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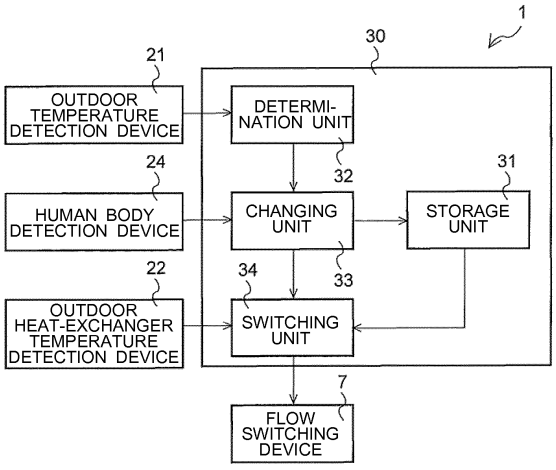
(54) AIR CONDITIONER

(57) An air-conditioning apparatus includes a refrigerant circuit in which a compressor, a flow switching device, an outdoor heat exchanger, an expansion device, and an indoor heat exchanger are connected by pipes and through which refrigerant flows, and a control device controlling an operation of the refrigerant circuit to perform switching between a heating operation and a defrosting operation. The control device includes a determination unit that determines, based on operation information regarding the refrigerant circuit, during the heating operation, whether to change a requirement for starting the defrosting operation, a changing unit that changes the requirement for starting the defrosting operation in accordance with a result of determination by the determination unit, and a switching unit that, when the requirement for starting the defrosting operation is satisfied, causes the flow switching device to perform switching to start the defrosting operation.

FIG. 2



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Description

Technical Field

[0001] The present invention relates to an air-conditioning apparatus that removes frost formed on an outdoor heat exchanger.

Background Art

[0002] An air-conditioning apparatus known in the art includes a refrigerant circuit in which a compressor, a flow switching device, an outdoor heat exchanger, an expansion unit, and an indoor heat exchanger are connected by pipes. In a heating operation, when a pressure saturation temperature in the outdoor heat exchanger functioning as an evaporator is at or below the dew point temperature of outdoor air and is at or below the freezing point of water, frost forms on the outdoor heat exchanger. When the outdoor heat exchanger is frosted, the air-conditioning apparatus performs a defrosting operation of removing frost on the outdoor heat exchanger, thus reducing worsening of the heat exchange performance of the outdoor heat exchanger, which is caused by a frost formation phenomenon.

[0003] Patent Literature 1 discloses an air-conditioning apparatus including an outdoor heat-exchanger temperature sensor, an outdoor air temperature sensor, and a human body sensor. As described in Patent Literature 1, when an output of the outdoor heat-exchanger temperature sensor, and an output of the outdoor air temperature sensor meet requirements for starting the defrosting operation and the human body sensor detects the absence of a person, the defrosting operation is started. The apparatus with such a configuration is intended to avoid performing the defrosting operation while a person is present in an indoor space, and to maintain comfortability.

Citation List

Patent Literature

[0004] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2011-185535

Summary of Invention

Technical Problem

[0005] The requirements for starting the defrosting operation in the air-conditioning apparatus disclosed in Patent Literature 1 are fixed. If the requirements for starting the defrosting operation are satisfied, the defrosting operation will not be performed as long as a person is present in the indoor space, resulting in worsening of the heat exchange performance of the outdoor heat exchanger. As described above, the air-conditioning apparatus disclosed in Patent Literature 1 fails to accurately determine whether to perform the defrosting operation.

[0006] The present invention has been made to solve the above problem, and aims to provide an air-conditioning apparatus which determines whether to perform a defrosting operation or not with a higher accuracy.

Solution to Problem

[0007] An air-conditioning apparatus according to an embodiment of the present invention includes: a refrigerant circuit in which a compressor, a flow switching device, an outdoor heat exchanger, an expansion unit, and an indoor heat exchanger are connected by pipes, and through which refrigerant flows; and a control unit configured to control an operation of the refrigerant circuit to perform switching between a heating operation and a defrosting operation. The control unit includes: a determination unit that determines, based on operation information regarding the refrigerant circuit, during the heating operation, whether to change a requirement for starting the defrosting operation or not; a changing unit that changes the requirement for starting the defrosting operation in accordance with a result of determination by the determination unit; and a switching unit that, when the requirement for starting the defrosting operation is satisfied, causes the flow switching device to perform switching such that the defrosting operation is started.

Advantageous Effects of Invention

[0008] According to the embodiment of the present invention, the requirement for starting the defrosting operation is changed based on the determination result based on the operation information. It can be therefore possible to accurately determine whether to perform the defrosting operation or not.

Brief Description of Drawings

[0009]

[Fig. 1] Fig. 1 is a circuit diagram illustrating an air-conditioning apparatus 1 according to Embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is a block diagram illustrating a control device 30 of the air-conditioning apparatus 1 according to Embodiment 1 of the present invention.

[Fig. 3] Fig. 3 is a flowchart illustrating an operation of the air-conditioning apparatus 1 according to Embodiment 1 of the present invention.

[Fig. 4] Fig. 4 is a block diagram illustrating a control unit 130 of an air-conditioning apparatus 100 according to Embodiment 2 of the present invention.

[Fig. 5] Fig. 5 is a block diagram illustrating a control unit 230 of an air-conditioning apparatus 200 according to Embodiment 3 of the present invention.

[Fig. 6] Fig. 6 is a block diagram illustrating a control

unit 330 of an air-conditioning apparatus 300 according to Embodiment 4 of the present invention.

[Fig. 7] Fig. 7 is a flowchart illustrating an operation of the air-conditioning apparatus 300 according to Embodiment 4 of the present invention.

[Fig. 8] Fig. 8 is a block diagram illustrating a control unit 430 of an air-conditioning apparatus 400 according to Embodiment 5 of the present invention.

[Fig. 9] Fig. 9 is a flowchart illustrating an operation of the air-conditioning apparatus 400 according to Embodiment 5 of the present invention.

Description of Embodiments

Embodiment 1

[0010] Embodiments of an air-conditioning apparatus according to the present invention will be described below with reference to the drawings. Fig. 1 is a circuit diagram illustrating an air-conditioning apparatus 1 according to Embodiment 1 of the present invention. The air-conditioning apparatus 1 will now be described with reference to Fig. 1. As illustrated in Fig. 1, the air-conditioning apparatus 1 includes an outdoor unit 2, an indoor unit 3, and a remote controller 4. The outdoor unit 2, which is disposed in an outdoor space, includes a compressor 6, a flow switching device 7, an outdoor heat exchanger 8, an outdoor fan 8a, an expansion device 9, an outdoor temperature detection device 21, an outdoor heat-exchanger temperature detection device 22, and an outdoor control board 30a. The indoor unit 3, which is disposed in an indoor space, includes an indoor heat exchanger 10, an indoor fan 10a, an indoor temperature detection unit 23, a human body detection device 24, and an indoor control board 30b. The compressor 6, the flow switching device 7, the outdoor heat exchanger 8, the expansion device 9, and the indoor heat exchanger 10 are connected by pipes, thus forming a refrigerant circuit 5 through which refrigerant flows. The outdoor control board 30a and the indoor control board 30b are included in a control device 30.

[0011] The compressor 6 compresses the refrigerant. The flow switching device 7 performs switching between flowing directions of the refrigerant in the refrigerant circuit 5. To be more specific, the flow switching device 7 performs the switching to cause the refrigerant discharged from the compressor 6 to flow to the outdoor heat exchanger 8 or the indoor heat exchanger 10, thus performing any of a cooling operation, a heating operation, and a defrosting operation. The outdoor heat exchanger 8 exchanges heat between the refrigerant and outdoor air. The outdoor fan 8a sends the outdoor air to the outdoor heat exchanger 8. The expansion device 9 expands and decompresses the refrigerant. For example, the expansion device 9 is a solenoid expansion valve whose opening degree is adjusted. The indoor heat exchanger 10 exchanges heat between the refrigerant and indoor air. The indoor fan 10a sends the indoor air to the indoor heat exchanger 10.

[0012] The outdoor temperature detection device 21 detects an outdoor temperature. The outdoor heat-exchanger temperature detection device 22 detects the temperature of the outdoor heat exchanger 8. The indoor temperature detection unit 23 detects an indoor temperature. The human body detection device 24 detects the presence or absence of a human body. The outdoor control board 30a controls components of the outdoor unit 2, and the indoor control board 30b controls components of the indoor unit 3. The outdoor control board 30a and the indoor control board 30b are connected by an interconnecting communication line 30c, through which signals are transmitted and received between the control boards.

[0013] The remote controller 4 is connected to the indoor control board 30b by a remote control line 4a, through which the remote controller 4 transmits and receives signals to/from the indoor control board 30b. For example, the remote controller 4 transmits a stop signal to stop an operation of the refrigerant circuit 5 to the indoor control board 30b, so that the indoor unit 3 and the outdoor unit 2 stop. In addition, the remote controller 4 transmits a start signal to start the operation of the refrigerant circuit 5 to the indoor control board 30b, so that the indoor unit 3 and the outdoor unit 2 start to operate.

[0014] Fig. 2 is a block diagram illustrating the control device 30 of the air-conditioning apparatus 1 according to Embodiment 1 of the present invention. The control device 30 will now be described. In Embodiment 1, the control device 30, which is, for example, a central processing unit (CPU), includes the outdoor control board 30a and the indoor control board 30b as described above. The control device 30 may be a single control board. In this case, the control device 30 may be disposed in either one of the outdoor unit 2 and the indoor unit 3. Furthermore, the control device 30 may be disposed outside the outdoor unit 2 and the indoor unit 3. As illustrated in Fig. 2, the control device 30 includes a storage unit 31, a determination unit 32, a changing unit 33, and a switching unit 34.

[0015] The storage unit 31 stores, for example, an outdoor heat-exchanger temperature threshold necessary for a requirement for starting the defrosting operation. The requirement for starting the defrosting operation is that the temperature of the outdoor heat exchanger 8 is at or below the outdoor heat-exchanger temperature threshold in the heating operation in which the outdoor heat exchanger 8 functions as an evaporator. A prolonged heating operation results in a reduction in pressure saturation temperature in the outdoor heat exchanger 8 functioning as an evaporator. When the pressure saturation temperature in the outdoor heat exchanger 8 is at or below the dew-point temperature of the outdoor air and is at or below the freezing point of water, frost forms on the outdoor heat exchanger 8. Upon frost formation on the outdoor heat exchanger 8, the air-conditioning apparatus 1 performs the defrosting operation of

removing the frost formed on the outdoor heat exchanger 8, thus reducing worsening of the heat exchange performance of the outdoor heat exchanger 8 which is caused by such a frost formation phenomenon. Although the requirement for starting the defrosting operation in Embodiment 1 is a reduction temperature of the outdoor heat exchanger 8, the requirement is not limited to it. For example, the requirement may be a reduction in outdoor temperature.

[0016] The determination unit 32 determines, based on operation information about the refrigerant circuit 5, during the heating operation, whether to change the requirement for starting the defrosting operation or not. In Embodiment 1, the operation information is a temperature detected by the outdoor temperature detection device 21. Specifically, the determination unit 32 determines whether or not the temperature detected by the outdoor temperature detection device 21 is at or below an outdoor temperature threshold.

[0017] The changing unit 33 changes the requirement for starting the defrosting operation in accordance with the result of determination by the determination unit 32. In Embodiment 1, the operation information is the temperature detected by the outdoor temperature detection device 21. Specifically, when the determination unit 32 determines that the temperature detected by the outdoor temperature detection device 21 is at or below the outdoor temperature threshold, the changing unit 33 changes the requirement for starting the defrosting operation.

[0018] As described above, the requirement for starting the defrosting operation in Embodiment 1 is that the temperature of the outdoor heat exchanger 8 is at or below the outdoor heat-exchanger temperature threshold in the heating operation in which the outdoor heat exchanger 8 functions as an evaporator. During the heating operation, the changing unit 33 changes, based on the operation information regarding the refrigerant circuit 5, the outdoor heat-exchanger temperature threshold to an outdoor heat-exchanger temperature relaxed threshold, which is higher than the outdoor heat-exchanger temperature threshold. Thex1 < Thex2 where Thex1 is the outdoor heat-exchanger temperature threshold, and Thex2 is the outdoor heat-exchanger temperature relaxed threshold. Consequently, when the temperature of the outdoor heat exchanger 8 decreases in the heating operation, it reaches the outdoor heat-exchanger temperature relaxed threshold Thex2 before reaching the outdoor heat-exchanger temperature threshold Thex1. That is, the requirement for starting the defrosting operation based on the outdoor heat-exchanger temperature relaxed threshold Thex2 is less strict than that based on the outdoor heat-exchanger temperature threshold Thex1. When the outdoor heat-exchanger temperature relaxed threshold Thex2 is applied, the defrosting operation starts earlier.

[0019] As described above, when it is determined that the temperature detected by the outdoor temperature detection device 21 is at or below the outdoor temperature threshold, the outdoor heat-exchanger temperature threshold is changed to the outdoor heat-exchanger temperature relaxed threshold. Consequently, when the outdoor temperature is low, it is determined that the outdoor heat exchanger 8 is highly likely to have been frosted, readily causing the defrosting operation to be performed.

[0020] The changing unit 33 further has a function of changing the requirement for starting the defrosting operation in accordance with the result of detection by the human body detection device 24. In Embodiment 1, when the human body detection device 24 detects the absence of a person during the heating operation, the changing unit 33 changes the outdoor heat-exchanger temperature threshold to the outdoor heat-exchanger temperature relaxed threshold, which is higher than the outdoor heat-exchanger temperature threshold. Consequently, in the absence of a person, it is determined that the heating operation is highly likely to have been unnecessary, readily causing the defrosting operation to be performed.

[0021] When the requirement for starting the defrosting operation stored in the storage unit 31 is satisfied, the switching unit 34 causes the flow switching device 7 to perform switching such that the defrosting operation is started. The requirement for starting the defrosting operation is that the temperature of the outdoor heat exchanger 8 is at or below the outdoor heat-exchanger temperature threshold in the heating operation in which the outdoor heat exchanger 8 functions as an evaporator. Where the requirement for starting the defrosting operation is not changed by the changing unit 33, the switching unit 34 causes the flow switching device 7 to perform switching when the temperature of the outdoor heat exchanger 8 detected by the outdoor heat-exchanger temperature detection device 22 is at or below the outdoor heat-exchanger temperature threshold. On the other hand, where the requirement for starting the defrosting operation is changed by the changing unit 33, the switching unit 34 causes the flow switching device 7 to perform switching when the temperature of the outdoor heat exchanger 8 detected by the outdoor heat-exchanger temperature detection device 22 is at or below the outdoor heat-exchanger temperature relaxed threshold.

[0022] The control device 30 further performs switching between a thermo-off state and a thermo-on state. Specifically, the control device 30 compares an actual indoor temperature U: i degrees C with a set temperature V: j degrees C, and determines whether to continue to operate the outdoor unit 2 and the indoor unit 3 or not. The actual indoor temperature U is a temperature detected by the indoor temperature detection unit 23. The set temperature V is a target indoor temperature set through the remote controller 4 by, for example, a user. When the actual indoor temperature U is at or above the set temperature V ($i \geq j$) in the heating operation, the control device 30 including the outdoor control board 30a and the indoor control board 30b determines that a heating capacity required by the user is ensured, and performs switching to the thermo-off state to temporarily stop the

operation. At this time, the stopped indoor unit 3 transmits a thermo-off signal to the control device 30.

[0023] In the thermo-off state, the control device 30 continues to operate. When the actual indoor temperature U is below the set temperature V (i < j) in the thermo-off state, the control device 30 including the outdoor control board 30a and the indoor control board 30b determines that the heating capacity required by the user is lacking, and performs switching to the thermo-on state to resume the operation. At this time, the indoor unit 3 that has resumed the operation transmits a thermo-on signal to the control device 30.

[0024] Operation modes of the air-conditioning apparatus 1 will now be described.

As the operation modes of the air-conditioning apparatus 1, a cooling operation, the heating operation, and the defrosting operation are present. In the cooling operation, the refrigerant flows through the compressor 6, the flow switching device 7, the outdoor heat exchanger 8, the expansion device 9, and the indoor heat exchanger 10 in that order. The refrigerant exchanges heat with indoor air in the indoor heat exchanger 10, thus cooling the indoor air. In the heating operation, the refrigerant flows through the compressor 6, the flow switching device 7, the indoor heat exchanger 10, the expansion device 9, and the outdoor heat exchanger 8 in that order. The refrigerant exchanges heat with indoor air in the indoor heat exchanger 10, thus heating the indoor air. In the defrosting operation, the refrigerant flows through the compressor 6, the flow switching device 7, the outdoor heat exchanger 8, the expansion device 9, and the indoor heat exchanger 10 in that order, thus removing frost formed on the outdoor heat exchanger 8.

[0025] An operation of the air-conditioning apparatus 1 in each of the operation modes will be described below. The cooling operation will now be described. In the cooling operation, the refrigerant taken in the compressor 6 is compressed into a high temperature and high pressure gas refrigerant, and is then discharged from the compressor 6. The high temperature and high pressure gas refrigerant discharged from the compressor 6 passes through the flow switching device 7 and flows into the outdoor heat exchanger 8, in which the refrigerant exchanges heat with the outdoor air sent by the outdoor fan 8a and is thus condensed and liquefied. The condensed and liquefied refrigerant flows into the expansion device 9, in which the refrigerant is expanded and decompressed such that the refrigerant is made to be in a two-phase gas-liquid state. The refrigerant being in the two-phase gas-liquid state flows into the indoor heat exchanger 10, in which the refrigerant exchanges heat with the indoor air and is thus evaporated and gasified. At this time, the indoor air is cooled, thus performing cooling. The evaporated and gasified refrigerant passes through the flow switching device 7 and is taken in the compressor 6.

[0026] The heating operation will now be described. In the heating operation, the refrigerant taken in the compressor 6 is compressed into a high temperature and high pressure gas refrigerant, and is then discharged from the compressor 6. The high temperature and high pressure gas refrigerant discharged from the compressor 6 passes through the flow switching device 7 and flows into the indoor heat exchanger 10, in which the refrigerant exchanges heat with the indoor air sent by the indoor fan 10a and is thus condensed and liquefied. At this time, the indoor air is heated, thus performing heating. The condensed and liquefied refrigerant flows into the expansion device 9, in which the refrigerant is expanded and decompressed such that the refrigerant is made to be in a two-phase gas-liquid state. The refrigerant being in the two-phase gas-liquid state flows into the outdoor heat exchanger 8, in which the refrigerant exchanges heat with the outdoor air and is thus evaporated and gasified. The evaporated and gasified refrigerant passes through the flow switching device 7 and is taken in the compressor 6.

[0027] The defrosting operation will now be described. In the heating operation of the air-conditioning apparatus 1, frost may form on the outdoor heat exchanger 8. The defrosting operation is performed to remove such frost. In the defrosting operation, the refrigerant taken in the compressor 6 is compressed into a high temperature and high pressure gas refrigerant and is then discharged from the compressor 6. The high temperature and high pressure gas refrigerant discharged from the compressor 6 passes through the flow switching device 7 and flows into the outdoor heat exchanger 8 to melt frost formed on the outdoor heat exchanger 8.

The refrigerant exchanges heat with the outdoor air and is thus condensed and liquefied in the outdoor heat exchanger 8. The condensed and liquefied refrigerant flows into the expansion device 9. At this time, the expansion device 9 is fully opened, and the refrigerant flows into the indoor heat exchanger 10 while kept liquefied. The refrigerant kept liquefied flows into the indoor heat exchanger 10, in which the refrigerant exchanges heat with the indoor air and is thus evaporated and gasified. The evaporated and gasified refrigerant passes through the flow switching device 7 and is taken in the compressor 6.

[0028] Fig. 3 is a flowchart illustrating an operation of the air-conditioning apparatus 1 according to Embodiment 1 of the present invention. An operation of the control device 30 of the air-conditioning apparatus 1 according to Embodiment 1 will now be described. Referring to Fig. 3, upon start of the heating operation, the determination unit 32 determines whether or not a temperature detected by the outdoor temperature detection device 21 is at or below the outdoor temperature threshold (step ST1). If the temperature detected by the outdoor temperature detection device 21 is above the outdoor temperature threshold (No in step ST1), it is determined whether or not a temperature of the outdoor heat exchanger 8 detected by the outdoor heat-exchanger temperature detection device 22 is at or below the outdoor heat-exchanger temperature threshold (step ST2). If the temperature

of the outdoor heat exchanger 8 is at or below the outdoor heat-exchanger temperature threshold (Yes in step ST2), the switching unit 34 causes the flow switching device 7 to perform switching to start the defrosting operation. If the temperature of the outdoor heat exchanger 8 is above the outdoor heat-exchanger temperature threshold (No in step ST2), the process returns to step ST1.

[0029] If the temperature detected by the outdoor temperature detection device 21 is at or below the outdoor temperature threshold (Yes in step ST1), the human body detection device 24 detects the presence or absence of a human body (step ST3). If the presence of a person in the indoor space is detected (No in step ST3), the process proceeds to step ST2. If the absence of a person is detected (Yes in step ST3), the changing unit 33 changes the outdoor heat-exchanger temperature threshold to the outdoor heat-exchanger temperature relaxed threshold, which is higher than the outdoor heat-exchanger temperature threshold. It is determined whether or not the temperature of the outdoor heat exchanger 8 detected by the outdoor heat-exchanger temperature detection device 22 is at or below the outdoor heat-exchanger temperature relaxed threshold (step ST4). If the temperature of the outdoor heat exchanger 8 is at or below the outdoor heat-exchanger temperature relaxed threshold (Yes in step ST4), the switching unit 34 causes the flow switching device 7 to perform switching to start the defrosting operation. If the temperature of the outdoor heat exchanger 8 is above the outdoor heat-exchanger temperature relaxed threshold (No in step ST4), the process returns to step ST1.

[0030] In Embodiment 1, the requirement for starting the defrosting operation is changed on the basis of the result of determination based on the operation information. An air-conditioning apparatus known in the art has a fixed requirement for starting the defrosting operation. Assuming that the requirement for starting the defrosting operation is fixed, even when the requirement for starting the defrosting operation is satisfied, the defrosting operation would not be performed as long as a person is present in the indoor space, thus worsening the heat exchange performance of the outdoor heat exchanger 8. As a result, it would be difficult to accurately determine whether to perform the defrosting operation or not. In contrast, according to Embodiment 1, since the requirement for starting the defrosting operation is changed on the basis of the result of determination based on the operation information, it is possible to accurately determine whether to perform the defrosting operation or not. Furthermore, an air-conditioning apparatus known in the art determines, only based on the presence or absence of a person, whether to start the defrosting operation or not. Then, suppose this air-conditioning apparatus is set such that the defrosting operation tends to be performed when a person is absent. In this case, if the outdoor temperature is high, even when ordinarily, defrosting is unnecessary, the defrosting operation may frequently be performed, causing a reduction in indoor temperature. In contrast, according to Embodiment 1, since the requirement for starting the defrosting operation is changed on the basis of the result of determination based on the operation information, this can inhibit an unnecessary defrosting operation, or idle defrosting, from being frequently performed.

[0031] The air-conditioning apparatus further includes the human body detection device 24 that detects the presence or absence of a human body. The changing unit 33 changes the requirement for starting the defrosting operation in accordance with the result of determination by the determination unit 32 and the result of detection by the human body detection device 24. Consequently, when for example, a person is absent, and the heating capacity is thus unnecessary, the defrosting operation is actively performed to the extent that idle defrosting is not frequently performed. In the presence of a user in the indoor space, therefore, the comfortability for the user is not lost.

[0032] The air-conditioning apparatus further includes the outdoor heat-exchanger temperature detection device 22 that detects the temperature of the outdoor heat exchanger 8. The requirement for starting the defrosting operation is that a temperature detected by the outdoor heat-exchanger temperature detection device 22 is at or below the outdoor heat-exchanger temperature threshold. During the heating operation, the changing unit 33 changes, based on the operation information regarding the refrigerant circuit 5, the outdoor heat-exchanger temperature threshold to the outdoor heat-exchanger temperature relaxed threshold, which is higher than the outdoor heat-exchanger temperature threshold. As described above, it is possible to determine whether or not to perform defrosting by determining the temperature of the outdoor heat exchanger 8.

[0033] The air-conditioning apparatus further includes the outdoor temperature detection device 21 that detects an outdoor temperature. The operation information is a temperature detected by the outdoor temperature detection device 21. The determination unit 32 determines whether or not the temperature detected by the outdoor temperature detection device 21 is at or below the outdoor temperature threshold. The changing unit 33 changes the requirement for starting the defrosting operation when the determination unit 32 determines that the temperature detected by the outdoor temperature detection device 21 is at or below the outdoor temperature threshold. As described above, it is possible to more accurately determine whether or not to perform defrosting by determining the outdoor temperature.

Embodiment 2

[0034] Fig. 4 is a block diagram illustrating a control unit 130 of an air-conditioning apparatus 100 according to Embodiment 2 of the present invention. Embodiment 2 differs from Embodiment 1 in that operation information

is an operation frequency of the compressor 6. In Embodiment 2, the same components as those in Embodiment 1 are denoted d by the same reference signs, and an explanation of these components will be omitted. The following description will be made mainly by referring to differences between these Embodiments.

[0035] As illustrated in Fig. 4, the air-conditioning apparatus 100 includes a frequency detection device 125. The frequency detection device 125 detects an operation frequency of the compressor 6. In Embodiment 2, the operation information is the operation frequency detected by the frequency detection device 125. A determination unit 132 determines whether or not the operation frequency detected by the frequency detection device 125 is at or above a frequency threshold. When the operation frequency of the compressor 6 is high, the amount of heat exchange in the outdoor heat exchanger 8 is increased, and the amount of frost formed on the outdoor heat exchanger 8 can thus be considered to be increased accordingly. When the determination unit 132 determines that the operation frequency detected by the frequency detection device 125 is at or above the frequency threshold, a changing unit 133 changes the outdoor heat-exchanger temperature threshold to the outdoor heat-exchanger temperature relaxed threshold, which is higher than the outdoor heat-exchanger temperature threshold, so that, as described above, when the operation frequency of the compressor 6 is high, it is determined that the outdoor heat exchanger 8 is highly likely to have been frosted, and the defrosting operation is readily performed.

[0036] The air-conditioning apparatus according to Embodiment 2 further includes the frequency detection device 125 that detects the operation frequency of the compressor 6. The operation information is the operation frequency detected by the frequency detection device 125. The determination unit 132 determines whether or not the operation frequency detected by the frequency detection device 125 is at or above the frequency threshold. The changing unit 133 changes the requirement for starting the defrosting operation when the determination unit 132 determines that the operation frequency detected by the frequency detection device 125 is at or above the frequency threshold. The same advantages as those of Embodiment 1 are achieved in the above-described use of the operation information indicating the operation frequency of the compressor 6.

Embodiment 3

[0037] Fig. 5 is a block diagram illustrating a control unit 230 of an air-conditioning apparatus 200 according to Embodiment 3 of the present invention. Embodiment 3 differs from Embodiments 1 and 2 in that operation information is an operation time period of the defrosting operation. In Embodiment 3, the same components as those in Embodiments 1 and 2 are denoted by the same reference signs and an explanation of these components is omitted. The following description will be made mainly by referring to differences between Embodiment 3 and Embodiments 1 and 2.

[0038] As illustrated in Fig. 5, the air-conditioning apparatus 200 includes a time measurement device 226. The time measurement device 226 measures the operation time period of the defrosting operation. In Embodiment 3, the operation information is the operation time period of the defrosting operation measured by the time measurement device 226. A determination unit 232 determines whether or not an operation time period of the preceding defrosting operation measured by the time measurement device 226 is at or above a time threshold. If the operation time period of the preceding defrosting operation is long, it is presumed that the amount of frost formed on the outdoor heat exchanger 8 is still likely to increase. When the determination unit 232 determines that the operation time period of the preceding defrosting operation measured by the time measurement device 226 is at or above the time threshold, a changing unit 233 changes the outdoor heat-exchanger temperature threshold to the outdoor heat-exchanger temperature relaxed threshold, which is higher than the outdoor heat-exchanger temperature threshold, so that, as described above, when the operation time period of the preceding defrosting operation is long, it is determined that the outdoor heat exchanger 8 is highly likely to have been frosted and the defrosting operation is readily performed.

[0039] The air-conditioning apparatus according to Embodiment 3 further includes the time measurement device 226 that measures an operation time period of the defrosting operation. The operation information is the operation time period measured by the time measurement device 226. The determination unit 232 determines whether or not an operation time period of the preceding defrosting operation measured by the time measurement device 226 is at or above the time threshold. When the determination unit 232 determines that the operation time period of the preceding defrosting operation measured by the time measurement device 226 is at or above the time threshold, the requirement for starting the defrosting operation is changed. In such a manner, the operation information is the operation time of the defrosting operation, and the same advantages as in Embodiments 1 and 2 are also achieved using the operation information.

Embodiment 4

[0040] Fig. 6 is a block diagram illustrating a control unit 330 of an air-conditioning apparatus 300 according to Embodiment 4 of the present invention. Embodiment 4 differs from Embodiment 1 in that the control unit 330 includes a signal determination unit 335. In Embodiment 4, the same components as those in Embodiments 1 to 3 are denoted by the same reference signs and an explanation of these components is omitted. The following description will be made mainly by referring to differences between Embodiment 4 and Embodiments 1 to 3.

[0041] As illustrated in Fig. 6, the control unit 330 in-

cludes the signal determination unit 335. The signal determination unit 335 allows starting the defrosting operation upon receiving a stop signal from the remote controller 4. The heating operation is continued unless the signal determination unit 335 receives the stop signal from the remote controller 4. In Embodiment 4, the requirement for starting the defrosting operation is changed based on operation information indicating a temperature detected by the outdoor temperature detection device 21. The requirement for starting the defrosting operation is not changed based on the result of detection by the human body detection device 24.

[0042] In Embodiment 4, after the requirement for starting the defrosting operation is changed, the defrosting operation is kept in a standby state even if the changed requirement for starting the defrosting operation is satisfied. If the signal determination unit 335 has received a stop signal, the standby state of the defrosting operation is left. The defrosting operation is started before the operation of the air-conditioning apparatus 300 is stopped. On the other hand, if the signal determination unit 335 has not received the stop signal, the standby state of the defrosting operation is maintained, and the operation of the air-conditioning apparatus 300 is stopped.

[0043] Fig. 7 is a flowchart illustrating an operation of the air-conditioning apparatus 300 according to Embodiment 4 of the present invention. An operation of the control unit 330 of the air-conditioning apparatus 300 according to Embodiment 4 will now be described. Referring to Fig. 7, upon start of the heating operation, it is determined whether or not a temperature of the outdoor heat exchanger 8 detected by the outdoor heat-exchanger temperature detection device 22 is at or below the outdoor heat-exchanger temperature threshold (step ST11). If the temperature of the outdoor heat exchanger 8 is at or below the outdoor heat-exchanger temperature threshold (Yes in step ST11), the switching unit 34 causes the flow switching device 7 to perform switching to start the defrosting operation.

[0044] If the temperature of the outdoor heat exchanger 8 is above the outdoor heat-exchanger temperature threshold (No in step ST11), the determination unit 32 determines whether or not a temperature detected by the outdoor temperature detection device 21 is at or below the outdoor temperature threshold (step ST12). If the temperature detected by the outdoor temperature detection device 21 is above the outdoor temperature threshold (No in step ST12), the signal determination unit 335 determines whether a stop signal has been received from the remote controller 4 or not (step ST13). If the stop signal has been received (Yes in step ST13), the operation of the air-conditioning apparatus 300 is stopped. This is because the outdoor temperature is high and it is presumed that the outdoor heat exchanger 8 has not been frosted. If the stop signal has not been received (No in step ST13), the process returns to step ST11.

[0045] In step ST12, if the temperature detected by the outdoor temperature detection device 21 is at or below the outdoor temperature threshold (Yes in step ST12), the changing unit 33 changes the outdoor heat-exchanger temperature threshold to the outdoor heat-exchanger temperature relaxed threshold, which is higher than the outdoor heat-exchanger temperature threshold. It is determined whether or not the temperature of the outdoor heat exchanger 8 detected by the outdoor heat-exchanger temperature detection device 22 is at or below the outdoor heat-exchanger temperature relaxed threshold (step ST14). If the temperature of the outdoor heat exchanger 8 is at or below the outdoor heat-exchanger temperature relaxed threshold (Yes in step ST14), the signal determination unit 335 determines whether the stop signal has been received from the remote controller 4 or not (step ST15). If the stop signal has been received (Yes in step ST15), the switching unit 34 causes the flow switching device 7 to perform switching to start the defrosting operation. After that, the operation of the air-conditioning apparatus 300 is stopped. If the stop signal has not been received (No in step ST15), the process returns to step ST11. This is because the outdoor temperature is low and it is presumed that the outdoor heat exchanger 8 is likely to have been frosted.

[0046] If the temperature of the outdoor heat exchanger 8 is above the outdoor heat-exchanger temperature relaxed threshold (No in step ST14), the signal determination unit 335 determines whether the stop signal has been received from the remote controller 4 or not (step ST16). If the stop signal has been received (Yes in step ST16), the operation of the air-conditioning apparatus 300 is stopped. If the stop signal has not been received (No in step ST16), the process returns to step ST11 for the following reason: although because of a low outdoor temperature, it is presumed that the outdoor heat exchanger 8 is likely to have been frosted, the stop signal has not been received and it is presumed that the user requires the heating operation.

[0047] The air-conditioning apparatus according to Embodiment 4 further includes the remote controller 4 that transmits a stop signal to stop the operation of the refrigerant circuit 5. The control unit 330 further includes the signal determination unit 335 that allows starting the defrosting operation upon receiving the stop signal from the remote controller 4. The switching unit 34 causes, when the signal determination unit 335 allows starting the defrosting operation, the flow switching device 7 to perform switching to start the defrosting operation. Consequently, when the user does not require the heating operation, the defrosting operation is actively performed, so that the heating capacity to be used when the heating operation is again required can be saved. Therefore, Embodiment 4 can obtain an advantage in which the comfortability for the user can be improved, in addition to the advantages obtained in Embodiment 1.

[0048] In Embodiment 4, the requirement for starting the defrosting operation may be changed based not only on operation information but on the result of detection result by the human body detection device 24 as in Em-

bodiment 1. Furthermore, in Embodiment 4, the operation information may be the operation frequency of the compressor 6 as in Embodiment 2 or may be the operation time period of the defrosting operation as in Embodiment 3.

Embodiment 5

[0049] Fig. 8 is a block diagram illustrating a control unit 430 of an air-conditioning apparatus 400 according to Embodiment 5 of the present invention. Embodiment 5 differs from Embodiment 4 in that a signal determination unit 435 determines whether to allow the defrosting operation in response to determining whether a thermo-off signal has been received or not. In Embodiment 5, the same components as those in Embodiments 1 to 4 are denoted by the same reference signs and an explanation of these components will be omitted. The following description will be made mainly by referring to differences between Embodiment 5 and Embodiments 1 to 4.

[0050] As illustrated in Fig. 8, the control unit 430 includes the signal determination unit 435. The signal determination unit 435 allows starting the defrosting operation upon receiving a thermo-off signal from the indoor unit 3. The heating operation is continued unless the signal determination unit 435 receives the thermo-off signal. In Embodiment 5, the requirement for starting the defrosting operation is changed based on operation information indicating a temperature detected by the outdoor temperature detection device 21. The requirement for starting the defrosting operation in Embodiment 5 is not changed based on the result of detection by the human body detection device 24.

[0051] In Embodiment 5, after the requirement for starting the defrosting operation is changed, the defrosting operation is kept in the standby state even if the changed requirement for starting the defrosting operation is satisfied. If the signal determination unit 435 has received a thermo-off signal, the standby state of the defrosting operation is left. The defrosting operation is started before the operation of the air-conditioning apparatus 400 is stopped. If the signal determination unit 435 has not received the thermo-off signal, the standby state of the defrosting operation is maintained and the operation of the air-conditioning apparatus 400 is stopped.

[0052] Fig. 9 is a flowchart of an operation of the air-conditioning apparatus 400 according to Embodiment 5 of the present invention. An operation of the control unit 430 of the air-conditioning apparatus 400 according to Embodiment 5 will now be described. Referring to Fig. 9, upon start of the heating operation, it is determined whether or not a temperature of the outdoor heat exchanger 8 detected by the outdoor heat-exchanger temperature detection device 22 is at or below the outdoor heat-exchanger temperature threshold (step ST21). If the temperature of the outdoor heat exchanger 8 is at or below the outdoor heat-exchanger temperature threshold (Yes in step ST21), the switching unit 34 causes the flow switching device 7 to start the defrosting operation.

[0053] If the temperature of the outdoor heat exchanger 8 is above the outdoor heat-exchanger temperature threshold (No in step ST21), the determination unit 32 determines whether or not a temperature detected by the outdoor temperature detection device 21 is at or below the outdoor temperature threshold (step ST22). If the temperature detected by the outdoor temperature detection device 21 is above the outdoor temperature threshold (No in step ST22), the signal determination unit 435 determines whether a thermo-off signal has been received from the indoor unit 3 or not (step ST23). If the thermo-off signal has been received (Yes in step ST23), the operation of the outdoor unit 2 and that of the indoor unit 3 are stopped. This is because the outdoor temperature is high and it is presumed that the outdoor heat exchanger 8 is free from frost. If the thermo-off signal has not been received (No in step ST23), the process returns to step ST21.

[0054] In step ST22, if the temperature detected by the outdoor temperature detection device 21 is at or below the outdoor temperature threshold (Yes in step ST22), the changing unit 33 changes the outdoor heat-exchanger temperature threshold to the outdoor heat-exchanger temperature relaxed threshold, which is higher than the outdoor heat-exchanger temperature threshold. It is determined whether or not the temperature of the outdoor heat exchanger 8 detected by the outdoor heat-exchanger temperature detection device 22 is at or below the outdoor heat-exchanger temperature relaxed threshold (step ST24). If the temperature of the outdoor heat exchanger 8 is at or below the outdoor heat-exchanger temperature relaxed threshold (Yes in step ST24), the signal determination unit 435 determines whether the thermo-off signal has been received from the indoor unit 3 (step ST25). If the thermo-off signal has been received (Yes in step ST25), the switching unit 34 causes the flow switching device 7 to start the defrosting operation. After that, the operation of the outdoor unit 2 and that of the indoor unit 3 are stopped. If the thermo-off signal has not been received (No in step ST25), the process returns to step ST21. This is because the outdoor temperature is low and it is presumed that the outdoor heat exchanger 8 is likely to have been frosted.

[0055] If the temperature of the outdoor heat exchanger 8 is above the outdoor heat-exchanger temperature relaxed threshold (No in step ST24), the signal determination unit 435 determines whether the thermo-off signal has been received from the indoor unit 3 (step ST26). If the thermo-off signal has been received (Yes in step ST26), the operation of the outdoor unit 2 and that of the indoor unit 3 are stopped. If the thermo-off signal has not been received (No in step ST26), the process returns to step ST21 for the following reason: although because of a low outdoor temperature, it is presumed that the outdoor heat exchanger 8 is likely to have been frosted, the thermo-off signal has not been received and it is presumed that the heating operation is still required.

[0056] In Embodiment 5, the control unit 430 further includes the signal determination unit 435 that allows starting the defrosting operation upon receiving a thermo-off signal indicating the thermo-off state, in which the heating operation is temporarily stopped when the actual indoor temperature is above a set temperature. When the signal determination unit 435 allows starting the defrosting operation, the switching unit 34 causes the flow switching device 7 to switch to start the defrosting operation. Consequently, when the heating operation is unnecessary, the defrosting operation is actively performed, so that the heating capacity to be used when the heating operation is resumed in response to switching to the thermo-on state can be saved. Therefore, Embodiment 5 can obtain an advantage in which the comfortability for the user can be improved, in addition to the advantages obtained in Embodiment 1.

[0057] In Embodiment 5, the requirement for starting the defrosting operation may be changed based not only on operation information but on the result of detection by the human body detection device 24 as in Embodiment 1. Furthermore, in Embodiment 5, the operation information may be the operation frequency of the compressor 6 as in Embodiment 2 or may be the operation time period of the defrosting operation as in Embodiment 3.

Reference Signs List

[0058] 1 air-conditioning apparatus 2 outdoor unit 3 indoor unit 4 remote controller 4a remote control line 5 refrigerant circuit 6 compressor 7 flow switching device 8 outdoor heat exchanger 8a outdoor fan 9 expansion device 10 indoor heat exchanger 10a indoor fan 21 outdoor temperature detection device 22 outdoor heat-exchanger temperature detection device 23 indoor temperature detection unit 24 human body detection device 30 control 30a outdoor control board 30b indoor control board 30c interconnecting communication line 31 storage unit 32 determination unit 33 changing unit 34 switching unit 100 air-conditioning apparatus 125 frequency detection device 130 control unit 132 determination unit 133 changing unit 200 air-conditioning apparatus 226 time measurement device 230 control unit 232 determination unit 233 changing unit 300 air-conditioning apparatus 330 control unit 335 signal determination unit 400 air-conditioning apparatus 430 control unit 435 signal determination unit

Claims

1. An air-conditioning apparatus comprising:

a refrigerant circuit in which a compressor, a flow switching device, an outdoor heat exchanger, an expansion device, and an indoor heat exchanger are connected by pipes, and through which refrigerant flows; and

a control device configured to control an operation of the refrigerant circuit to perform switching between a heating operation and a defrosting operation,

the control device including

a determination unit configured to determine, based on operation information regarding the refrigerant circuit, during the heating operation, whether or not to change a requirement for starting the defrosting operation,

a changing unit configured to change the requirement for starting the defrosting operation in accordance with a result of determination by the determination unit, and

a switching unit configured to cause, when the requirement for starting the defrosting operation is satisfied, the flow switching device to perform switching to start the defrosting operation.

2. The air-conditioning apparatus of claim 1, further comprising:

a human body detection device configured to detect presence or absence of a human body,

wherein the changing unit is configured to change the requirement for starting the defrosting operation in accordance with the result of determination by the determination unit and a result of detection by the human body detection device.

3. The air-conditioning apparatus of claim 1, further comprising:

a remote controller configured to transmit a stop signal to stop the operation of the refrigerant circuit,

wherein the control device further includes a signal determination unit configured to allow starting the defrosting operation upon receiving the stop signal from the remote controller, and

wherein when the signal determination unit allows starting the defrosting operation, the switching unit causes the flow switching device to perform switching to start the defrosting operation.

4. The air-conditioning apparatus of claim 1,

wherein the control device further includes a signal determination unit configured to allow starting the defrosting operation upon receiving a thermo-off signal indicating a thermo-off state in which the heating operation is temporarily stopped since an actual indoor temperature is higher than a set temperature, and

wherein when the signal determination unit allows starting the defrosting operation, the switching unit causes the flow switching device to perform switching to start the defrosting operation.

5. The air-conditioning apparatus of any one of claims 1 to 4, further comprising:

an outdoor heat-exchanger temperature detection device configured to detect a temperature of the outdoor heat exchanger,
wherein the requirement for starting the defrosting operation is that the temperature detected by the outdoor heat-exchanger temperature detection device is at or below an outdoor heat-exchanger temperature threshold, and
wherein the changing unit is configured to change, during the heating operation, the outdoor heat-exchanger temperature threshold to an outdoor heat-exchanger temperature relaxed threshold higher than the outdoor heat-exchanger temperature threshold in accordance with the operation information regarding the refrigerant circuit.

6. The air-conditioning apparatus of any one of claims 1 to 5, further comprising:

an outdoor temperature detection device configured to detect an outdoor temperature,
wherein the operation information is the temperature detected by the outdoor temperature detection device,
wherein the determination unit is configured to determine whether or not the temperature detected by the outdoor temperature detection device is at or below an outdoor temperature threshold, and
wherein when the determination unit determines that the temperature detected by the outdoor temperature detection device is at or below the outdoor temperature threshold, the changing unit changes the requirement for starting the defrosting operation.

7. The air-conditioning apparatus of any one of claims 1 to 5, further comprising:

a frequency detection device configured to detect an operation frequency of the compressor,
wherein the operation information is the operation frequency detected by the frequency detection device,
wherein the determination unit is configure to determine whether the operation frequency detected by the frequency detection device is at or above a frequency threshold, and
wherein when the determination unit determines that the operation frequency detected by the frequency detection device is at or above the frequency threshold, the changing unit changes the requirement for starting the defrosting operation.

8. The air-conditioning apparatus of any one of claims 1 to 5, further comprising:

a time measurement device configured to measure an operation time period of the defrosting operation,
wherein the operation information is the operation time period measured by the time measurement device,
wherein the determination unit is configured to determine whether an operation time period of a preceding defrosting operation measured by the time measurement device is at or above a time threshold, and
wherein when the determination unit determines that the operation time period of the preceding defrosting operation measured by the time measurement device is at or above the time threshold, the requirement for starting the defrosting operation is changed.

FIG. 1

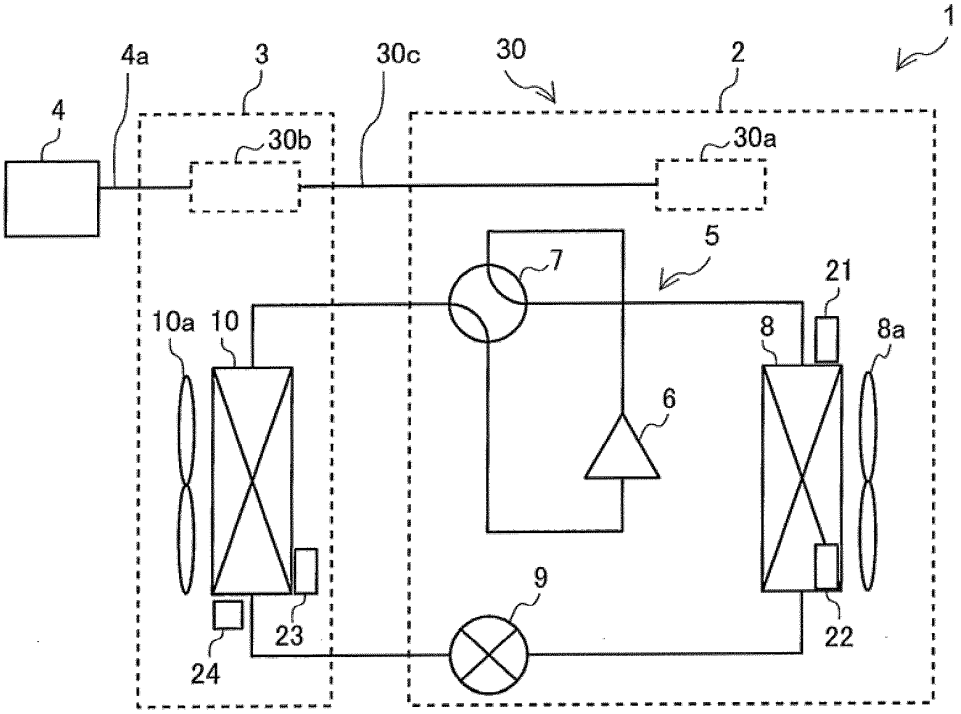

1
4a
3
30c
30
2
4
30b
30a
5
7
21
10a
10
8
8a
6
9
23
22
24

FIG. 2

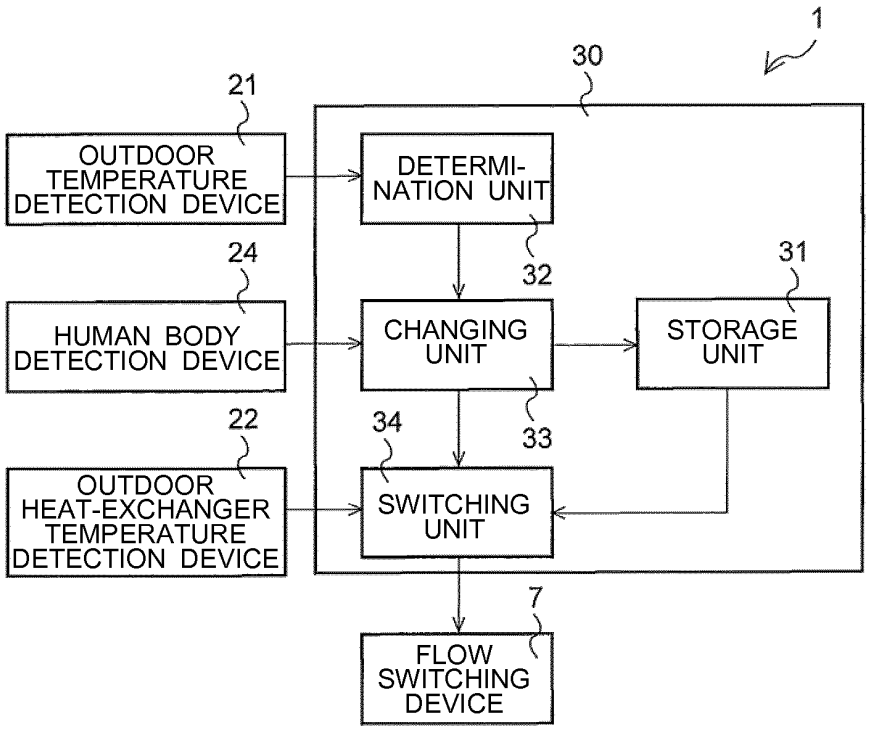

1
30
21
OUTDOOR TEMPERATURE DETECTION DEVICE
DETERMI-NATION UNIT
32
31
24
HUMAN BODY DETECTION DEVICE
CHANGING UNIT
STORAGE UNIT
33
22
34
OUTDOOR HEAT-EXCHANGER TEMPERATURE DETECTION DEVICE
SWITCHING UNIT
7
FLOW SWITCHING DEVICE

FIG. 3

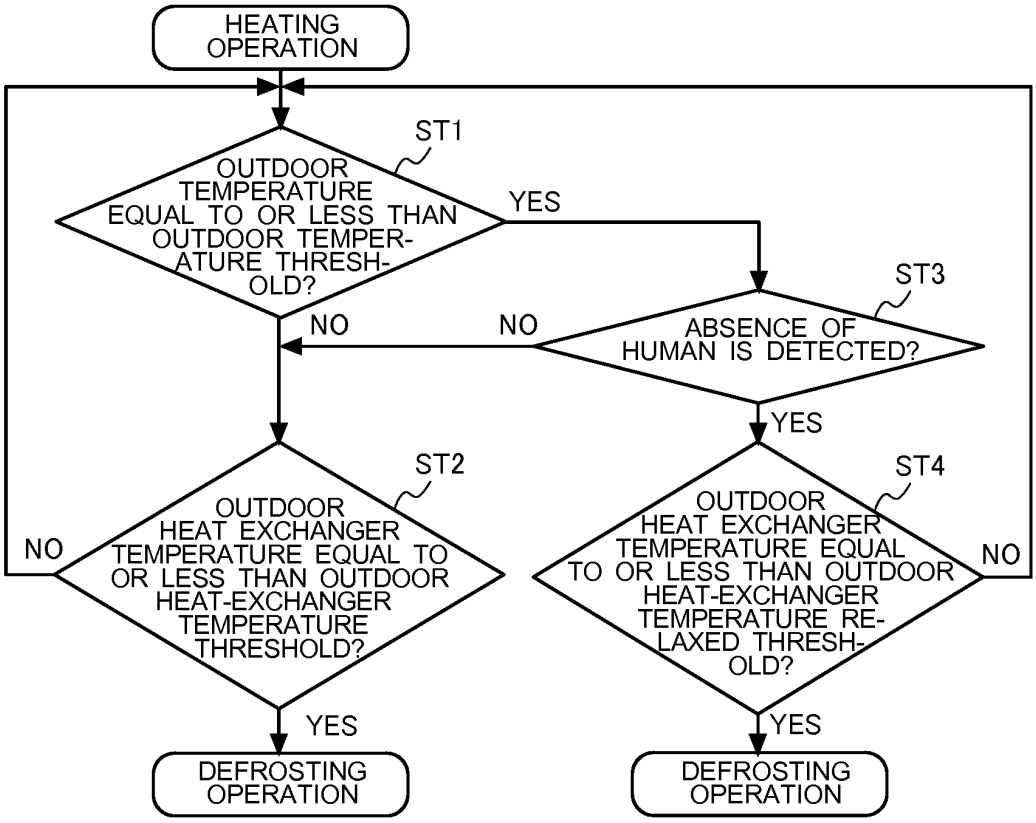

HEATING OPERATION
ST1
OUTDOOR TEMPERATURE EQUAL TO OR LESS THAN OUTDOOR TEMPER-ATURE THRESH-OLD?
YES
NO
ST3
NO
ABSENCE OF HUMAN IS DETECTED?
YES
ST2
OUTDOOR HEAT EXCHANGER TEMPERATURE EQUAL TO OR LESS THAN OUTDOOR HEAT-EXCHANGER TEMPERATURE THRESHOLD?
NO
ST4
OUTDOOR HEAT EXCHANGER TEMPERATURE EQUAL TO OR LESS THAN OUTDOOR HEAT-EXCHANGER TEMPERATURE RE-LAXED THRESH-OLD?
NO
YES
YES
DEFROSTING OPERATION
DEFROSTING OPERATION

FIG. 4

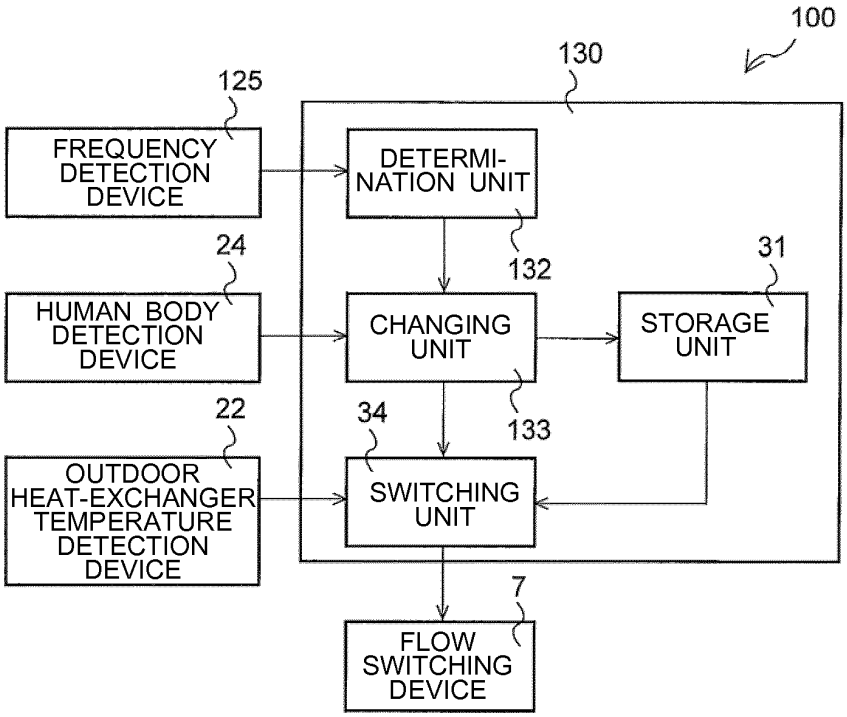

100
130
125
FREQUENCY DETECTION DEVICE
DETERMI-NATION UNIT
132
24
HUMAN BODY DETECTION DEVICE
CHANGING UNIT
31
STORAGE UNIT
22
34
133
OUTDOOR HEAT-EXCHANGER TEMPERATURE DETECTION DEVICE
SWITCHING UNIT
7
FLOW SWITCHING DEVICE

FIG. 5

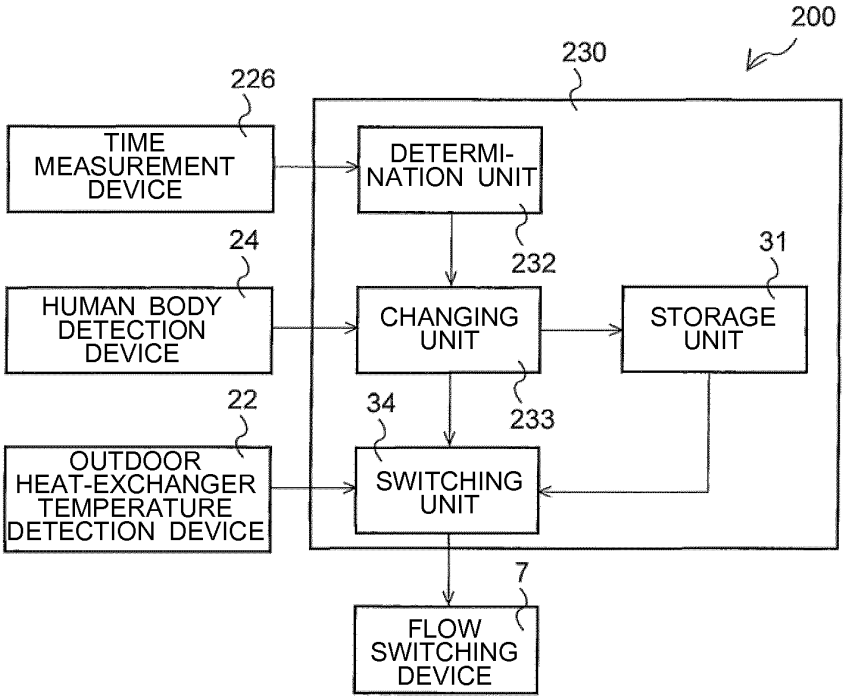

200
230
226
TIME MEASUREMENT DEVICE
DETERMI-NATION UNIT
232
24
HUMAN BODY DETECTION DEVICE
CHANGING UNIT
31
STORAGE UNIT
233
22
34
OUTDOOR HEAT-EXCHANGER TEMPERATURE DETECTION DEVICE
SWITCHING UNIT
7
FLOW SWITCHING DEVICE

FIG. 6

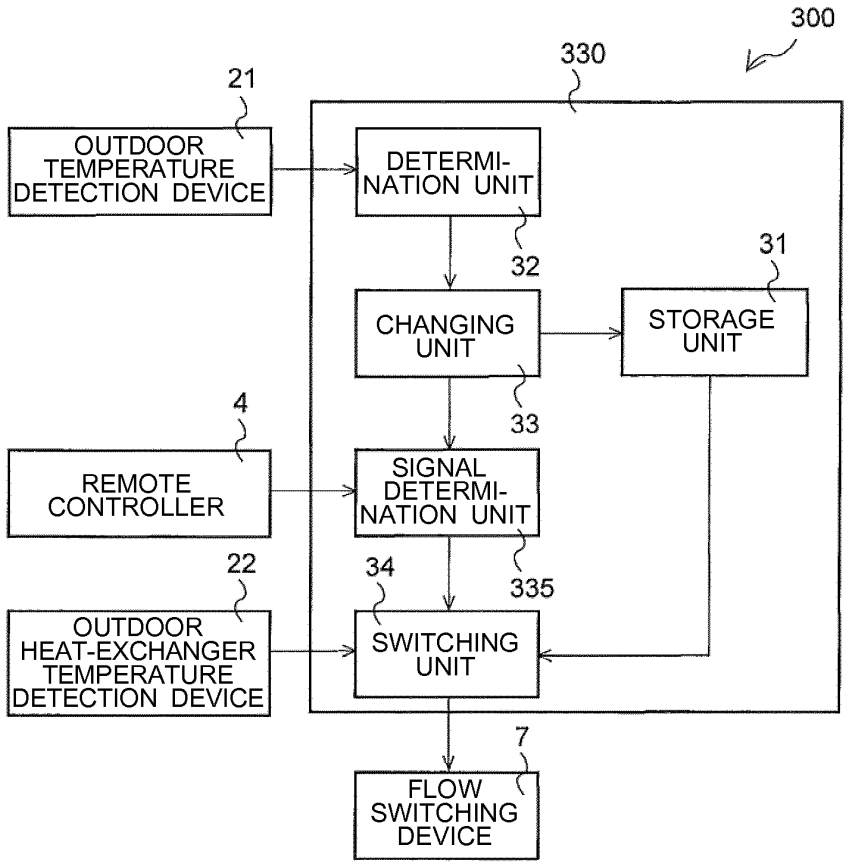

300
330
21
OUTDOOR TEMPERATURE DETECTION DEVICE
DETERMI-NATION UNIT
32
31
CHANGING UNIT
STORAGE UNIT
33
4
REMOTE CONTROLLER
SIGNAL DETERMI-NATION UNIT
335
22
34
OUTDOOR HEAT-EXCHANGER TEMPERATURE DETECTION DEVICE
SWITCHING UNIT
7
FLOW SWITCHING DEVICE

FIG. 7

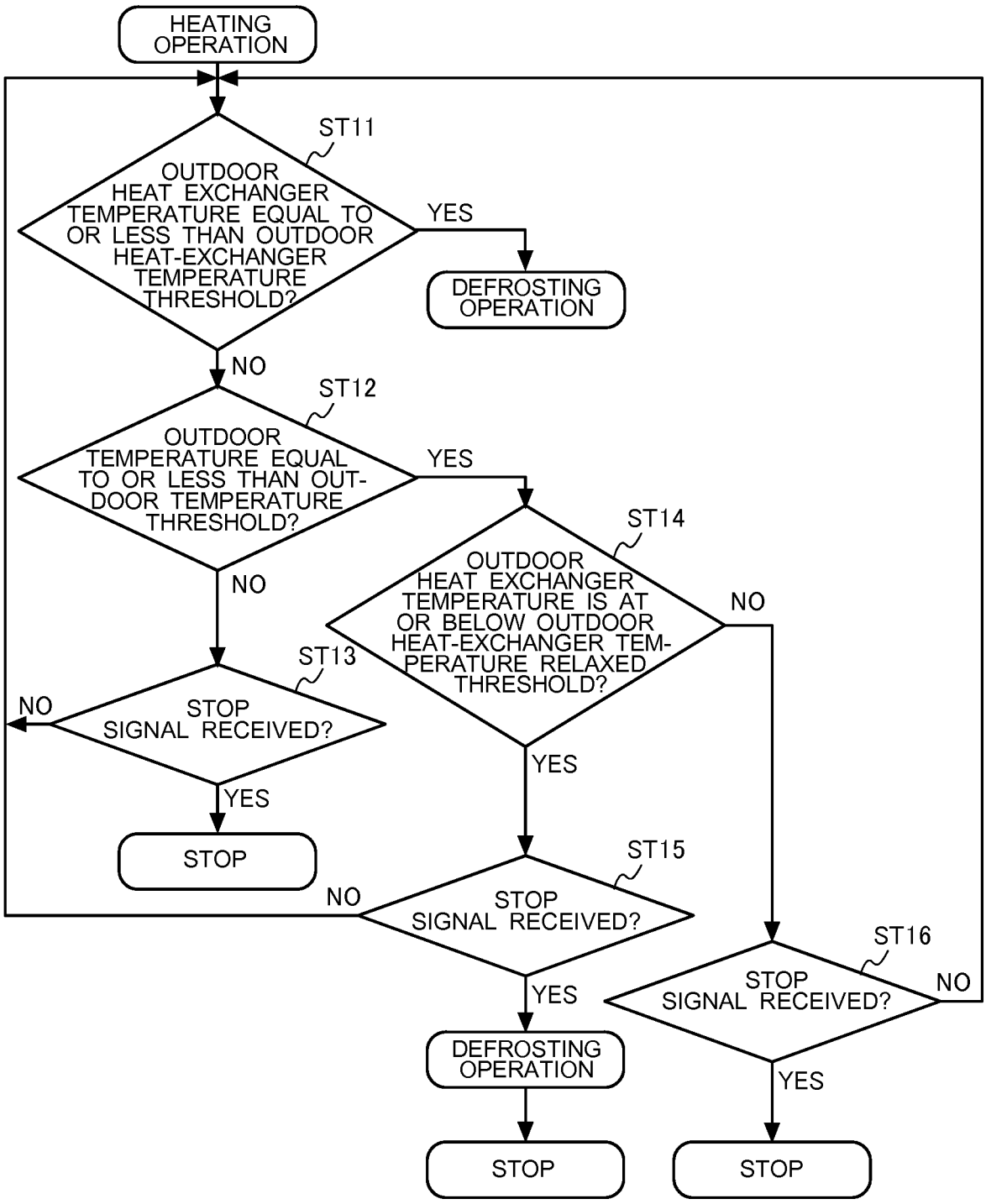

HEATING OPERATION
ST11
OUTDOOR HEAT EXCHANGER TEMPERATURE EQUAL TO OR LESS THAN OUTDOOR HEAT-EXCHANGER TEMPERATURE THRESHOLD?
YES
DEFROSTING OPERATION
NO
ST12
OUTDOOR TEMPERATURE EQUAL TO OR LESS THAN OUTDOOR TEMPERATURE THRESHOLD?
YES
NO
ST14
OUTDOOR HEAT EXCHANGER TEMPERATURE IS AT OR BELOW OUTDOOR HEAT-EXCHANGER TEMPERATURE RELAXED THRESHOLD?
NO
ST13
NO
STOP SIGNAL RECEIVED?
YES
STOP
YES
ST15
NO
STOP SIGNAL RECEIVED?
YES
DEFROSTING OPERATION
STOP
ST16
STOP SIGNAL RECEIVED?
NO
YES
STOP

FIG. 8

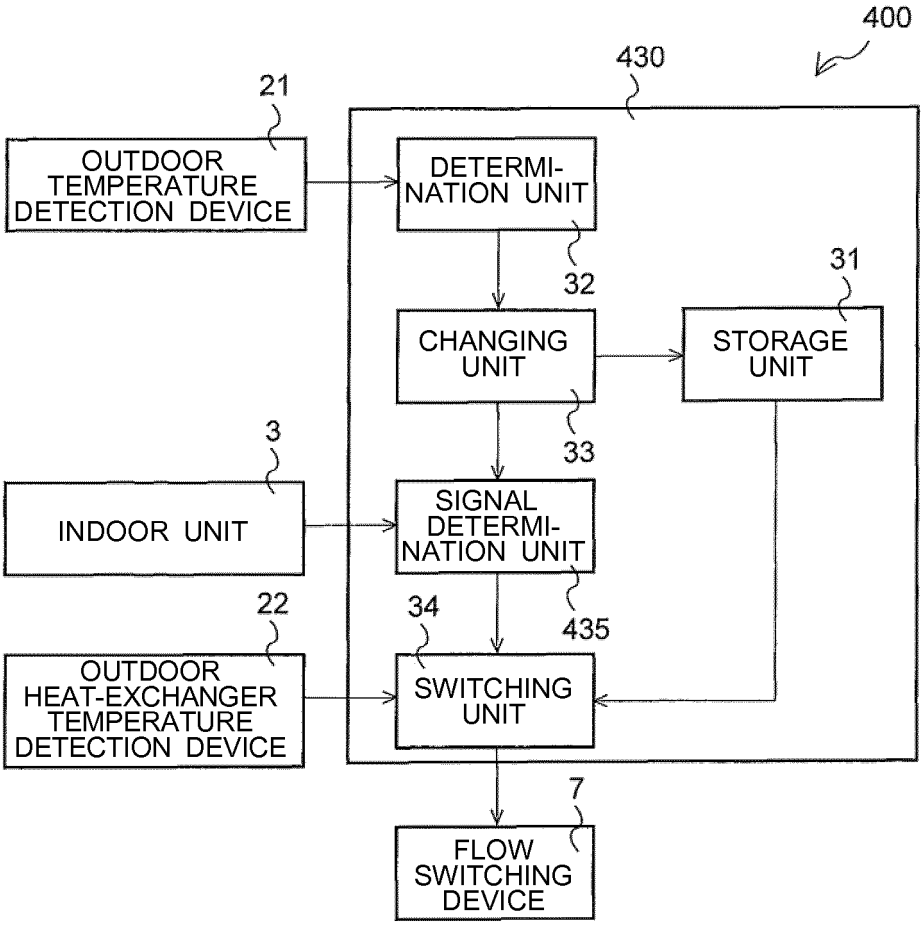
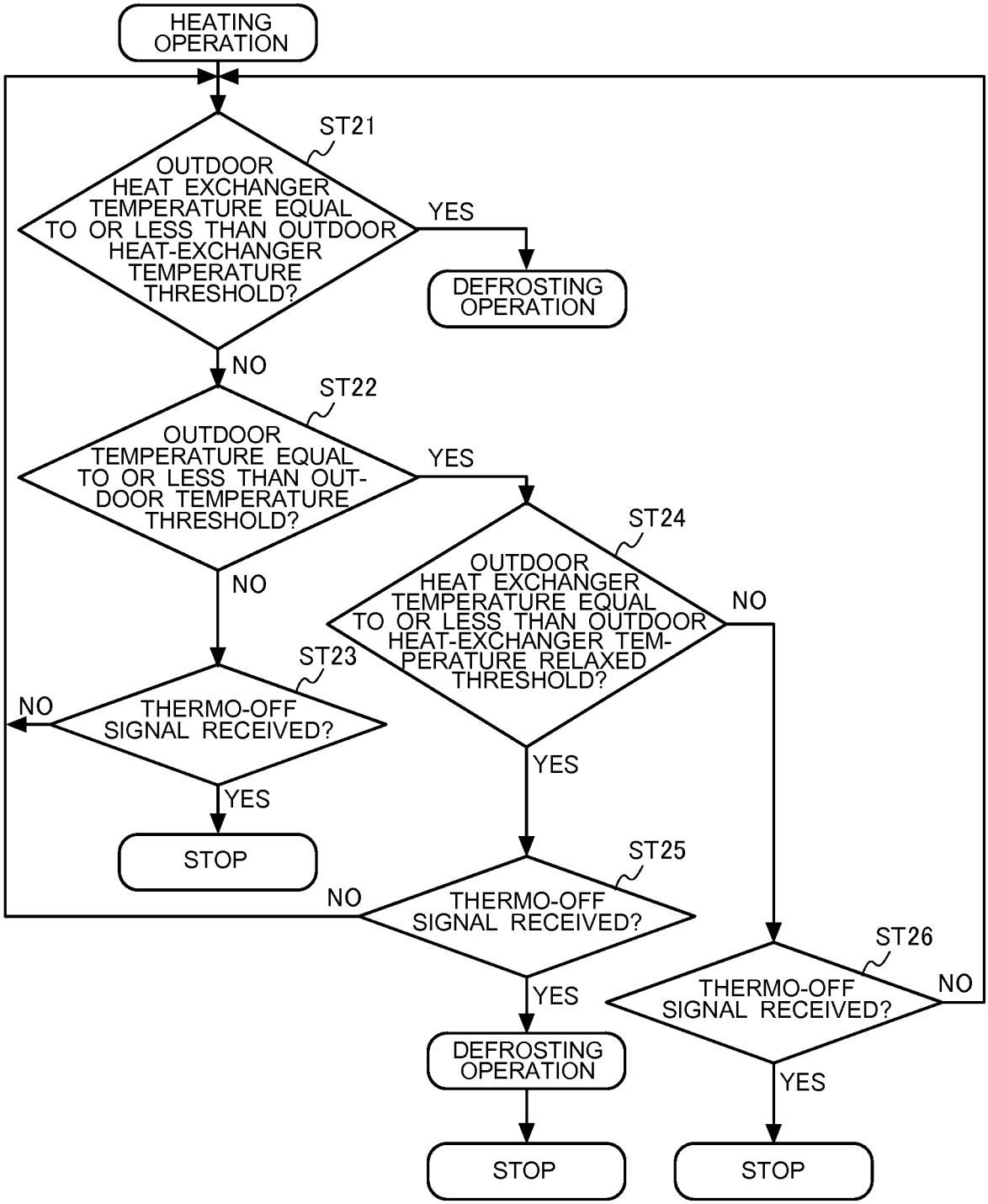

400
430
21
OUTDOOR TEMPERATURE DETECTION DEVICE
DETERMI-NATION UNIT
32
31
CHANGING UNIT
STORAGE UNIT
33
3
INDOOR UNIT
SIGNAL DETERMI-NATION UNIT
435
22
34
OUTDOOR HEAT-EXCHANGER TEMPERATURE DETECTION DEVICE
SWITCHING UNIT
7
FLOW SWITCHING DEVICE

FIG. 9


HEATING OPERATION
ST21
OUTDOOR HEAT EXCHANGER TEMPERATURE EQUAL TO OR LESS THAN OUTDOOR HEAT-EXCHANGER TEMPERATURE THRESHOLD?
YES
DEFROSTING OPERATION
NO
ST22
OUTDOOR TEMPERATURE EQUAL TO OR LESS THAN OUT-DOOR TEMPERATURE THRESHOLD?
YES
NO
ST24
OUTDOOR HEAT EXCHANGER TEMPERATURE EQUAL TO OR LESS THAN OUTDOOR HEAT-EXCHANGER TEM-PERATURE RELAXED THRESHOLD?
NO
ST23
NO
THERMO-OFF SIGNAL RECEIVED?
YES
STOP
YES
ST25
NO
THERMO-OFF SIGNAL RECEIVED?
YES
DEFROSTING OPERATION
STOP
ST26
THERMO-OFF SIGNAL RECEIVED?
NO
YES
STOP

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/053458

A. CLASSIFICATION OF SUBJECT MATTER
F25B47/02(2006.01)i, *F24F11/02*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25B47/02, F24F11/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2016
Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 2012-47423 A (Fujitsu General Ltd.), 08 March 2012 (08.03.2012), paragraphs [0003], [0015], [0023], [0035] to [0036], [0040] to [0041]; fig. 1 (Family: none)	1,5 2-4 6-8
X Y A	JP 2-31300 B2 (Daikin Industries, Ltd.), 12 July 1990 (12.07.1990), column 5, line 34 to column 6, line 27; column 7, line 34 to column 8, line 20; column 10, line 24 to column 12, line 13; fig. 3 (Family: none)	1,8 2-4 5-7
X Y A	JP 7-104082 B2 (Daikin Industries, Ltd.), 13 November 1995 (13.11.1995), column 7, line 26 to column 10, line 15; fig. 2 (Family: none)	1,6-8 2-4 5

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

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"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
21 April 2016 (21.04.16)	10 May 2016 (10.05.16)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/053458

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2013-130341 A (Daikin Industries, Ltd.), 04 July 2013 (04.07.2013), paragraphs [0006] to [0010], [0049] to [0067]; fig. 1, 4 (Family: none)	2-3
Y	JP 2015-183873 A (Hitachi Appliances, Inc.), 22 October 2015 (22.10.2015), paragraphs [0004], [0016] to [0026]; fig. 1 to 2 (Family: none)	2
Y	JP 61-276648 A (Daikin Industries, Ltd.), 06 December 1986 (06.12.1986), page 4, lower left column, line 17 to page 5, upper right column, line 4 (Family: none)	4

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011185535 A **[0004]**