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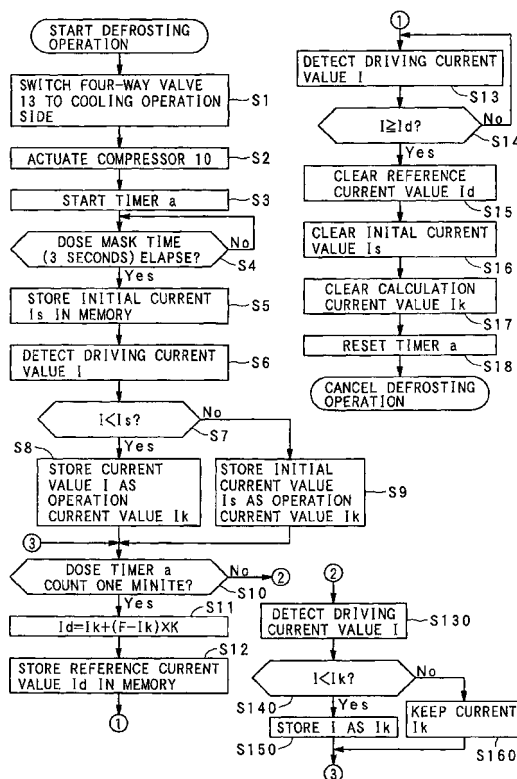
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(54) **Defrosting operation cancelling method for air conditioner and air conditioner using the same**

(57) A driving current value I of a compressor under the defrosting operation is monitored to achieve a calculation current value I_k corresponding to the minimum driving current value for a predetermined time period. A reference current value I_d used for canceling the defrosting operation is determined by a predetermined calculation using the calculation current value I_k and predetermined parameters. Thereafter, the driving current value I of the compressor is further detected, and it is judged whether the driving current value I is not less than the reference current value I_d . If it is judged that the driving current value I is not less than the reference current value I_d , the controller cancels (stops) the defrosting operation.

FIG. 2



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a method of properly canceling defrosting operation and an air condition using the method.

2. Description of the Related Art

[0002] Air conditioners having constant-rate type compressors, containing air conditioners for overseas use, generally adopt any one of the following methods to cancel a defrosting operation. According to a first method, a timer for counting a fixed time as a defrosting operation time is equipped to an air conditioner, and the defrosting operation is canceled (stopped) at the time when the timer counts the predetermined defrosting operation time. According to a second method, an indoor unit is equipped with an indoor temperature sensor, an indoor heat exchanger temperature sensor and an indoor controller while an outdoor unit is equipped with an outdoor heat exchanger and an outdoor controller, and the defrosting operation is canceled on the basis of the temperature detected by each of the indoor temperature sensor, the indoor heat exchanger temperature sensor and outdoor heat exchanger temperature sensor. Further, according to a third method, the defrosting operation is canceled on the basis of the indoor temperature detected by an indoor temperature sensor, the indoor heat-exchanger temperature detected by an indoor heat exchanger temperature sensor and a fixed driving current value which is preset to cancel the defrosting operation.

[0003] In the second method of canceling the defrosting operation on the basis of the temperature of each sensor, the defrosting operation can be surely performed, however, it is necessary to equip the outdoor heat exchanger temperature sensor to the outdoor unit and also equip the outdoor controller for processing temperature information from the outdoor heat exchanger temperature sensor, so that the manufacturing cost rises up.

[0004] Further, in the third method of controlling the defrosting operation on the basis of the preset current value, the outdoor controller and the outdoor temperature sensor in the outdoor unit can be omitted, and thus this method is advantageous in cost. However, when a power source voltage applied to a compressor is varied (or switched to another voltage), the current value (the driving current value) of the compressor under the defrosting operation is also varied. However, the driving current value preset to cancel the defrosting operation is fixed (unvaried) irrespective of the variation of the power source voltage, the type of the compressor, etc., so that there occurs such a problem that frost remains

partially or excessive defrosting operation is unintentionally carried out.

SUMMARY OF THE INVENTION

[0005] Therefore, an object of the present invention is to provide a defrosting operation canceling method which can more accurately cancel the defrosting operation in accordance with the capacity of a compressor being used, the type of a compressor being used or the like, so that occurrence of residual frost can be prevented and also excessively defrosting operation can be prevented.

[0006] In order to attain the above object, according to a first aspect of the present invention, there is provided an air conditioner having a compressor and a defrosting function that is characterized by comprising: a detector for detecting a driving current value applied to the compressor under defrosting operation; and a controller for calculating a reference current value for cancellation of the defrosting operation on the basis of the driving current value of the compressor detected by the detector, and judging, whether the defrosting operation should be canceled or not, on the basis of the comparison between the reference current value and a driving current value of the compressor that is detected after the calculation of the reference current value.

[0007] In the air conditioner described above, the controller cancels the defrosting operation when the driving current of the compressor detected after the calculation of the reference current value is not less than the reference current value.

[0008] In the air conditioner described above, the controller includes a memory for storing parameters in advance, and the controller calculates the reference current value on the basis of the driving current value of the compressor detected under the defrosting operation and the parameters stored in the memory by using a predetermined calculation equation.

[0009] In the air conditioner described above, plural sets of parameters which are usable in the calculation equation for the cancellation of the defrosting operation are prepared and stored in the memory, and any one set of parameters which is most suitable to determine the reference current value for the compressor being used is properly selected from the plural sets.

[0010] In the air conditioner described above, the reference current value is calculated on the following equation:

$$I_d = I_k + (F - I_k) \times K,$$

wherein I_d represents the reference current value, F and K represent the set of parameters and I_k represents the minimum driving current value of the compressor in driving current values of the compressor that are detected for a predetermined time period.

[0011] According to a second aspect of the present invention, there is provided a method of canceling defrosting operation for an air conditioner, characterized by comprising the steps of: detecting a driving current value of the compressor under defrosting operation; calculating a reference current value for cancellation of the defrosting operation on the basis of the driving current value of the compressor detected in the detecting step and a set of parameters; judging, whether the defrosting operation should be canceled or not, on the basis of the comparison between the reference current value and the driving current value of the compressor that is detected after the calculation of the reference current value.

[0012] The method described above further comprises a canceling step of canceling the defrosting operation when it is judged in the judging step that the driving current of the compressor detected after the calculation of the reference current value is not less than the reference current value.

[0013] In the method described above, the reference current value is calculated on the following equation:

$$I_d = I_k + (F - I_k) \times K,$$

wherein I_d represents the reference current value, F and K represent the set of parameters and I_k represents the minimum driving current value of the compressor in driving current values of the compressor that are detected for a predetermined time period.

[0014] According to the present invention, the driving current value I of the compressor under the defrosting operation is monitored for a predetermined time period, and the calculation current value I_k corresponding to the minimum current value for the predetermined time period is determined. At the time when the predetermined time period elapses, a reference current value I_d which corresponds to a threshold value for canceling the defrosting operation is determined by the predetermined calculation using the calculation current value I_k and the parameters set in the controller in advance, and the reference current value I_d thus determined is stored in the controller. Thereafter, the driving current value I of the compressor is further detected, and it is judged whether the driving current value I is not less than the reference current value I_d . If it is judged that the driving current value I is not less than the reference current value I_d , the controller cancels (stops) the defrosting operation (i. e., the cooling operation), and resumes the heating operation. In conformity with variation (increase/reduction) of a power source voltage, the driving current I of the compressor is also varied (increased/reduced) and thus the reference current value I_d for the cancellation of the defrosting operation is also varied (increased/reduced), so that the defrosting operation canceling timing can accurately follow the variation of the power source voltage. Therefore, occurrence of residual frost can be prevented

ed and also the excessively defrosting operation can be prevented. Therefore, the defrosting canceling method and the air conditioner according to the present invention can be applied in a broader power source voltage range and under a larger power source variation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 is a diagram showing a refrigerant circuit and a control circuit of an air conditioner according to the present invention;

Fig. 2 is a flowchart showing an embodiment of a method of canceling defrosting operation of the air conditioner;

Fig. 3 is a conceptual graph showing variation of the driving current of the compressor with the time lapse under the defrosting operation; and

Fig. 4 is a graph showing variations of a reference current value for cancellation of defrosting operation and a driving current value of a compressor with variation of a power source voltage in the flowchart of Fig. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] A preferred embodiment according to the present invention will be described hereunder with reference to Figs. 1 to 4.

[0017] Fig. 1 schematically shows an air conditioner which carries out air conditioning operation with no outdoor heat exchanger temperature sensor and no outdoor controller in an outdoor unit.

[0018] First, an outdoor unit 1 is equipped with a compressor 10 for compressing refrigerant, an outdoor heat exchanger 11 for performing heat exchange with the outside air in such a way as to radiate heat to the outside air when the cooling operation is carried out and absorb heat from the outside air when the heating operation is carried out, an four-way valve 13 for inverting the circulating direction of refrigerant, an expansion valve 14, an accumulator 15 and service valves 16a and 16b connected to inter-unit pipes extending from the indoor unit. These parts are connected to one another through a refrigerant pipe. Further, the outdoor unit 1 contains an outdoor air blower 12 for blowing air to the outdoor heat exchanger 11, and a terminal board 17 connected to inter-unit wires extending from the indoor unit.

[0019] The indoor unit 2 is equipped with an indoor heat exchanger 20 for performing heat exchange with indoor air, an indoor air blower 21 for blowing the indoor air to the indoor heat exchanger 20, a temperature sensor 22 for detecting the indoor temperature, and an indoor controller 23 for controlling the whole operation of the air conditioner. The indoor controller 23 contains a power relay 24 for controlling the driving of the compressor

sor 10 (actuating/stopping the compressor 10) and a current sensor 25 for detecting the driving current value of the compressor 10. Further, the indoor controller 23 of the indoor unit 2 is equipped with a receiver 26 for receiving driving information (signals) output from a wireless remote controller (hereinafter referred to as "remote controller") 28 for outputting various instructions for the driving of the air conditioner (setting parameters, actuating/stopping the air conditioner, etc.), and a plug 27 through which power is supplied to the air conditioner.

[0020] At the outdoor unit 1, the two inter-unit pipes 3 extending from the indoor unit 2 are connected to the service valves 16a and 16b, and the five inter-unit wires 4 extending from the indoor unit 2 are connected to the terminal board 17. In this case, it is needless to say that the number of the inter-unit pipes 3 and the number of the inter-unit wires 4 are not limited to these values.

[0021] Here, the flow of refrigerant in the refrigerant circuit shown in Fig. 1 will be described.

[0022] Under the heating operation of the air conditioner, the four-wave valve 13 is first switched to a heating-operation side. At this time, as indicated by broken-line arrows, the refrigerant compressed in the compressor 10 passes through the four-way valve 13 and flows through the service valve 16a and the inter-unit pipe 3a into the indoor heat exchanger 20 of the indoor unit 2. The refrigerant in the indoor heat exchanger 20 is heat-exchanged with air blown out from the indoor air blower 21 to radiate the heat of the refrigerant to the air. The refrigerant thus heat-exchanged passes through the inter-unit pipe 3b and the service valve 16b and returns to the indoor unit 1. Thereafter, the refrigerant passed through the expansion valve 14, and flows into the outdoor heat exchanger 11. In the outdoor heat exchanger 11, the refrigerant is heat-exchanged with air blown out from the outdoor air blower 12 to absorb the heat of the outside air, and then flows through the four-way valve 13 and the accumulator 15 into the compressor 10, thereby performing the heating operation based on the heating cycle.

[0023] On the other hand, under the cooling operation of the air conditioner, the four-way valve 13 is first switched to a cooling-operation side. At this time as indicated by solid-line arrows, the refrigerant passes through the four-way valve 13 and then flows into the outdoor heat exchanger 11. In the outdoor heat exchanger 11, the refrigerant is heat-exchanged with the outside air blown out from the outdoor air blower 12 to radiate the heat thereof to the outside air. Thereafter, the refrigerant thus heat-exchanged passes through the expansion valve 14 and flows through the service valve 16b and the inter-unit pipe 3b into the indoor heat exchanger 20 of the indoor unit 2. In the indoor heat exchanger 20, the refrigerant is heat-exchanged with the indoor air blown from the indoor air blower 21 to absorb the heat of the indoor air. Thereafter, the refrigerant thus heat-exchanged passes through the inter-unit pipe 3a

and the service valve 16a, and returns to the outdoor unit 1. In the outdoor unit 1, the refrigerant flows through the four-way valve 13 and the accumulator 15 into the compressor 10, thereby performing the cooling operation based on the cooling cycle.

[0024] Under the defrosting operation, the same cooling cycle as the cooling operation described above is carried out, however, the outdoor air blower 12 and the indoor air blower 21 are operated under a calm state (non-blowing state) or a weak air-blowing state.

[0025] Next, the control operation of the air conditioner is generally carried out as follows.

[0026] First, the plug 27 is connected to a socket of a power source to keep the air conditioner under such a state that power can be applied to the air conditioner at all times. Further, any driving mode of the cooling operation mode and the heating operation mode is selected by using the remote controller 28, desired indoor temperature is set as target temperature by using the remote controller 28, and a driving start instruction is transmitted to the air conditioner by operating a driving switch of the remote controller 28.

[0027] When the driving start instruction is received by the receiver 26, the indoor controller 23 switches the four-way valve 13 of the outdoor unit 1 to the cooling operation side if the driving mode received by the receiver 26 indicates the cooling operation mode or switches the four-way valve 13 of the outdoor unit 1 to the heating operation side if the driving mode indicates the heating operation mode, and also turns on the indoor air blower 21. Further, the indoor controller 23 calculates the difference in temperature between the temperature detected by the indoor temperature sensor 22 and the target temperature which is transmitted from the remote controller 28 and received by the receiver 26, and turns on the outdoor air blower 12 and the power relay 24 on the basis of the temperature difference thus calculated, thereby performing the air conditioning operation.

[0028] If the defrosting operation is needed when the heating operation is selected and carried out in the air conditioner, the indoor controller 23 switches the four-way valve 13 to the cooling operation side to invert the circulating flow of the refrigerant, so that the defrosting operation as the cooling cycle is carried out. According to this embodiment, when it is judged on the basis of the following method that the defrosting operation should be canceled, the defrosting operation is canceled and the four-way valve 13 is switched to the heating operation side to resume the heating operation.

[0029] The detection method and the judgment method for the cancellation of the defrosting operation will be described with reference to the flowchart of Fig. 2.

[0030] When the defrosting operation is started, the four-way valve 13 is switched to the cooling operation side (S1), and the compressor 10 of the outdoor unit 1 is operated while the refrigerant circulation is set to the cooling cycle (S2). Further, a timer a is operated (S3). The timer a is installed in the indoor controller to count

the time under the defrosting operation.

[0031] With respect to some kinds of compressors, there occurs such a case that the driving current value for each compressor becomes unstable at the time when the defrosting operation is started. Therefore, in order to make the controller neglect the unstable driving current, a mask time is set to detection of the driving current value of the compressor 10, and it is judged in step S4 whether the timer a counts lapse of 3 seconds. If the timer a does not count the lapse of 3 seconds, The time lapse check described above is repeated, and if it is judged that 3 seconds has elapsed, the current value I of the compressor 10 is detected as an initial current value Is, and stored into a first memory M1 of the indoor controller (S5).

[0032] Subsequently, the current value I of the compressor 10 is detected (S6), and the initial current value Is stored in the first memory M1 and the current I of the compressor 10 thus detected are compared with each other (S7). If it is judged that the current value I is less than the initial current value Is, the current value I is set as a calculation current value Ik, and stored in a second memory M2 of the indoor controller 23 (S8). On the other hand, if the current value I is equal to or larger than the initial current value Is, the initial current value Is is set as a calculation current value Ik and stored in the second memory M2 (S9).

[0033] It is checked whether the timer a counts one minute (60 seconds), that is, it is checked whether 60 seconds elapse or not (S10). If one minute does not elapse, the processing goes to step S130 to detect the driving current I of the compressor 10, and then the current value I thus detected is compared with the calculation current value Ik stored in the second memory (S140). If the current value I is less than the calculation current value Ik, the current value I thus detected is stored as a new calculation current value Ik in the second memory (step S150). On the other hand, if the current value I is not less than the calculation current value Ik, the calculation current value Ik is kept unchanged (step S160). Thereafter, the processing returns to the step S10 to judge whether the timer counts one minute. These steps from S10 to S160 are repeated until the counter counts one minute in step S10.

[0034] If in step S10 the counter counts one minute, the processing goes to step S11 to calculate a reference current value Id by the following equation on the basis of the current value Ik finally-stored in the second memory M2 in step S150 or S160 and the parameters F and K stored in the indoor controller 23 of the indoor unit 2 in advance:

$$Id = Ik + (F - Ik) \times K$$

The calculation result is set as the reference current value Id and stored in a third memory M3 of the indoor controller 23 (S12) to judge whether the defrosting driving

operation should be canceled or not.

[0035] Here, the parameters F and K are determined in accordance with the capacity of a compressor being used, the maker of a compressor being used, etc. In this embodiment, plural pairs of parameters F and K are prepared in advance and stored in a memory other than the first to third memories in the indoor controller 23 of the indoor unit 2. For example, in the process of manufacturing an air conditioner in a maker, a pair of parameters F and K which are most suitable to determine the reference current value for the compressor of the air conditioner are selected from the preset pairs of parameters.

[0036] After 60 seconds elapse, the current value (driving current value) I of the compressor 10 under the defrosting operation is further detected (S13), and it is judged whether the current value I is equal to or more than the reference current value Id calculated in step S11 (S14). If the current value I of the compressor 10 is less than the reference current value Id, the defrosting operation is continued and the processing returns to step S13 to repetitively detect the current value I of the compressor 10 and compare it with the reference current value Id again. If the current value I of the compressor 10 is equal to or more than the reference current value Id, the initial current value Is, the calculation current value Ik and the reference current value Id which are stored in the first to third memories are cleared (S15 to S17), and the timer a is reset (S18), whereby the defrosting operation is canceled and the operation is returned to the normal heating operation.

[0037] Here, the calculation of the reference current value Id for the cancellation of the defrosting operation based on the calculation equation of the step S11 in the flowchart of Fig. 2 will be described by using some examples.

[0038] In these examples, it is assumed that the parameters F and K (F=4.78, K=0.591) are selected from the plural numeral values prepared in the indoor controller 23 in advance. At this time, for example, when the power source voltage is equal to a rated voltage Va [volt], the calculation current value Ik that is finally stored in the second memory M2 through the flowchart of Fig. 2 is equal to 3.0[Ampere]=Ia, Id is represented by the following equation of the step S11 of the flowchart of Fig. 2;

$$\begin{aligned} Id &= Ia + (F - Ia) \times K \\ &= 3.0 + (4.78 - 3.0) \times 0.591 \\ &\approx 4.05 \end{aligned} \quad (1)$$

[0039] As described above, the reference current value Id for the cancellation of the defrosting operation is equal to 4.05 [ampere] = Ida. The defrosting operation is canceled at the time point ta when the current value I of the compressor 10 exceeds the reference current

value I_{da} .

[0040] For example, when the power source voltage is equal to V_b [volt] lower than the rated voltage, the voltage to be applied to the compressor 10 is also reduced, and thus the calculation current value I_k which is finally stored in the second memory M2 through the flowchart of Fig. 2 is also reduced. Therefore, if I_k is equal to 2.5 [amperes] = I_b ,

$$\begin{aligned} I_d &= I_b + (F - I_b) \times K \\ &= 2.5 + (4.78 - 2.5) \times 0.591 \\ &\approx 3.85 \end{aligned} \quad (2)$$

At this time, the reference current value I_d for the cancellation of the defrosting operation is equal to 3.85 [amperes] = I_{db} . Accordingly, the defrosting operation is canceled at the time point t_b when the current value I of the compressor 10 exceeds the reference current value I_{db} .

[0041] On the other hand, when the power source voltage is equal to V_c [volt] higher than the rated voltage V , the voltage to be applied to the compressor 10 is increased, and thus the calculation current value I_k which is finally stored in the second memory M2 through the flowchart of Fig. 2 is increased. Therefore, if the calculation current value is equal to 4.0 [amperes] = I_c ,

$$\begin{aligned} I_d &= I_c + (F - I_c) \times K \\ &= 4.0 + (4.78 - 4.0) \times 0.591 \\ &\approx 4.46 \end{aligned} \quad (3)$$

At this time, the reference current value I_d for the cancellation of the defrosting operation is equal to 4.46 [amperes] = I_{dc} . Accordingly, the defrosting operation is canceled at the time point t_c when the current value I of the compressor exceeds the reference current value I_{dc} .

[0042] Fig. 3 is a conceptual graph showing variation of the driving current I of the compressor 10 with the time lapse during the defrosting operation.

[0043] In order to start the defrosting operation, the air conditioner is controlled to switch the heating operation to the cooling operation. Therefore, at the start time of the defrosting operation, the driving current I of the compressor 10 is regarded as being equal to zero or a small value as shown in Fig. 3 because the air conditioning load at this instantaneous time point is equal to zero. As the cooling operation progresses, the driving current I of the compressor 10 increases. When the cooling operation further progresses, the driving current I of the compressor 10 approaches to a substantially fixed value based on an air conditioning load.

[0044] As shown in Fig. 3, the driving current I at the time of 3 seconds corresponds to the initial current value I_s , and stored in the first memory M1. After 30 seconds elapse, the driving current I which varies up and down is compared with the initial current value I_s stored in the first memory. If the driving current I is less than the initial current value I_s , the driving current I at this time is stored as the calculation current value I_k in the second memory M2. This comparison operation is continued until 60 seconds (1 minute).

[0045] The calculation current value I_k which is finally stored in the second memory at the time of 60 seconds corresponds to the minimum value of the function of the driving current I in the time period from 30 seconds to 60 seconds. At the time of 60 seconds, the reference current value I_d is calculated on the basis of the calculation current value I_k finally-stored in the second memory and the parameters F and K . After 60 seconds elapse, at the time when the driving current I exceeds the reference current value I_d (at t_s in Fig. 3), the defrosting operation is stopped.

[0046] In the conventional air conditioner, the reference current value I_d is fixed irrespective of the compressor type, etc. However, in this embodiment, the reference current value I_d is varied according to the calculation equation: $I_d = I_k + (F - I_k) \times K$. As described above, the parameters F and K are determined every capacity (power) of a compressor being used or every maker of the compressor, and thus the reference current value I_d is more excellently used as a parameter to cancel the defrosting operation as compared with the conventional air conditioner.

[0047] Fig. 4 is a graph showing variation of the calculation current value I_k (I_a , I_b , I_c) finally-stored in the second memory M2 and variation of the defrosting operation time t (t_a , t_b , t_c) of the compressor with respect to variation of the power source voltage V (V_a to V_c), and also Fig. 4 shows the reference current value (I_{da} to I_{dc}) for the calculation of the defrosting operation which is calculated on the basis of the calculation current value I_k (I_a , I_b , I_c) and the power source voltage V (V_a , V_b , V_c) by the calculation equation of the flow chart (S11) of Fig. 2.

[0048] The variation of the power source value V contains not only a case where the power source value V to be supplied to the air conditioner is varied due to some cause, but also a case where the power source (commercial power source) is different among countries in which the same types of air conditioners are used.

[0049] As shown in Fig. 4, for example when the power source voltage V is varied in the ascending direction, the reference current value I_d is increased, so that the defrosting operation can be prevented from being canceled at an excessively early timing and thus the defrosting operation can be performed without residual frost. On the other hand, when the power source voltage V is varied in the descending direction, the reference current value is reduced, so that the defrosting operation

can be prevented from being canceled at an excessively late timing and thus the excessively defrosting operation can be prevented.

[0050] In the above embodiment, it is preferable that the compressor used in the air conditioner is a constant-rate type compressor. Further, in the above embodiment, two kinds of parameters F and K are used to determine the timing of the cancellation of the defrosting operation. However, the number of parameters is not limited to two, and it may be three or more to more enhance the accuracy of the timing of the cancellation of the defrosting operation. In this case, the calculation equation is replaced by an improved calculation equation.

[0051] In the above embodiment, the defrosting operation canceling method of the present invention is applied to an air conditioner. However, the present invention is not limited to the air conditioner, and it may be applied to any apparatus having a compressor and a defrosting function such as a refrigerating machine, a refrigerator or the like.

[0052] As described above, according to the present invention, the current value of the compressor during the defrosting operation is detected, and the reference current value for the cancellation of the defrosting operation is determined on the basis of the current value thus detected. After the reference current value is determined, the driving current of the compressor is detected, and the driving current is compared with the reference current value. If the driving current value is larger than the reference current value, the defrosting operation is canceled. Accordingly, the defrosting operation can be properly canceled while preventing occurrence of residual frost and the excessive defrosting.

[0053] Further, according to the present invention, the cancellation of the defrosting operation which can support a broad power source voltage range can be performed with no indoor temperature sensor, no indoor heat exchanger temperature sensor and no outdoor heat exchanger temperature sensor and without measuring the power source voltage.

Claims

1. An air conditioner having a compressor and a defrosting function, comprising:

a detector for detecting a driving current value applied to the compressor under defrosting operation; and

a controller for calculating a reference current value for cancellation of the defrosting operation on the basis of the driving current value of the compressor detected by said detector, and judging, whether the defrosting operation should be canceled or not, on the basis of the comparison between the reference current value

and a driving current value of the compressor that is detected after the calculation of the reference current value.

2. The air conditioner as claimed in claim 1, wherein said controller cancels the defrosting operation when the driving current of the compressor detected after the calculation of the reference current value is not less than the reference current value.
3. The air conditioner as claimed in claim 1, wherein said controller includes a memory for storing parameters in advance, and said controller calculates the reference current value on the basis of the driving current value of the compressor detected under the defrosting operation and the parameters stored in said memory by using a predetermined calculation equation.
4. The air conditioner as claimed in claim 3, wherein plural sets of parameters which are usable in the calculation equation for the cancellation of the defrosting operation are prepared and stored in said memory, and any one set of parameters is selected from the plural sets to achieve the reference current value which is most suitable for the compressor being used.
5. The air conditioner as claimed in claim 3, wherein the reference current value is calculated on the following equation:

$$I_d = I_k + (F - I_k) \times K,$$

wherein I_d represents the reference current value, F and K represent the set of parameters and I_k represents the minimum driving current value of the compressor in driving current values of the compressor that are detected for a predetermined time period.

6. A method of canceling defrosting operation for an air conditioner, comprising the steps of:

detecting a driving current value of the compressor under defrosting operation;
calculating a reference current value for cancellation of the defrosting operation on the basis of the driving current value of the compressor detected in said detecting step and a set of parameters;
judging, whether the defrosting operation should be canceled or not, on the basis of the comparison between the reference current value and the driving current value of the compressor that is detected after the calculation of the reference current value.

7. The method as claimed in claim 6, further comprising a canceling step of canceling the defrosting operation when it is judged in said judging step that the driving current of the compressor detected after the calculation of the reference current value is not less than the reference current value. 5

8. The method as claimed in claim 6, wherein the reference current value is calculated on the following equation: 10

$$I_d = I_k + (F - I_k) \times K,$$

wherein I_d represents the reference current value, 15
 F and K represent the set of parameters and I_k represents the minimum driving current value of the compressor in driving current values of the compressor that are detected for a predetermined time period. 20

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FIG. 1

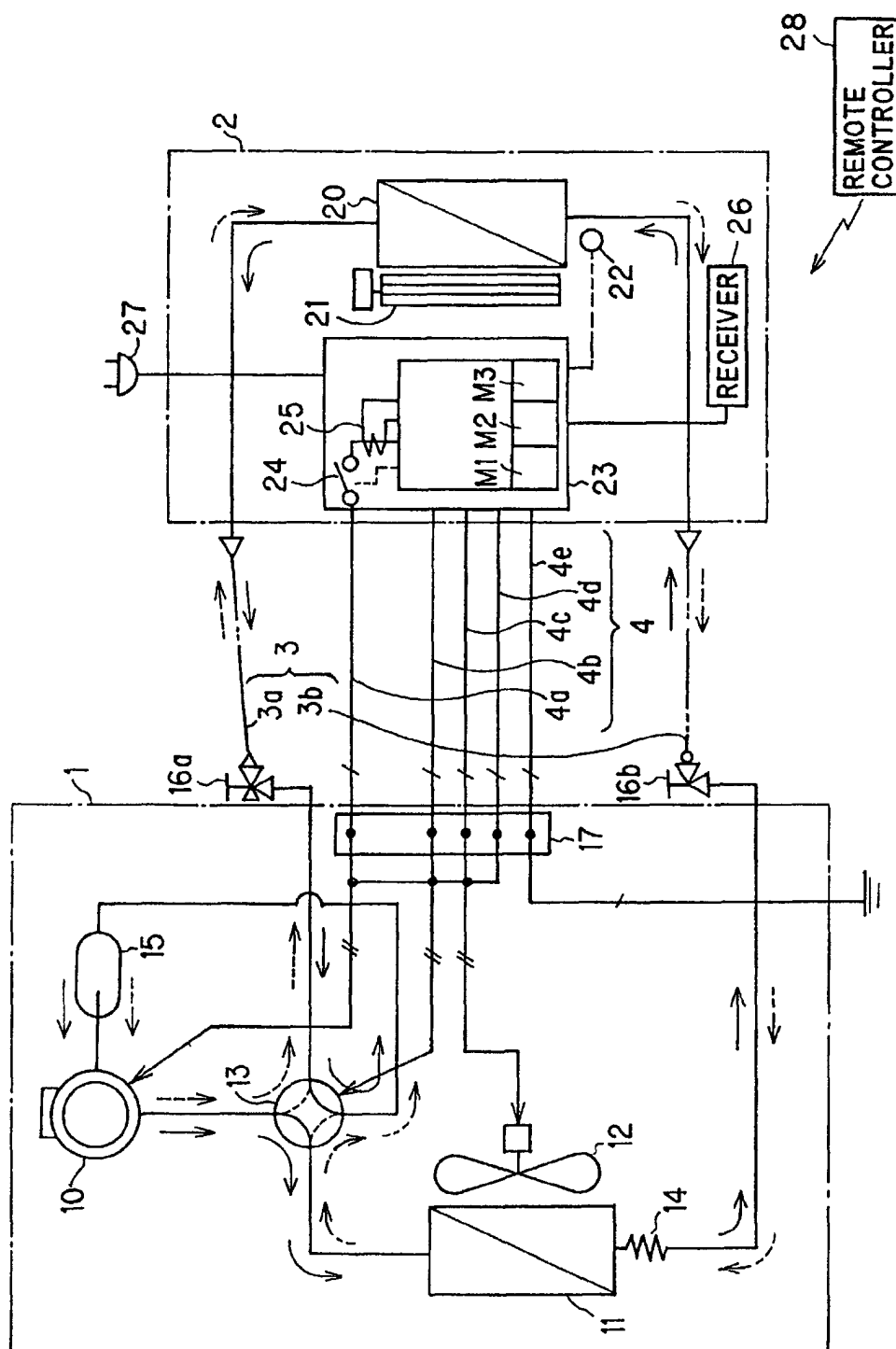


FIG. 2

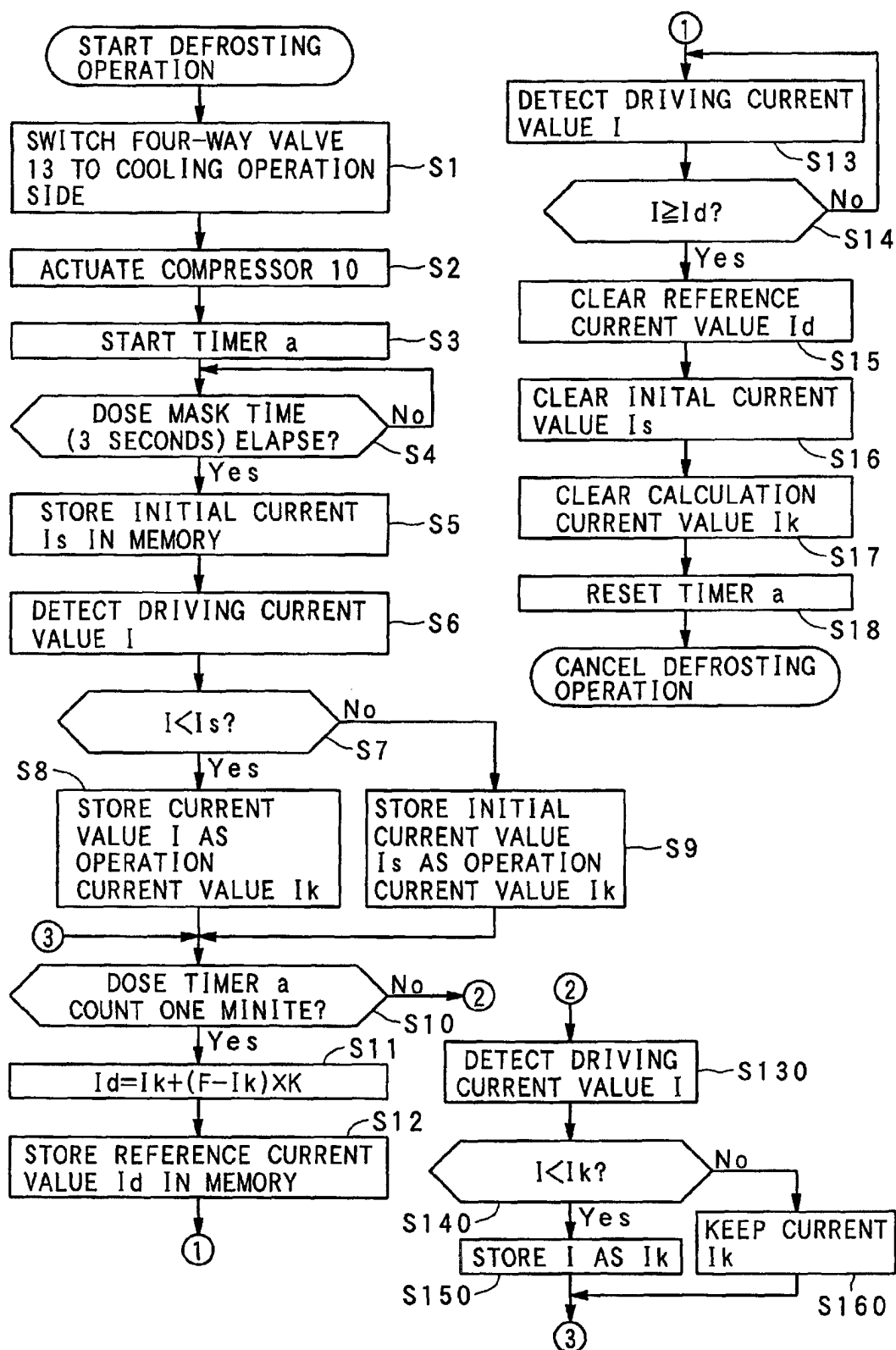
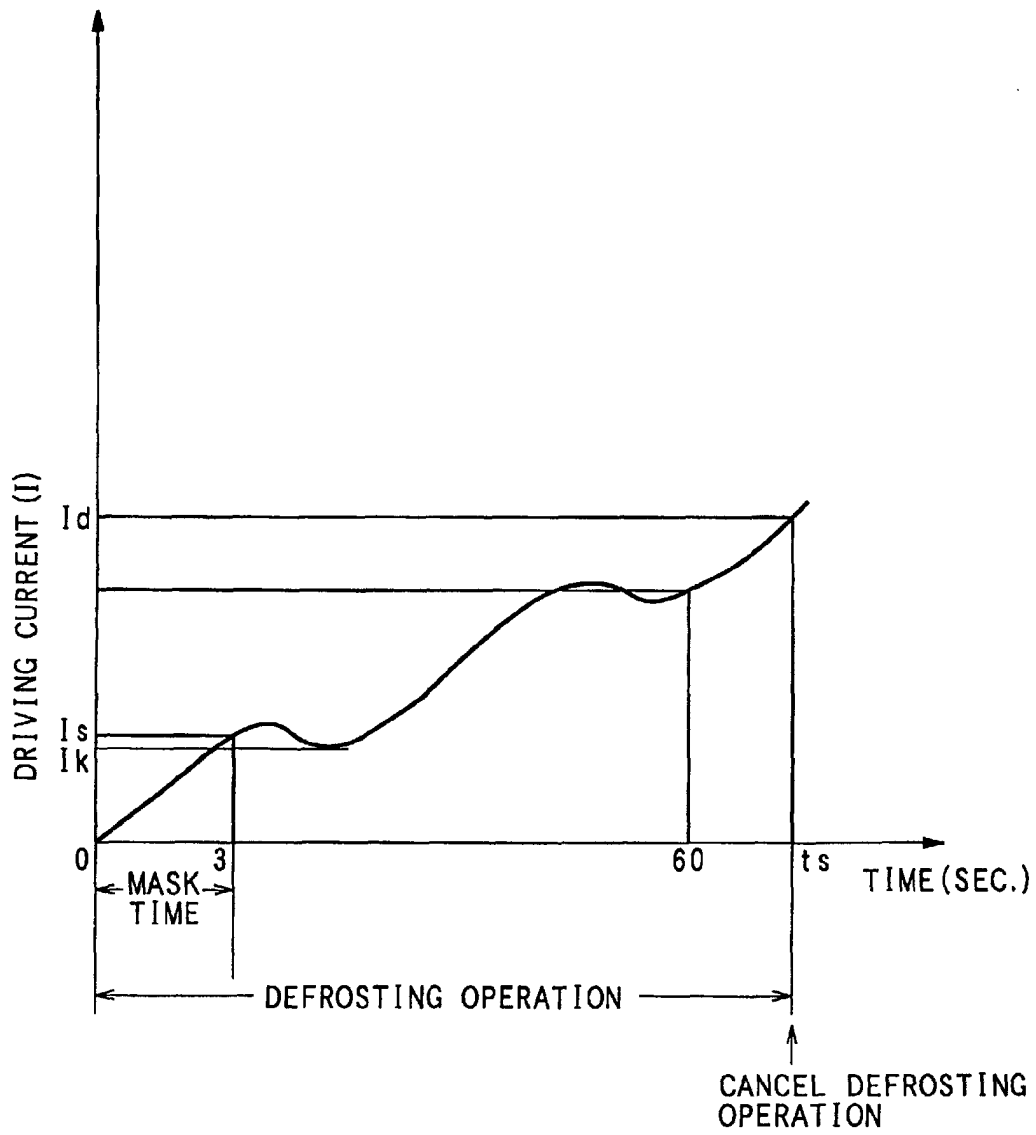
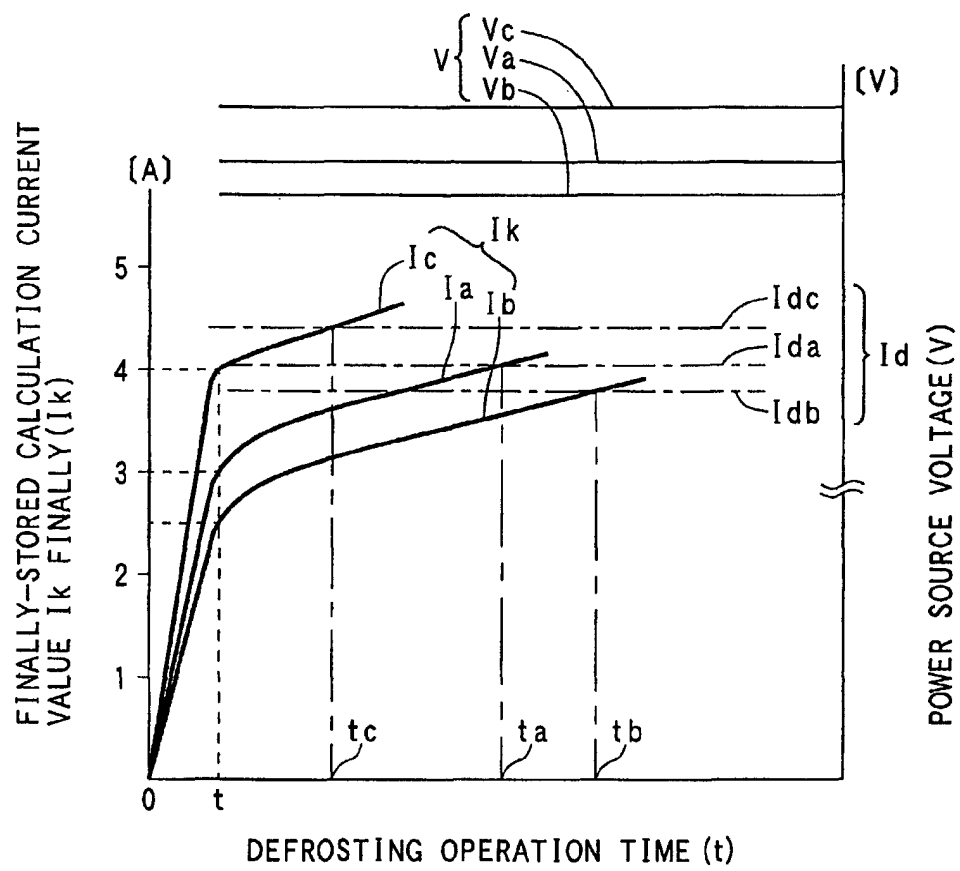


FIG. 3



$$I_d = I_k + (F - I_k) \times K$$

FIG. 4





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EUROPEAN SEARCH REPORT

Application Number
EP 02 01 3979

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	FR 2 379 037 A (CARRIER CORP) 25 August 1978 (1978-08-25) * page 3, line 23 - line 26 * * page 4, line 20 - line 34 * * page 6, line 15 - line 28 * * page 8, line 17 - page 9, line 37 *	1-4, 6, 7	F25D21/00 F25B47/02
A	FR 2 553 184 A (CARRIER CORP) 12 April 1985 (1985-04-12) * the whole document *	1-8	
A	PATENT ABSTRACTS OF JAPAN vol. 1995, no. 10, 30 November 1995 (1995-11-30) & JP 07 174440 A (FUJITSU GENERAL LTD), 14 July 1995 (1995-07-14) * abstract *	1-8	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			F25D F25B
The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 3 September 2002	Examiner Ritter, C
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/82 (P04/C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 02 01 3979

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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03-09-2002

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
FR 2379037	A	25-08-1978	US	4104888 A	08-08-1978
			AR	224229 A1	13-11-1981
			AU	509718 B2	22-05-1980
			AU	3276178 A	02-08-1979
			BR	7800555 A	12-09-1978
			EG	13085 A	31-07-1980
			ES	466475 A1	16-10-1978
			ES	469744 A1	01-01-1979
			FR	2379037 A1	25-08-1978
			GB	1595741 A	19-08-1981
			GR	66406 A1	20-03-1981
			IN	149162 A1	26-09-1981
			IT	1092018 B	06-07-1985
			JP	1284158 C	27-09-1985
			JP	53096548 A	23-08-1978
			JP	60009221 B	08-03-1985
			NZ	186181 A	11-02-1981
			SU	1179948 A3	15-09-1985
			TR	20249 A	02-12-1980
			YU	19578 A1	30-06-1982
			ZA	7707429 A	25-10-1978
FR 2553184	A	12-04-1985	US	4494382 A	22-01-1985
			FR	2553184 A1	12-04-1985
			JP	60082757 A	10-05-1985
JP 07174440	A	14-07-1995	NONE		

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82