operation. Accordingly, at Step 32, it is decided whether or not a specified valve-opening time (e.g., 5 sec.) has elapsed since opening of the bypass-use two-way valve 17. If the specified valve-opening time has elapsed, the program goes to Step 33. If the specified valve-opening time has not elapsed, the program returns to Step 31.

[0059] Next, at Step 33, the bypass-use two-way valve 17 is closed. At subsequent Step 34, it is decided whether or not a specified valve-closing time (e.g., 20 sec.) has elapsed. If the specified valve-closing time has elapsed, the program goes to Step 35; if the specified valve-closing time has not elapsed, the program returns to Step 33. It is noted that setting the specified valve-opening time shorter than the specified valve-closing time makes it possible to suppress extreme temperature decreases of the indoor heat exchanger 5, so that the indoor user's comfort can be maintained.

[0060] Next, at Step 35, it is decided whether or not the number of opening and closing times of the bypass-use two-way valve 17 has reached an upper-limit value. With one cycle taken as a course from an opening to a closing of the bypass-use two-way valve 17, and with setting of an upper-limit value for the number of times of execution of this cycle, excess number of opening and closing times of the bypass-use two-way valve 17 beyond the upper-limit value can be suppressed. Thus, reliability of the bypass-use two-way valve 17 is secured. Further, the temperature decreasing extent of the indoor heat exchanger 5 can be suppressed to a smaller one, and extreme temperature decreases of the indoor heat exchanger 5 can be suppressed, so that the indoor user's comfort can be maintained. If the number of opening and closing times of the bypass-use two-way valve 17 has reached the upper-limit value, the thermo-off operation delay control is ended. If the number of opening and closing times has not reached the upper-limit value, the program goes to Step 36.

[0061] At Step 36, it is decided whether the temperature of the indoor heat exchanger 5 is not lower than a specified indoor heat exchanger temperature. The reason of providing this Step 36 is the same as that for Step 23. A flow of the refrigerant into the bypass circuit 16 in a low-temperature state of the indoor heat exchanger 5 may cause the indoor heat exchanger 5 to extremely lower in temperature, so that the indoor user's comfort may be impaired.

[0062] It is noted that the specified indoor heat exchanger temperature is set in correspondence to an indoor set temperature set by the remote control unit. The specified indoor heat exchanger temperature may be determined either in a unique correspondence or not in a

unique correspondence to the indoor set temperature depending on the structure of the refrigerating cycle. For example, the specified indoor heat exchanger temperature in Step 23 shown in Fig. 2 and the specified indoor heat exchanger temperature in Step 36 shown in Fig. 3 may be equal to, or different from, each other depending on the structure of the refrigerating cycle.

[0063] If it is decided at Step 36 that the indoor heat exchanger temperature is not lower than the specified indoor heat exchanger temperature, the program returns to Step 31, where the thermo-off operation delay control is continued. On the other hand, if the indoor heat exchanger temperature is lower than the specified indoor heat exchanger temperature, the thermo-off operation delay control is ended.

[0064] As described above, according to Embodiment 1, the refrigerant is made to flow through the bypass circuit 16 during heating operation to lower the temperature of the indoor heat exchanger 5, so that the execution of the thermo-off operation, which is an operation involving the stopping of the compressor 11, can be delayed. As a result, the heating operation can be fulfilled while the indoor user's comfort is maintained. Also, since the stopping of the compressor 11 is delayed, power consumption due to restarts of the compressor 11 can be prevented.

(Embodiment 2)

[0065] Fig. 4 is a schematic constructional view of a refrigerating cycle in an air conditioner according to Embodiment 2. The same component members as in Embodiment 1 are designated by the same reference signs as those of Embodiment 1. Also, the description of the same component members as in Embodiment 1 is omitted. A difference of Embodiment 2 from Embodiment 1 lies in that the air conditioner of this Embodiment 2 includes a heat storage unit 18 and a defrosting-use bypass circuit 21.

[0066] The heat storage unit 18 is provided in the bypass circuit 16. The heat storage unit 18 also has a heat storage material 19 which is housed inside a heat storage container wound around the compressor 11 and formed from resin and which serves for storing exhaust heat radiated from the compressor 11. As the heat storage material, for example, a solution mixed with chemical substances such as ethylene glycol aqueous solution, simple water, and metal members such as aluminum and copper may be used. That is, the heat storage material 19 has only to be a substance capable of storing exhaust heat radiated from the compressor 11.

[0067] Further, a heat-storage heat exchanger 20 is provided in the heat storage material 19 (heat storage container). Between the refrigerant flowing through refrigerant piping provided inside the heat-storage heat exchanger and the heat storage material 19, heat exchange is performed. The heat storage material 19 exchanges heat with the refrigerant of a high-pressure liquid state

flowing through the bypass circuit 16 to run toward the inlet port of the compressor 11. Also, a temperature sensor 23 which is a heat-storage-material temperature detection means for detecting a temperature of the heat storage material 19 is provided.

[0068] A defrosting-use bypass circuit 21 is further provided for merging a refrigerant discharged from a discharge port of the compressor 11 with a refrigerant flowing between the pressure reducer 13 and the outdoor heat exchanger 9. In the defrosting-use bypass circuit 21, a defrosting-use two-way valve 22 is provided. As the defrosting-use two-way valve 22 is opened, the refrigerant flows through the defrosting-use bypass circuit 21.

[0069] Defrosting operation of the air conditioner constructed as described above is explained below. In the refrigerating cycle of the air conditioner in Embodiment 2, defrosting operation can be carried out while heating operation is continued.

[0070] First, upon detection that the temperature of the outdoor heat exchanger detected by the temperature sensor 14 is a temperature that is a defrosting-operation start condition, the defrosting operation is started. It is noted that the defrosting-operation start condition is not limited to this. For example, other conditions such as outside air temperature or a case that the temperature of the outdoor heat exchanger has kept lower than the temperature of the defrosting-operation start condition continuously for a specified time duration may be added. Besides, the detection of the temperature of the outdoor heat exchanger 9 may also be fulfilled by detecting a temperature of refrigerant piping of the outdoor heat exchanger 9.

[0071] With the defrosting-operation start condition satisfied, the defrosting-use two-way valve 22 and the bypass-use two-way valve 17 are opened, and the pressure reducer 13 is controlled to a proper openness. Thus, the defrosting operation can be executed while heating operation is continued.

[0072] Such defrosting operation under continued heating operation is carried out in a state that both the defrosting-use two-way valve 22 and the bypass-use two-way valve 17 are opened. In this case, if the bypass-use two-way valve 17 is opened earlier than the defrosting-use two-way valve 22, heat quantity stored in the heat storage material 19 is used wastefully (i.e. not used for defrosting). When the defrosting-use two-way valve 22 and the bypass-use two-way valve 17 are opened simultaneously, a refrigerant that has flowed from the defrosting-use bypass circuit 21 and passed through the outdoor heat exchanger 9 and another refrigerant that has flowed from the indoor heat exchanger 5 and passed through the bypass circuit 16 are simultaneously taken into the compressor 11. Due to this, a pressure change of the refrigerant may be caused. Therefore, opening the bypass-use two-way valve 17 after a proper time elapse since the opening of the defrosting-use two-way valve 22 makes it possible to suppress pressure changes to a

minimum. For this reason, in this Embodiment 2, the defrosting-use two-way valve 22 is opened earlier than the bypass-use two-way valve 17.

[0073] Next, a transition to the thermo-off operation delay control in this Embodiment 2 is explained. Fig. 5 is a flowchart for the transition to the thermo-off operation delay control.

[0074] First, Steps 51 to 54 are of the same contents as Steps 21 to 24 shown in Fig. 2 and so their description is omitted. However, in Step 54 in this Embodiment 2, if it is decided that a specified closure time has elapsed since a last-time closure of the bypass-use two-way valve 17, the program goes to Step 55.

[0075] Next, at Step 55, it is decided whether the temperature of the heat storage material 19 is not lower than a specified heat-storage-material temperature (e.g., 80°C). The higher the temperature of the heat storage material 19 is, the smaller the temperature decreasing extent of the indoor heat exchanger 5 after an opening of the bypass-use two-way valve 17 becomes, so that the indoor user's comfort is less likely to be impaired. On the other hand, the lower the temperature of the heat storage material 19 is, the larger the temperature decreasing extent of the indoor heat exchanger 5 after an opening of the bypass-use two-way valve 17 becomes, so that the indoor user's comfort is more likely to be impaired. Accordingly, under the condition that the temperature of the heat storage material is lower than the specified heat-storage-material temperature, opening of the bypass-use two-way valve 17 (i.e., execution of the thermo-off operation delay control at later-described Step 59) may cause the user's comfort to be further impaired.

[0076] Therefore, if the temperature of the heat storage material 19 is not lower than the specified heat-storage-material temperature, the program goes to Step 56. On the other hand, if the temperature of the heat storage material 19 is lower than the specified heat-storage-material temperature, the program returns to Step 51.

[0077] Next, at Step 56, it is decided whether or not a specified defrosting non-execution period has elapsed since an end of the last-time defrosting operation. Once the defrosting operation is executed, it is highly likely that the defrosting operation is executed repeatedly. Then, if the bypass-use two-way valve 17 is opened before execution of the next-time defrosting operation, causing the temperature of the heat storage material 19 to be lowered, it becomes impossible to execute the defrosting operation while the heating operation is kept ongoing, so that the user's comfort may be impaired.

[0078] Therefore, at Step 56, it is decided whether or not a specified defrosting non-execution period (e.g., 1 hour) has elapsed since an end of the last-time defrosting operation. If the specified defrosting non-execution period has elapsed since an end of the last-time defrosting operation, the program goes to Step 57. On the other hand, if the specified defrosting non-execution period has not elapsed since an end of the last-time defrosting operation, the program returns to Step 51.

[0079] Next, at Step 57, it is decided whether the temperature of the outdoor heat exchanger 9 is not lower than a specified outdoor-heat-exchanger temperature. As the bypass-use two-way valve 17 is opened (i.e., the thermo-off operation delay control in later-described Step 59 is executed), the temperature of the heat storage material 19 is lowered, so that it may become impossible to execute the defrosting operation while the heating operation is kept ongoing. Therefore, under the condition that the temperature of the outdoor heat exchanger 9 is lower than the specified outdoor-heat-exchanger temperature, i.e., the temperature of the outdoor heat exchanger 9 is such a temperature that the defrosting operation may be executed, opening of the bypass-use two-way valve 17 is suppressed, preparatorily making it possible to execute the defrosting operation while the heating operation is kept ongoing. Therefore, if the temperature of the outdoor heat exchanger 9 is not lower than the specified outdoor-heat-exchanger temperature, the program goes to Step 58. If the temperature is lower than the specified outdoor-heat-exchanger temperature, the program returns to Step 51.

[0080] Next, at Step 58, it is decided whether the outside air temperature is not lower than a specified outside air temperature (e.g., -1°C). As the bypass-use two-way valve 17 is opened (i.e., the thermo-off operation delay control at later-described Step 59 is executed), the temperature of the heat storage material 19 is lowered, so that it may become impossible to execute the defrosting operation while the heating operation is kept ongoing. Therefore, under the condition that the outside air temperature is lower than the specified outside air temperature, i.e., the outside air temperature is such a temperature that the defrosting operation may be executed, opening of the bypass-use two-way valve 17 is suppressed, preparatorily making it possible to execute the defrosting operation while the heating operation is kept ongoing. Therefore, if the outside air temperature is not lower than the specified outside air temperature, the program goes to Step 59, where the thermo-off operation delay control is executed. On the other hand, if the outside air temperature is lower than the specified outside air temperature, the program returns to Step 51.

[0081] In addition, the thermo-off operation delay control of Step 59 is of the same contents as the thermo-off operation delay control of Embodiment 1 shown in Fig. 3, and so its description is omitted.

[0082] According to Embodiment 2, the heating operation can be continued while the defrosting operation is kept ongoing securely, and moreover the thermo-off operation delay control is executed when the defrosting operation is less likely to be executed. As a result, the heating operation can be executed while the user's comfort is maintained.

[0083] It is noted that numerical values of temperatures and time durations given as examples in the foregoing description are not limited to those described, and may be changed as required.

INDUSTRIAL APPLICABILITY

[0084] As described hereinabove, the present invention is applicable not only to air conditioners that perform ordinary four-way valve defrosting but also to air conditioners that perform defrosting operation while heating operation is kept ongoing.

REFERENCE SIGNS LIST

[0085]

1	indoor unit
2	outdoor unit
5	indoor heat exchanger
9	outdoor heat exchanger
11	compressor
13	pressure reducer
16	bypass circuit
17	bypass-use two-way valve
18	heat storage unit
19	heat storage material
20	heat-storage heat exchanger
21	defrosting-use bypass circuit
22	defrosting-use two-way valve

Claims

1. An air conditioner comprising:

a refrigerating cycle which comprises a compressor (11), a four-way valve, an indoor heat exchanger (5), a pressure reducer (13), and an outdoor heat exchanger (9) and in which during heating operation a refrigerant flows in an order of the compressor (11), the four-way valve, the indoor heat exchanger (5), the pressure reducer (13), the outdoor heat exchanger (9), the four-way valve, and the compressor (11);
 an indoor temperature detection means for detecting an indoor temperature; and
 a target temperature setting means configured to set a target temperature, wherein
 a specified compressor-stop condition is previously set, the specified compressor-stop condition is satisfied when a state, which the indoor temperature is higher than the target temperature by a specified temperature difference, has lasted for a specified duration time, and the compressor (11) is stopped when, after the indoor temperature has exceeded the target temperature, the specified compressor-stop condition is satisfied,
 the air conditioner further comprising:

a bypass circuit (16) for connecting one point between the indoor heat exchanger

- (5) and the pressure reducer (13) and another point between the four-way valve and an inlet port of the compressor (11); and a bypass-use two-way valve (17) provided in the bypass circuit (16), wherein
- after the indoor temperature has exceeded the target temperature and before the specified compressor-stop condition is satisfied, the bypass-use two-way valve (17) is configured to be opened;
- wherein after the indoor temperature has exceeded the target temperature and when a specified valve-opening time has elapsed since an opening of the bypass-use two-way valve (17), the bypass-use two-way valve (17) is configured to be closed;
- characterized in that** the air conditioner is configured to open and to close the bypass-use two-way valve (17) repeatedly to a plurality of times, after the indoor temperature has exceeded the target temperature,
2. The air conditioner according to Claim 1, further comprising a heat storage unit (18) which is provided in the bypass circuit (16) and which conducts exhaust heat of the compressor (11) to the refrigerant.
 3. The air conditioner according to Claim 2, further comprising:

a defrosting-use bypass circuit (21) for merging a refrigerant discharged from a discharge port of the compressor (11) with a refrigerant flowing between the pressure reducer (13) and the outdoor heat exchanger (9); and

a defrosting-use two-way valve (22) provided in the defrosting-use bypass circuit (21), wherein during defrosting operation for defrosting the outdoor heat exchanger (9), the defrosting-use two-way valve (22) and the bypass-use two-way valve (17) are opened while heating operation is kept ongoing.
 4. The air conditioner according to Claim 2 or 3, wherein the heat storage unit (18) has a heat storage material (19) for storing exhaust heat of the compressor (11), and a heat-storage heat exchanger (20) for conducting heat of the heat storage material (19) to the refrigerant flowing through the bypass circuit (16), and a heat-storage-material temperature detection means for detecting a temperature of the heat storage material (19) is further included, and wherein while the temperature of the heat storage material (19) is lower than a specified heat-storage-material temperature, the bypass-use two-way valve (17) is kept closed.
 5. The air conditioner according to any one of Claims 2 to 4, wherein during a period from an end of defrosting operation till an elapse of a specified defrosting non-execution period, the bypass-use two-way valve (17) is kept closed.
 6. The air conditioner according to any one of Claims 2 to 5, further comprising an outside-air temperature detection means for detecting an outside air temperature, wherein when an outside air temperature detected by the outside-air temperature detection means is lower than a specified outside air temperature, the bypass-use two-way valve (17) is kept closed.
 7. The air conditioner according to any one of Claims 2 to 6, further comprising an outdoor-heat-exchanger temperature detection means for detecting a temperature of the outdoor heat exchanger (9), wherein while the temperature of the outdoor heat exchanger (9) is lower than a specified outdoor-heat-exchanger temperature, the bypass-use two-way valve (17) is kept closed.
 8. The air conditioner according to Claim 1, wherein an upper limit is provided for a number of opening and closing times of the bypass-use two-way valve (17).
 9. The air conditioner according to any one of Claims 1 to 8, further comprising:

an indoor-heat-exchanger temperature detection means for detecting a temperature of the indoor heat exchanger (5), wherein when the temperature of the indoor heat exchanger (5) is lower than a specified indoor heat exchanger (5) temperature, the bypass-use two-way valve (17) is closed.
 10. The air conditioner according to any one of Claims 1 to 9, wherein during a period from a closing of the bypass-use two-way valve (17) till an elapse of a specified closure time, the bypass-use two-way valve (17) is kept closed.

Patentansprüche

1. Klimaanlage, enthaltend:

einen Kühlkreislauf, der einen Verdichter (11), ein Vierwegeventil, einen Innenwärmetauscher (5), einen Druckminderer (13) und einen Außenwärmetauscher (9) enthält und in dem während des Heizbetriebs ein Kältemittel in einer Reihenfolge von dem Verdichter (11), zu dem Vierwegeventil, zu dem Innenwärmetauscher (5), zu

dem Druckminderer (13), zu dem Außenwärmetauscher (9), zu dem Vierwegeventil und zu dem Verdichter (11) strömt;

ein Innentemperaturerfassungsmittel zum Erfassen einer Innentemperatur; und
 ein Solltemperatureinstellmittel, das konfiguriert ist, eine Solltemperatur einzustellen, wobei eine festgelegte Verdichter-Stoppbedingung zuvor eingestellt ist, wobei die festgelegte Verdichter-Stoppbedingung erfüllt ist, wenn ein Zustand, in dem die Innentemperatur um eine festgelegte Temperaturdifferenz höher als die Solltemperatur ist, für eine festgelegte Zeitspanne angedauert hat, und der Verdichter (11) gestoppt wird, wenn, nachdem die Innentemperatur die Solltemperatur überschritten hat, die festgelegte Verdichter-Stoppbedingung erfüllt ist, wobei die Klimaanlage weiter enthält:

einen Bypasskreislauf (16) zum Verbinden eines Punktes zwischen dem Innenwärmetauscher (5) und dem Druckminderer (13) und eines weiteren Punktes zwischen dem Vierwegeventil und einer Einlassöffnung des Verdichters (11); und

ein Zweiwegeventil (17) für den Bypassgebrauch, das in dem Bypasskreislauf (16) vorgesehen ist,

wobei, nachdem die Innentemperatur die Solltemperatur überschritten hat und bevor die festgelegte Verdichter-Stoppbedingung erfüllt ist, das Zweiwegeventil (17) für den Bypassgebrauch konfiguriert ist, geöffnet zu werden;

wobei, nachdem die Innentemperatur die Solltemperatur überschritten hat und wenn eine festgelegte Ventilöffnungszeit seit dem Öffnen des Zweiwegeventils (17) für den Bypassgebrauch verstrichen ist, das Zweiwegeventil (17) für den Bypassgebrauch konfiguriert ist, geschlossen zu werden;

dadurch gekennzeichnet, dass

die Klimaanlage konfiguriert ist, das Zweiwegeventil (17) für den Bypassgebrauch wiederholt mehrmals zu öffnen und zu schließen, nachdem die Innentemperatur die Solltemperatur überschritten hat.

2. Klimaanlage nach Anspruch 1, weiter enthaltend eine Wärmespeichereinheit (18), die im Bypasskreislauf (16) vorgesehen ist und die Abwärme des Verdichters (11) an das Kältemittel leitet.

3. Klimaanlage nach Anspruch 2, weiter enthaltend:

einen Bypasskreislauf (21) für den Abtaugebrauch zum Zusammenführen eines Kältemittels, das aus einer Auslassöffnung des Verdich-

ters (11) abgegeben wird, mit einem Kältemittel, das zwischen dem Druckminderer (13) und dem Außenwärmetauscher (9) strömt; und ein Zweiwegeventil (22) für den Abtaugebrauch, das in dem Bypasskreislauf (21) für den Abtaugebrauch vorgesehen ist, wobei während des Abtauvorgangs zum Abtauen des Außenwärmetauschers (9), das Zweiwegeventil (22) für den Abtaugebrauch und das Zweiwegeventil (17) für den Bypassgebrauch geöffnet sind, während der Heizvorgang aufrechterhalten wird.

4. Klimaanlage nach Anspruch 2 oder 3, wobei

die Wärmespeichereinheit (18) ein Wärmespeichermaterial (19) zum Speichern der Abwärme des Verdichters (11) und einen Wärmespeichwärmetauscher (20) zum Leiten der Wärme des Wärmespeichermaterials (19) zu dem durch den Bypasskreislauf (16) strömenden Kältemittel aufweist, und

ferner ein Wärmespeichermaterial-Temperaturerfassungsmittel zum Erfassen einer Temperatur des Wärmespeichermaterials (19) enthalten ist, und

wobei, während die Temperatur des Wärmespeichermaterials (19) niedriger ist als eine festgelegte Wärmespeichermaterialtemperatur, das Zweiwegeventil (17) für den Bypassgebrauch geschlossen gehalten wird.

5. Klimaanlage nach einem der Ansprüche 2 bis 4, wobei während eines Zeitraums von einem Ende des Abtauvorgangs bis zum Ablauf eines festgelegten Abtau-Nichtausführungszeitraums das Zweiwegeventil (17) für den Bypassgebrauch geschlossen gehalten wird.

6. Klimaanlage nach einem der Ansprüche 2 bis 5, weiter enthaltend

ein Außenlufttemperaturerfassungsmittel zum Erfassen einer Außenlufttemperatur, wobei, wenn eine vom Außenlufttemperaturerfassungsmittel erfasste Außenlufttemperatur niedriger ist als eine festgelegte Außenlufttemperatur, das Zweiwegeventil (17) für den Bypassgebrauch geschlossen gehalten wird.

7. Klimaanlage nach einem der Ansprüche 2 bis 6, weiter enthaltend

ein Außenwärmetauscher-Temperaturerfassungsmittel zum Erfassen einer Temperatur des Außenwärmetauschers (9), wobei, während die Temperatur des Außenwärmetauschers (9) niedriger ist als eine festgeleg-

te Außenwärmetauschartemperatur, das Zweiwegeventil (17) für den Bypassgebrauch geschlossen gehalten wird.

8. Klimaanlage nach Anspruch 1, wobei eine Obergrenze für eine Anzahl von Öffnungs- und Schließzeiten des Zweiwegeventils (17) für den Bypassgebrauch vorgesehen ist. 5
9. Klimaanlage nach einem der Ansprüche 1 bis 8, weiter enthaltend: 10
 - ein Innenwärmetauscher-Temperaturerfassungsmittel zum Erfassen einer Temperatur des Innenwärmetauschers (5), 15
 - wobei, wenn die Temperatur des Innenwärmetauschers (5) niedriger ist als eine festgelegte Temperatur des Innenwärmetauschers (5), das Zweiwegeventil (17) für den Bypassgebrauch geschlossen wird. 20
10. Klimaanlage nach einem der Ansprüche 1 bis 9, wobei, während eines Zeitraums vom Schließen des Zweiwegeventils (17) für den Bypassgebrauch bis zum Ablauf eines festgelegten Schließzeitraums, das Zweiwegeventil (17) für den Bypassgebrauch geschlossen gehalten wird. 25

Revendications 30

1. Climatiseur comprenant:

un cycle de réfrigération qui comprend un compresseur (11), une soupape à quatre voies, un échangeur de chaleur intérieur (5), un réducteur de pression (13), et un échangeur de chaleur extérieur (9) et dans lequel, pendant l'opération de chauffage, un fluide frigorigène circule dans un ordre du compresseur (11), de la soupape à quatre voies, de l'échangeur de chaleur intérieur (5), du réducteur de pression (13), de l'échangeur de chaleur extérieur (9), de la soupape à quatre voies et du compresseur (11); 35

un moyen de détection de température intérieure pour détecter une température intérieure; et 40

un moyen de réglage de température cible conçu pour régler une température cible, dans lequel 45

une condition d'arrêt de compresseur spécifiée est définie au préalable, la condition d'arrêt de compresseur spécifiée est satisfaite lorsqu'un état dans lequel, la température intérieure est supérieure à la température cible d'une différence de température spécifiée, a duré pendant une durée spécifiée, et 50

le compresseur (11) est arrêté lorsque, après que la température intérieure a dépassé la tem-

pérature cible, la condition d'arrêt de compresseur spécifiée est satisfaite, 55

le climatiseur comprenant en outre:

un circuit de dérivation (16) pour relier un point entre l'échangeur de chaleur intérieur (5) et le réducteur de pression (13) et un autre point entre la soupape à quatre voies et un orifice d'entrée du compresseur (11); 5

et

une soupape à deux voies à utilisation de dérivation (17) disposée dans le circuit de dérivation (16), dans lequel 10

après que la température intérieure a dépassé la température cible et avant que la condition d'arrêt de compresseur spécifiée soit satisfaite, la soupape à deux voies à utilisation de dérivation (17) est configurée pour être ouverte; 15

dans lequel après que la température intérieure a dépassé la température cible et lorsqu'un temps d'ouverture de soupape spécifié s'est écoulé depuis une ouverture de la soupape à deux voies à utilisation de dérivation (17), la soupape à deux voies à utilisation de dérivation (17) est configurée pour être fermée; 20

caractérisé en ce que

le climatiseur est conçu pour ouvrir et pour fermer la soupape à deux voies à utilisation de dérivation (17) à plusieurs reprises, après que la température intérieure a dépassé la température cible. 25

2. Climatiseur selon la revendication 1, comprenant en outre une unité de stockage de chaleur (18) qui est disposée dans le circuit de dérivation (16) et qui conduit la chaleur d'échappement du compresseur (11) vers le fluide frigorigène. 35

3. Climatiseur selon la revendication 2, comprenant en outre: 40

un circuit de dérivation à utilisation de dégivrage (21) pourfusionner un fluide frigorigène évacué à partir d'un orifice d'évacuation du compresseur (11) avec un fluide frigorigène s'écoulant entre le réducteur de pression (13) et l'échangeur de chaleur extérieur (9); et 45

une soupape à deux voies à utilisation de dégivrage (22) disposée dans le circuit de dérivation à utilisation de dégivrage (21), dans lequel 50

pendant l'opération de dégivrage pour dégivrer l'échangeur de chaleur extérieur (9), la soupape à deux voies à utilisation de dégivrage (22) et la soupape à deux voies à utilisation de dérivation (17) sont ouvertes pendant que l'opération de chauffage est maintenue. 55

4. Climatiseur selon la revendication 2 ou 3, dans lequel
l'unité de stockage de chaleur (18) a un matériau de
stockage de chaleur (19) pour stocker la chaleur
d'échappement du compresseur (11), et un échangeur
de chaleur de stockage de chaleur (20) pour
conduire la chaleur du matériau de stockage de cha-
leur (19) vers le fluide frigorigène s'écoulant à travers
le circuit de dérivation (16), et
un moyen de détection de température de matériau
de stockage de chaleur pour détecter une tempéra-
ture du matériau de stockage de chaleur (19) est en
outre inclus, et dans lequel
tant que la température du matériau de stockage de
chaleur (19) est inférieure à une température de ma-
tériel de stockage de chaleur spécifiée, la soupape
à deux voies à utilisation de dérivation (17) est main-
tenue fermée.
5. Climatiseur selon l'une quelconque des revendica-
tions 2 à 4, dans lequel, pendant une période allant
d'une fin de fonctionnement de dégivrage jusqu'à ce
qu'une période de non-exécution de dégivrage spé-
cifiée se soit écoulée, la soupape à deux voies à
utilisation de dérivation (17) est maintenue fermée.
6. Climatiseur selon l'une quelconque des revendica-
tions 2 à 5, comprenant en outre
un moyen de détection de température d'air extérieur
pour détecter une température d'air extérieur, dans
lequel
lorsqu'une température d'air extérieur détectée par
le moyen de détection de température d'air extérieur
est inférieure à une température d'air extérieur spé-
cifiée, la soupape à deux voies à utilisation de déri-
vation (17) est maintenue fermée.
7. Climatiseur selon l'une quelconque des revendica-
tions 2 à 6, comprenant en outre
un moyen de détection de température d'échangeur
de chaleur extérieur pour détecter une température
de l'échangeur de chaleur extérieur (9), dans lequel
tant que la température de l'échangeur de chaleur
extérieur (9) est inférieure à une température
d'échangeur de chaleur extérieur spécifiée, la sou-
pape à deux voies à utilisation de dérivation (17) est
maintenue fermée.
8. Climatiseur selon la revendication 1, dans lequel une
limite supérieure est prévue pour un certain nombre
de temps d'ouverture et de fermeture de la soupape
à deux voies à utilisation de dérivation (17).
9. Climatiseur selon l'une quelconque des revendica-
tions 1 à 8, comprenant en outre:
- un moyen de détection de température d'échan-
geur de chaleur intérieur pour détecter une tem-

pérature de l'échangeur de chaleur intérieur (5),
dans lequel
lorsque la température de l'échangeur de cha-
leur intérieur (5) est inférieure à une température
de l'échangeur de chaleur intérieur (5) spécifiée,
la soupape à deux voies à utilisation de dériva-
tion (17) est fermée.

10. Climatiseur selon l'une quelconque des revendica-
tions 1 à 9, dans lequel pendant une période allant
d'une fermeture de la soupape à deux voies à utili-
sation de dérivation (17) jusqu'à ce qu'un temps de
fermeture spécifié se soit écoulé, la soupape à deux
voies à utilisation de dérivation (17) est maintenue
fermée.

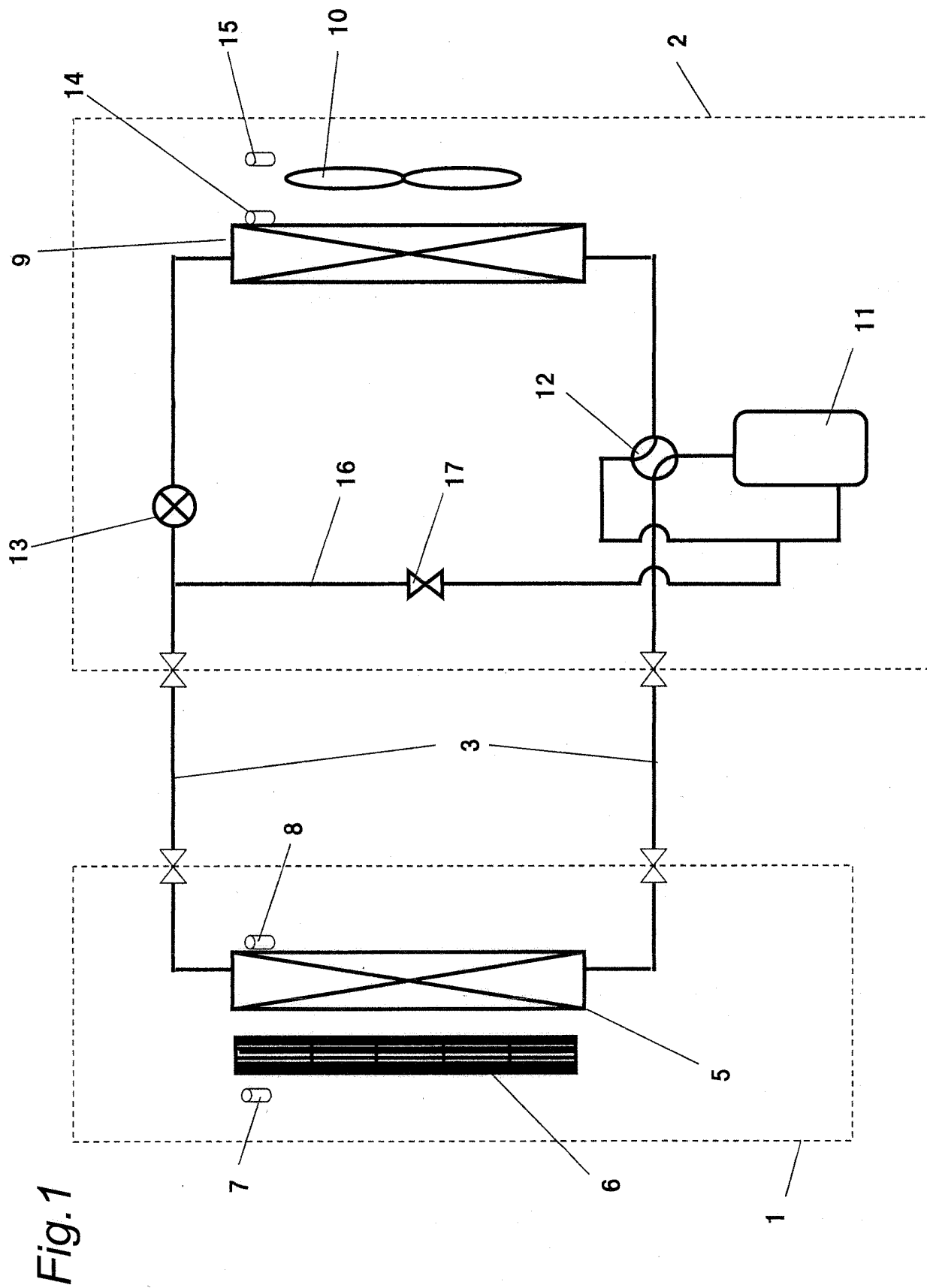


Fig. 1

Fig.2

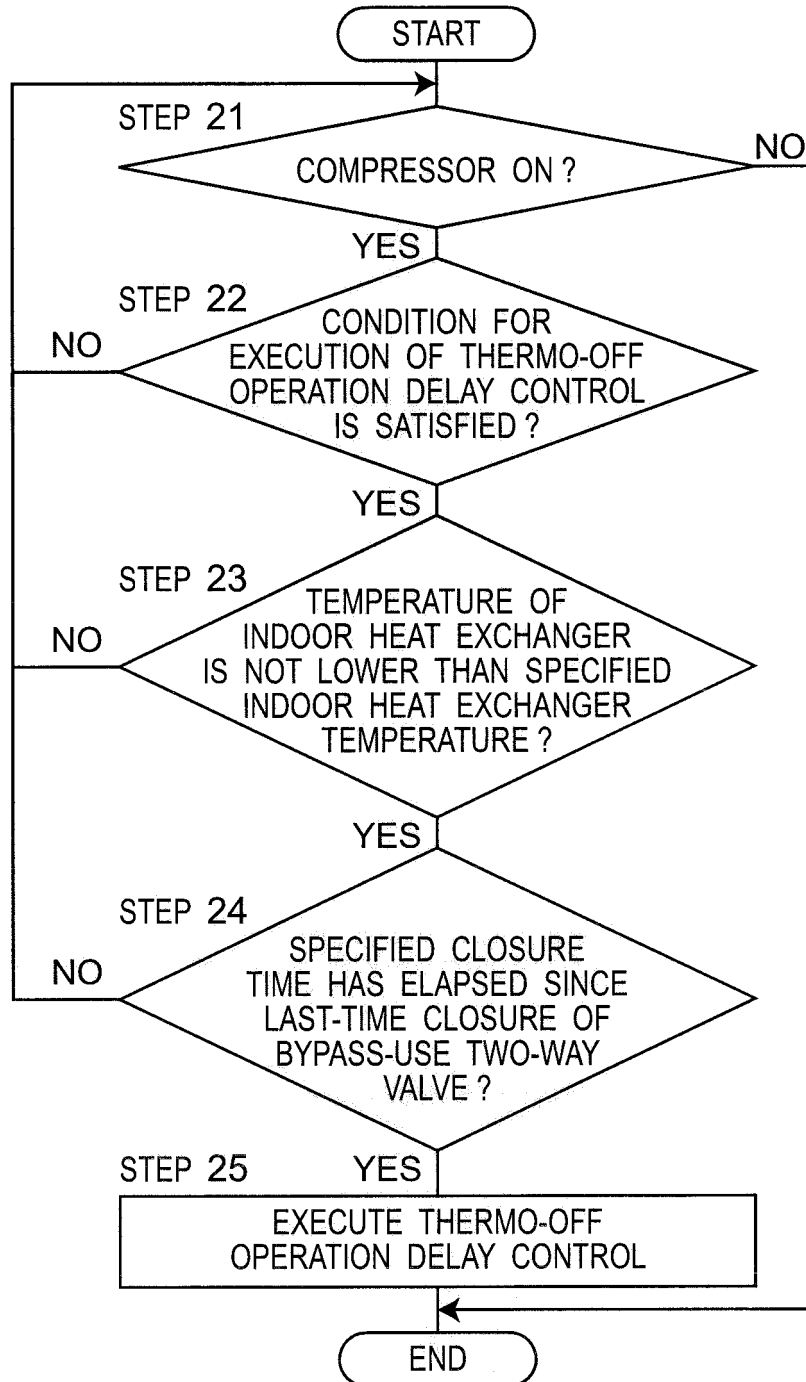
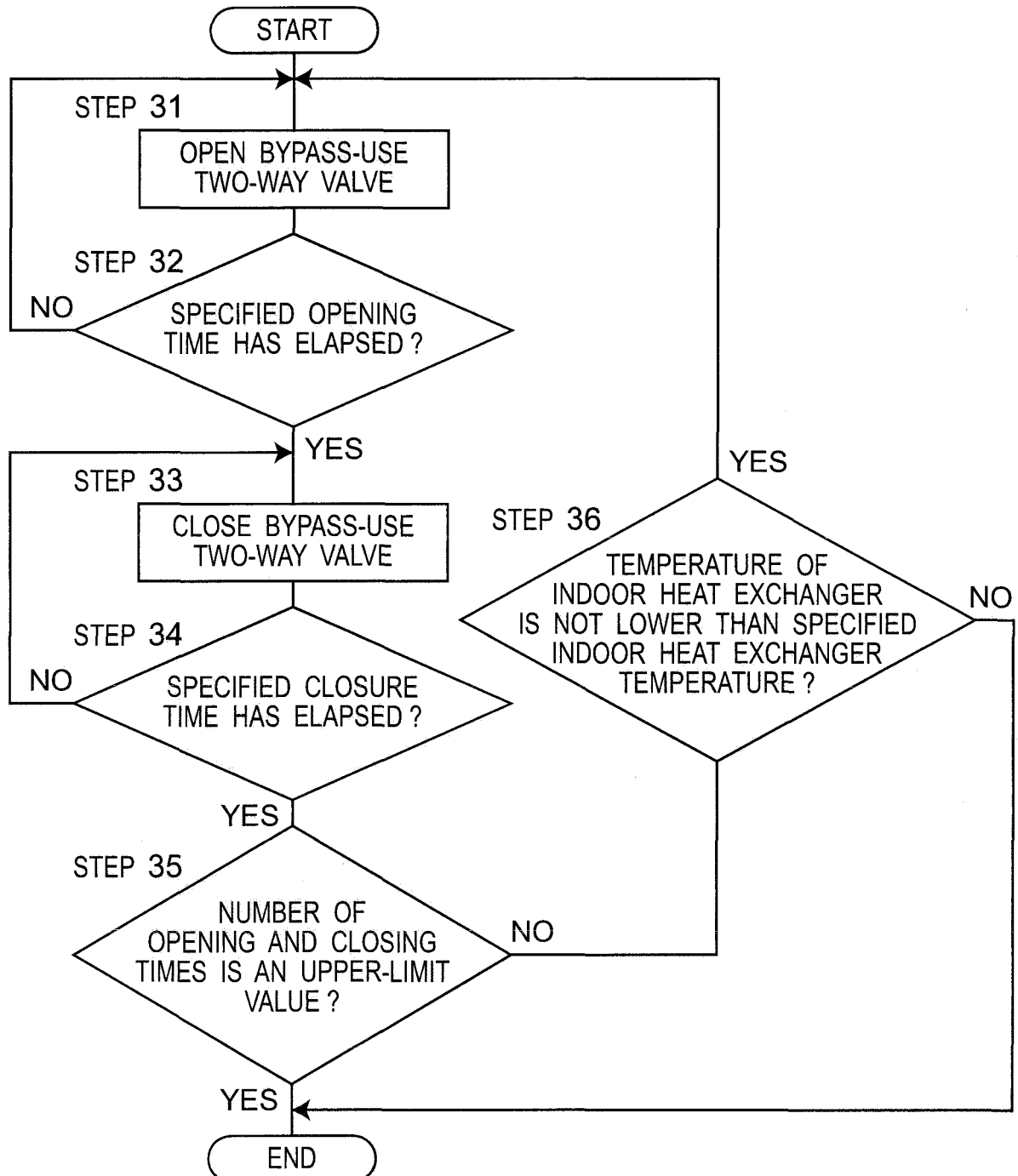


Fig.3

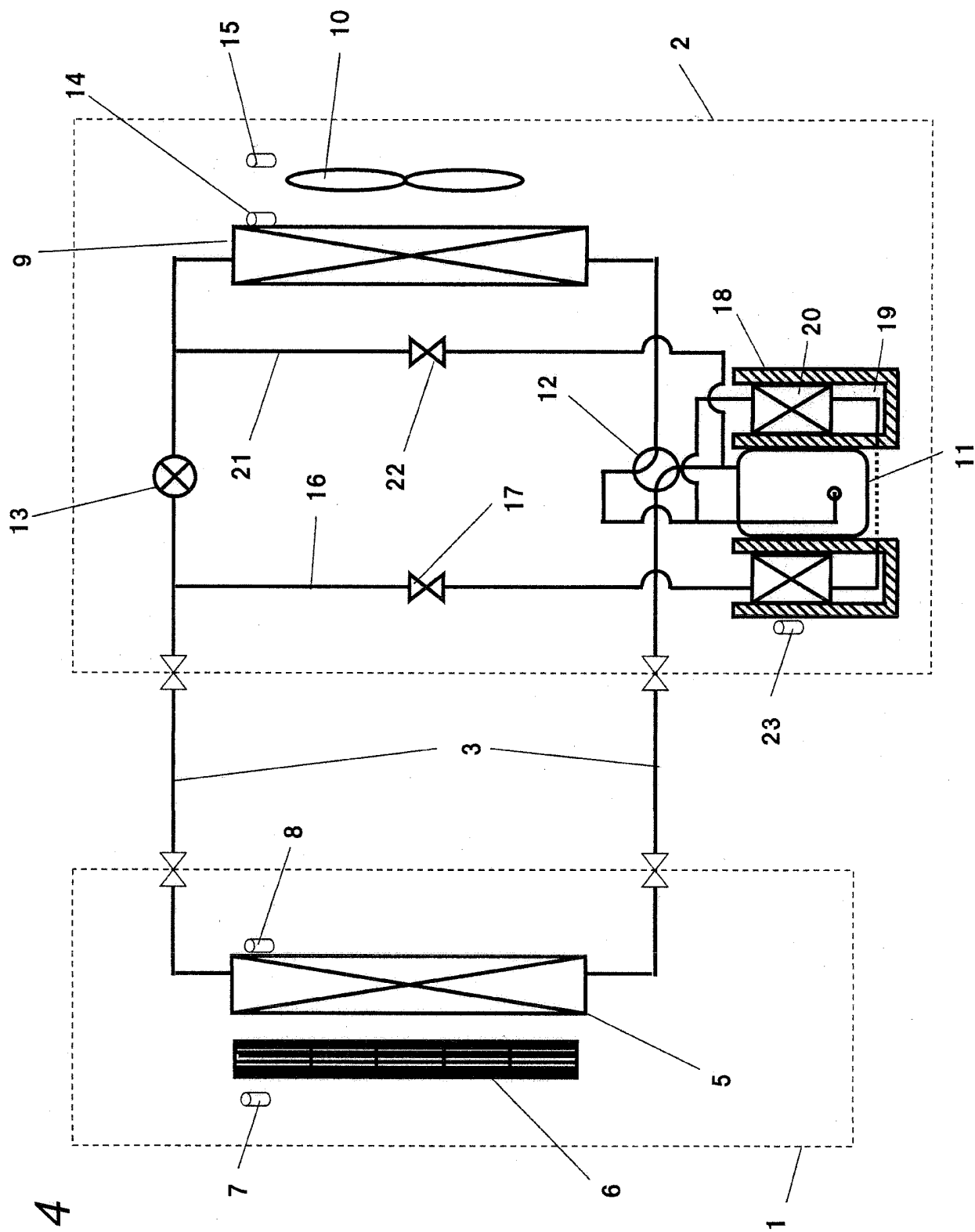
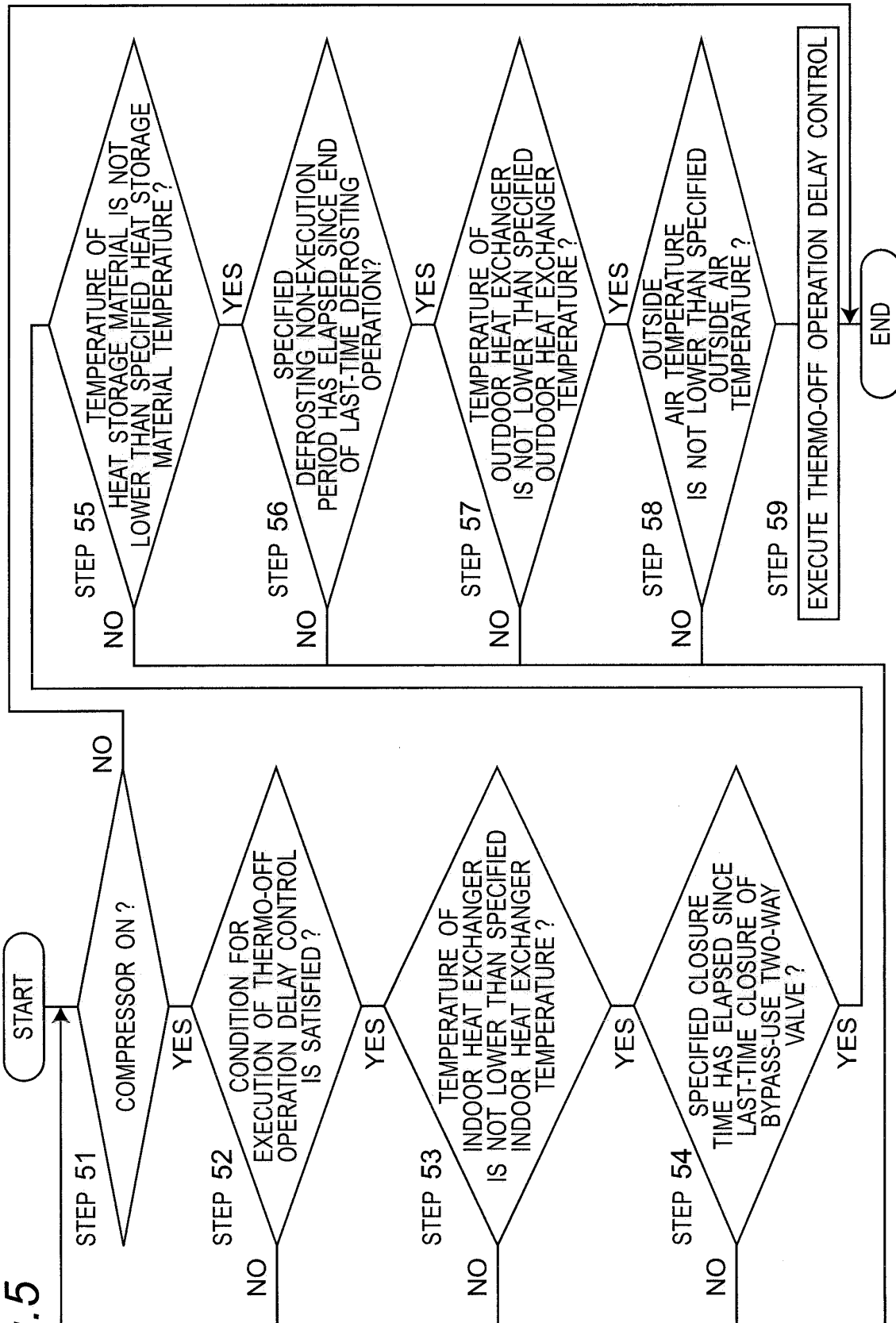


Fig.4

Fig. 5



REFERENCES CITED IN THE DESCRIPTION

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