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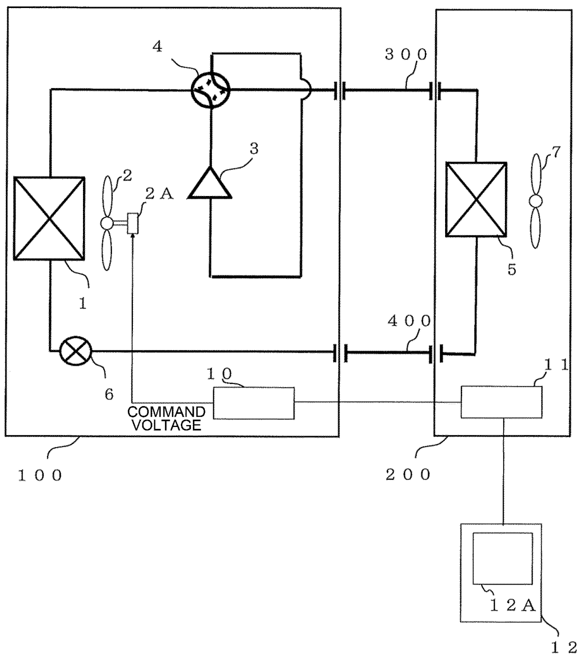
(54) AIR CONDITIONER

(57) An air-conditioning apparatus in accordance with the present disclosure includes a heat exchanger, a fan, and a controller. The heat exchanger causes heat exchange to be performed between a medium that transfers heat, and air. The fan sends air to the heat exchanger. The controller determines whether clogging due to foreign matter has occurred in the heat exchanger, based on a command voltage varying in accordance with the rotation speed of a fan motor that drives the fan.

FIG. 1



EP 3 792 563 A1

Description

Technical Field

[0001] The present disclosure relates to an air-conditioning apparatus. In particular, the present disclosure relates to prediction of clogging of a heat exchanger provided in an outdoor unit.

Background Art

[0002] In the outdoor unit used in the heat pump refrigeration cycle device, during the heating operation, frost may often be formed on a heat exchanger, and, as a result, the passage of the air through the heat exchanger is narrowed by frosting, resulting in reduction in capacity. Hereinafter, narrowing and blocking of the air passage through the heat exchanger due to frost formation on the heat exchanger will be referred to as frosting. To prevent a decrease in capacity due to frosting, it is necessary to perform a defrosting operation to remove frost formed on the heat exchanger. Hitherto, whether to perform the defrosting operation is determined by utilizing the temperature detected by a temperature sensor attached to the outdoor heat exchanger. Determination based on temperature alone, however, may often result in determining that a defrosting operation is to be performed even when there is no frosting. If the defrosting operation is performed frequently, the operation efficiency of a refrigeration cycle apparatus is lowered. Under such circumstances, a technique has been proposed that whether frosting has occurred or not is determined based on a command voltage for controlling the rotation speed which is the rotation speed of the fan motor in the outdoor fan for sending air to the outdoor heat exchanger (see, for example, Patent Literature 1). Generally, there is a relationship that, when the amount of frost formed on the outdoor heat exchanger is increased, the load for fan rotation is increased, whereby the command voltage is increased. Based on this relationship, with the technique described in Patent Literature 1, if the command voltage exceeds a defrost determination threshold previously set to determine whether defrosting is required to be performed, it is assumed that the amount of frost formed has become equal to or greater than a predetermined value, and then a defrosting operation is performed.

Citation List

Patent Literature

[0003] Patent Literature 1: International Publication No. 2016/084139

Summary of Invention

Technical Problem

[0004] Thus, in the technique described in Patent Literature 1, occurrence of frosting is determined based on the command voltage for controlling the rotation speed of a fan motor of the outdoor unit. However, the command voltage for controlling the rotation speed of the fan motor in the outdoor unit is also increased by clogging caused by foreign matter such as dust in the outdoor heat exchanger.

[0005] When frosting occurs in an outdoor heat exchanger being clogged due to foreign matter such as dust, the time to reach the defrosting determination threshold is shortened. Even if the defrosting operation is performed, since the foreign matter is not removed from the outdoor heat exchanger, clogging is not eliminated, and hence, frosting occurs again in the clogged state. Therefore, if there is clogging due to foreign matter, the interval of the defrosting operation is shortened since more frequent defrosting operations are performed, whereby the operation efficiency of a refrigeration cycle device is reduced. Therefore, it is desirable to be able to deal with clogging caused by foreign matter at an early stage.

Solution to Problem

[0006] In order to solve the problem mentioned above, the present disclosure is aimed at obtaining an air-conditioning apparatus that can deal with clogging of a heat exchanger due to foreign matter at an early stage.

[0007] To attain the above-mentioned object, the air-conditioning apparatus in accordance with an embodiment of the present disclosure includes a heat exchanger, a fan, and a controller. The heat exchanger causes heat exchange to be performed between a medium that transfers heat, and air. The fan sends air to the heat exchanger. The controller determines whether clogging due to foreign matter has occurred in the heat exchanger, based on a command voltage varying in accordance with the rotation speed of a fan motor that drives the fan.

Advantageous Effects of Invention

[0008] According to the present disclosure, if, during the set time after starting the operation of the air-conditioning apparatus, the command voltage is equal to or greater than a clogging determination threshold, it is determined that clogging of a heat exchanger due to foreign matter has occurred. As a result, clogging of a heat exchanger due to foreign matter can be coped with at an early stage. Brief Description of Drawings

[0009]

[Fig. 1] Fig. 1 illustrates the configuration of an air-conditioning apparatus in accordance with Embodiment 1 of the present disclosure.

[Fig. 2] Fig. 2 illustrates an exemplary configuration of an outdoor control device 10 in accordance with Embodiment 1 of the present disclosure.

[Fig. 3] Fig. 3 explains a clogging determination performed by a determination unit 10B in accordance with Embodiment 1 of the present disclosure.

[Fig. 4] Fig. 4 explains the procedure for a clogging determination performed by the outdoor control device 10 in accordance with Embodiment 1 of the present disclosure.

[Fig. 5] Fig. 5 illustrates an example of how a command voltage for a fan motor 2A of the air-conditioning apparatus changes with time in accordance with Embodiment 2 of the present disclosure.

[Fig. 6] Fig. 6 explains the procedure for a clogging determination performed by the outdoor control device 10 in accordance with Embodiment 2 of the present disclosure.

[Fig. 7] Fig. 7 illustrates an example of how a command voltage for the fan motor 2A of the air-conditioning apparatus changes with time in accordance with Embodiment 3 of the present disclosure.

Description of Embodiments

Embodiment 1

[0010] Fig. 1 illustrates a configuration of an air-conditioning apparatus according to Embodiment 1 of the present disclosure. As shown in Fig. 1, the air-conditioning apparatus of Embodiment 1 is a refrigeration cycle apparatus including a refrigeration circuit configured by connecting an outdoor unit 100 and an indoor unit 200 with a gas refrigerant pipe 300 and a liquid refrigerant pipe 400. In the air-conditioning apparatus of Embodiment 1, one outdoor unit 100 and one indoor unit 200 are connected. The air-conditioning apparatus of Embodiment 1 can switch between a cooling operation for cooling the room, which is the space to be air-conditioned, and a heating operation for heating the room.

[0011] The indoor unit 200 according to Embodiment 1 includes an indoor heat exchanger 5 and an indoor fan 7. The indoor heat exchanger 5 causes heat exchange to be performed between the indoor air, which is air in an air-conditioned space, and refrigerant. For example, it functions as a condenser during the heating operation to condense and liquefy the refrigerant. Also, during the cooling operation and the defrosting operation, it functions as an evaporator to evaporate and vaporize the refrigerant. The indoor fan 7 allows the air in the room to pass through the indoor heat exchanger 5, and supplies the air that has passed through the indoor heat exchanger 5 into the room.

[0012] Further, the indoor unit 200 has an indoor control device 11 and a remote control 12 as control-related devices. The indoor control device 11 controls devices such as the indoor fan 7 of the indoor unit 200. Here, in Embodiment 1, the indoor control device 11 relays communication between the outdoor control device 10 and the remote control 12. The remote control 12 has an input device (not shown), and sends a signal including instructions, settings, etc. input by the user to the indoor control device 11. Further, the remote control 12 includes the display device 12A to perform, for example, display of information based on the signal sent from the outdoor control device 10. In Embodiment 1, the indoor control device 11 and the remote control 12 have different configurations, but the indoor control device 11 and the remote control 12 may be integrated such that the remote control 12 has the device control function of the indoor control device 11.

[0013] On the other hand, the outdoor unit 100 has a compressor 3, a four-way valve 4, an electronic expansion valve 6, an outdoor heat exchanger 1 and an outdoor fan 2. The compressor 3 compresses the suctioned refrigerant and discharges the compressed refrigerant. Although not particularly limited, as for the compressor 3 of Embodiment 1, the capacity thereof (amount of refrigerant discharged per unit time) can be changed by arbitrarily changing an operating frequency by, for example, an inverter circuit. The four-way valve 4 is, for example, a valve that switches the flow of the refrigerant between the cooling operation and the heating operation. Further, the electronic expansion valve 6 such as a throttle device adjusts the opening degree based on an instruction from an outdoor control device 10 described later to decompress and expand the refrigerant. The outdoor heat exchanger 1 causes heat exchange to be performed between the refrigerant and air (outdoor air). For example, during the heating operation, it functions as an evaporator to evaporate and vaporize the refrigerant. Further, it functions as a condenser during the cooling operation and the defrosting operation to condense and liquefy the refrigerant. The outdoor fan 2 allows the outdoor air to pass through the outdoor heat exchanger 1 to promote heat exchange in the outdoor heat exchanger 1. A fan motor 2A of the outdoor fan 2 is driven at a rotation speed based on a command voltage sent from an outdoor control device 10 described later to adjust the air volume. The outdoor control device 10 controls devices inside the outdoor unit 100. The outdoor control device 10 will be described later.

[0014] Here, the operation of the air-conditioning apparatus will be explained. First, the flow of refrigerant during the heating operation in the air-conditioning apparatus will be explained. Refrigerant in the high-pressure, high-temperature gaseous state discharged from the compressor 3 flows into the indoor heat exchanger 5 through the four-way valve 4. In the indoor heat exchanger 5, by condensing through heat exchange with the indoor air supplied by the indoor fan 7, the refrigerant is turned to be refrigerant in the high-pressure liquid state, and flows out from the indoor heat exchanger 5. The refrigerant in the high-pressure liquid state flowing out of the indoor heat exchanger 5 flows into the electronic expansion valve 6, and is turned to be refrigerant in the low-pressure two-phase gas-liquid state. The refrigerant in the low-pressure two-phase gas-liquid state flowing out from the electronic expansion valve 6 flows into the outdoor heat exchanger 1, is turned to be the refrigerant in the low-pressure gaseous state by evaporating through heat exchange with the outside air supplied by the outdoor fan 2, and then flows out from the outdoor heat exchanger 1. The refrigerant in the low-pressure gaseous state flowing out from the outdoor heat exchanger 1 is suctioned into the compressor 3 through the four-way valve 4.

[0015] Next, the flow of refrigerant at the time of cooling operation in the air-conditioning apparatus will be described. The refrigerant in the high-pressure, high-temperature gaseous state discharged from the compressor 3 flows into the outdoor heat exchanger 1 via the four-way valve 4. Then, by condensing through heat exchange with the outside air supplied by the outdoor fan 2, the refrigerant is turned to be refrigerant in the high-pressure liquid state, and then flows out from the outdoor heat exchanger 1. The refrigerant in the high-pressure liquid state flowing out of the outdoor heat exchanger 1 flows into the electronic expansion valve 6, and is turned to be refrigerant in the low-pressure two-phase gas-liquid state. The refrigerant in the low-pressure two-phase gas-liquid state flowing out of the electronic expansion valve 6 flows into the indoor heat exchanger 5. The refrigerant is then turned to be refrigerant in the low-pressure gas state by evaporating through heat exchange with the indoor air supplied by the indoor fan 7, and flows out from the indoor heat exchanger 5. The refrigerant in the low-pressure gaseous state flowing out of the indoor heat exchanger 5 is suctioned to the compressor 3 through the four-way valve 4.

[0016] Fig. 2 illustrates an exemplary configuration of an outdoor control device 10 in accordance with Embodiment 1 of the present disclosure. As described above, the outdoor unit 100 in Embodiment 1, as a control-related device, has an outdoor control device 10. The outdoor control device 10 of Embodiment 1 has, as shown in Fig. 2, a device control unit 10A, a determination unit 10B, a calculation unit 10C, a communication unit 10D, and a storage unit 10E. The device control unit 10A controls devices associated with the air-conditioning apparatus, such as the compressor 3, an electronic expansion valve 6, and the outdoor fan 2. The device control unit 10 particularly performs control of the devices included in the outdoor unit 100. Control of the devices is performed based on an instruction such as a set temperature issued from the remote control 12. The determination unit 10B performs a determination process. In Embodiment 1, as will be described later, when starting the operation of the air-conditioning apparatus, it performs a determination process relating to clogging. The calculation unit 10C performs a calculation process necessary for the determination and the like performed by the determination unit 10B. The communication unit 10D performs a process relating to signal communication performed between the indoor control device 11. In Embodiment 1, in particular, the communication unit 10D sends a signal to cause the clogging determination result to be displayed on the remote control 12. The storage unit 10E stores, either temporarily or on a long-term basis, various data required for various units of the outdoor control device 10 to perform a process. The communication unit 10D also stores data or other information obtained as a result of computation or other as performed by the calculation unit 10C.

[0017] The outdoor control unit 10 includes a microcomputer. The microcomputer includes, for example, a control processing unit such as a CPU (Central Processing Unit). The control processing unit implements the respective functions of the device control unit 10A, the determination unit 10B and the calculation unit 10C. Further, the outdoor control unit also has, for example, a volatile storage device (not shown) such as a random access memory (RAM) for temporarily storing data and a non-volatile auxiliary storage device (not shown) such as a hard disk and a flash memory for long-term storage of data. These storage devices implement the function of the storage unit 10E. For example, the storage device includes data in which the processing procedure performed by the control processing unit is programmed. The control processing unit executes a process based on the data of the program to thereby implement a calculation, a determination, or other processes performed by various units of the outdoor control device 10. However, this is not restrictive, and each unit may be implemented as a dedicated device (hardware).

[0018] The device control unit 10A of the outdoor control unit 10 of Embodiment 1, in the heating operation described above, in accordance with the current rotation speed of fan motor 2A in the outdoor fan 2 of the outdoor unit 100, performs a process of changing the command voltage. To be more specific, the device control unit 10A changes the command voltage so that the current rotation speed of the fan motor 2A becomes the target rotation speed set based on evaporating temperature or the like in the outdoor heat exchanger 1, and controls the rotation speed of the fan motor 2A. Here, the greater the command voltage, the larger the rotation speed of the fan motor 2A.

[0019] Fig. 3 explains a clogging determination performed by the determination unit 10B in accordance with Embodiment 1 of the present disclosure. As shown in Fig. 3, when the outdoor heat exchanger 1 of the outdoor unit 100 is clogged due to foreign matter, the load applied to the fan motor 2A increases. For this reason, the command voltage for the fan motor 2A becomes larger than the command voltage when the load in the normal state is applied. Here, as described above, the load applied to the fan motor 2A is increased even when frosting occurs. However, it is unlikely that a load due to frosting will occur immediately after the start of operation. Therefore, if the command voltage of the fan motor 2A exceeds the set threshold value for a preset set time t after the start of the operation of the air-conditioning apparatus, it can be determined that clogging due to foreign matter such as dust occurs.

[0020] Fig. 4 explains the procedure for a clogging determination performed by the outdoor control device 10 in accordance with Embodiment 1 of the present disclosure. Next, while referring to Fig. 4, the determination process relating to clogging due to foreign matter of the outdoor control device 10 will be described.

[0021] The device control unit 10A determines the target rotation speed of the fan motor 2A (step S11). Next, the device control unit 10A sets the command voltage so that the actual rotation speed of the fan motor 2A becomes the target rotation speed, rotates the fan motor 2A, and performs control (step S12).

[0022] The determination unit 10B determines whether or not the command voltage set by the device control unit 10A is equal to or greater than the clogging determination threshold value (step S13). The determination unit 10B, when the command voltage is determined not to be equal to or greater than the clogging determination threshold value, the process ends as clogging does not occur.

[0023] On the other hand, when it is determined that the command voltage is equal to or greater than the clogging determination threshold value, the determination unit 10B determines whether or not the clogging determination threshold value continues to be equal to or greater than the clogging determination threshold value continues for a set time t (step S14). If the determination unit 10B determines that such a state has not continued for the set time t, the process returns to step S13, and the determination is performed.

[0024] When the determination unit 10B determines that the clogging determination threshold is continued to be equal to or greater than the threshold set time t, the communication unit 10D transmits a signal indicating that clogging due to foreign matter has occurred to the remote control 12 (step S15). Based on the signal transmitted to the remote control 12, the remote control 12 displays, on the display device 12A of the remote control 12, characters, symbols, graphics, or other information indicating occurrence of clogging due to foreign matter, thus informing that clogging due to foreign matter has occurred.

[0025] As described above, with the outdoor unit 100 according to Embodiment 1, when it is determined that the command voltage is equal to or greater than the clogging determination threshold value during the set time t after the operation of the air-conditioning apparatus is started, clogging due to foreign matter is determined to have occurred. Therefore, it is possible to quickly deal with clogging due to foreign matter of the outdoor heat exchanger 1. The display device 12A of the remote control 12 displays the fact that clogging due to foreign matter has occurred, so that the clogging can be notified more quickly. Here, the determination unit 10B may continue the determination process based on the command voltage even after the set time t has elapsed, and may perform the determination process regarding frosting.

Embodiment 2

[0026] In Embodiment 1 described above, whether clogging due to foreign matter has occurred is determined at the start of operation of the air-conditioning apparatus. With the air-conditioning apparatus according to Embodiment 2, whether clogging has occurred is determined during operation of the air-conditioning apparatus.

[0027] Fig. 5 illustrates an example of how the command voltage for the fan motor 2A of the air-conditioning apparatus changes with time in accordance with Embodiment 2 of the present disclosure. Fig. 5 shows the operation of the air-conditioning apparatus when the outdoor heat exchanger 1 of the outdoor unit 100 is clogged due to foreign matter. At this time, the increase rate α of the command voltage in the fan motor 2A from the device control unit 10A tends to be larger as compared with the increase rate β of the command voltage for the fan motor 2A due to frosting.

[0028] Therefore, in the air-conditioning apparatus of Embodiment 2, based on the increase rate α of the command voltage for the fan motor 2A during operation, it is determined whether clogging due to foreign matter has occurred.

[0029] Fig. 6 explains the procedure for a clogging determination performed by the outdoor control device 10 in accordance with Embodiment 2 of the present disclosure. Next, while referring to Fig. 6, the determination process relating to clogging due to foreign matter of the outdoor control device 10 will be described.

[0030] The determination unit 10B determines, during the operation of the air-conditioning apparatus, whether the command voltage is increased (step S21). When the determination unit 10B determines that the command voltage is not increased, the determination unit 10B continues the determination in step S21. When the determination unit 10B determines that the command voltage is increased, the determination unit 10B determines whether the command voltage has stopped increasing (step S22). The determination unit 10B continues the determination until the command voltage stops increasing.

[0031] When the determination unit 10B determines that the command voltage has stopped increasing, the calculation unit 10C calculates the increase rate $\alpha 1$ of the command voltage in its increase period (step S23). The determination unit 10B determines whether or not the increase rate $\alpha 1$ calculated by the calculation unit 10C is equal to or greater than a preset increase rate determination threshold A (step S24). If the determination unit 10B determines that the rate of increase $\alpha 1$ is not equal to or greater than the rate of increase determination threshold A, the process returns to step S21.

[0032] On the other hand, when the determination unit 10B determines that the rate of increase $\alpha 1$ is equal to or greater than the increase rate determination threshold A, the determination unit 10B determines whether or not the state of increased command voltage after the stop of the increase continues for a preset set duration T or longer in step S25. When the determination unit 10B determines that the state of increased command voltage has continued for the set duration T or longer, the communication unit 10D transmits, to the remote control 12, a signal indicating that clogging due to foreign matter has occurred (step S26). Based on the signal transmitted to the remote control 12, the remote control 12 displays information on the display device 12A of the remote control 12 to inform that clogging due to foreign matter has occurred. If the determination unit 10B determines that the state of increased command voltage has not continued for the set duration T or more, the determination unit 10B returns to step S21.

[0033] As described above, according to the air-conditioning apparatus of Embodiment 2, during operation, the outdoor control device 10 determines whether clogging has occurred based on the rate of increase α of the command voltage and the set duration T for which the state of increased command voltage continues after the increase stops. Then, the display device 12A of the remote control 12 displays information indicating that clogging due to foreign matter has occurred. As a result, it is possible to determine occurrence of clogging due to foreign matter even during the operation of air-conditioning apparatus, whereby clogging of the outdoor heat exchanger 1 can be coped with at an early stage.

Embodiment 3

[0034] In Embodiment 1, the determination was made at the beginning of the operation of the air-conditioning apparatus. Further, in Embodiment 2, the determination was made based on the rate of increase of the command voltage during the operation of the air-conditioning apparatus. In Embodiment 3, the determination threshold value is set for determining whether clogging due to foreign matter has occurred or not based on the command voltage during the operation of the air-conditioning apparatus.

[0035] Fig. 7 illustrates an example of how the command voltage for the fan motor 2A of the air-conditioning apparatus changes with time in accordance with Embodiment 3 of the present disclosure. As illustrated in Fig. 7, in Embodiment 3, an operating time t1 under normal condition multiplied by a ratio K of allowable decrease in operating time is defined as the operating time $K \times t2$ when clogging has occurred. As described above, when clogging has occurred, the interval of time until a defrosting operation is performed becomes shorter than that when the air-conditioning apparatus is operating under normal condition. The ratio K of allowable decrease in operating time refers to the allowable range of decrease in operating time due to clogging. Further, the difference between the operating time under normal condition and the operating time under clogged condition, multiplied by the maximum rate of increase βmax of the command voltage for the fan motor 2A due to frosting, is defined as a clogging threshold Vo associated with clogging due to foreign matter. The above relationships are expressed by mathematical formula (1) given below. With a smaller decrease ratio K, a more accurate determination can be made, although a longer period of time is taken until the clogging determination is made.

[Math.1]

$$\text{Clogging threshold Vo} = (\text{maximum rate of increase } \beta\text{max of command voltage due to frosting}) \times (\text{difference in operating time } (1\text{-}K) \times t2 \text{ between normal and clogging conditions}) \qquad (1)$$

[0036] The determination unit 10B of the outdoor control device 10 determines, based on the clogging threshold Vo, whether clogging due to foreign matter has occurred by comparing with the command voltage of the fan motor 2A during the operation of the air-conditioning apparatus.

[0037] As described above, in the air-conditioning apparatus of Embodiment 3, during operation, based on the command voltage sent to the fan motor 2A of the outdoor fan 2, the determination unit 10B of the outdoor control device 10 can more accurately determine occurrence of clogging due to foreign matter. Clogging can also be predicted by making the threshold condition strict by using the decrease ratio K.

Embodiment 4

[0038] In Embodiments 1 to 3 described above, determination was made on occurrence of clogging due to foreign matter of the outdoor heat exchanger 1 in the outdoor unit 100, but it is not restrictive. A determination of whether clogging due to foreign matter has occurred can be made also for the indoor heat exchanger 5 of the indoor unit 200 based on the air flow rate of the indoor fan 7 or other information.

[0039] In Embodiments 1 to 3, the air-conditioning apparatus has been described on the assumption that it includes a refrigeration circuit for circulating refrigerant, but it is not restrictive. For example, the above-described determination can be applied to clogging due to foreign matter in a heat exchanger that causes heat exchange to be performed between a medium other than refrigerant and is capable of transferring heat. Reference Signs List

[0040] 1 outdoor heat exchanger 2 outdoor fan 2A fan motor 3 compressor 4 four-way valve 5 indoor heat exchanger 6 electronic expansion valve 7 indoor fan 10 outdoor control device 10A component control unit 10B determination unit 10C calculation unit 10D communication unit 10E storage unit 11 indoor control device 12 remote control 12A display device 100 outdoor unit 200 indoor unit 300 gas refrigerant pipe 400 liquid refrigerant pipe.

Claims

1. An air-conditioning apparatus comprising:

a heat exchanger configured to cause heat exchange to be performed between a medium and air, the medium being a medium to transfer heat;
a fan configured to send the air to the heat exchanger; and
a controller configured to determine whether clogging due to foreign matter has occurred in the heat exchanger, based on a command voltage varying in accordance with a rotation speed of a fan motor that drives the fan.

2. The air-conditioning apparatus of claim 1, wherein, in response to determining that the command voltage sent to the fan motor is equal to or greater than a set clogging determination threshold for a set time after start of operation of the air-conditioning apparatus, the controller determines that the clogging due to foreign matter has occurred.

3. The air-conditioning apparatus of claim 1 or 2, wherein, in response to determining that a rate of increase of the command voltage during execution of operation of the air-conditioning apparatus is equal to or greater than a set increase rate determination threshold, and that an increased state of the command voltage after the increase stops continues for a set duration, the controller determines that the clogging due to foreign matter has occurred.

4. The air-conditioning apparatus of claim 1 or 2, wherein the controller determines whether the clogging due to foreign matter has occurred based on a comparison between the command voltage sent during execution of operation of the air-conditioning apparatus and the clogging threshold being set based on a rate of increase of the command voltage associated with frosting.

5. The air-conditioning apparatus of any one of claims 1 to 4, comprising a display device configured to display information based on a signal,
wherein in response to determining that the clogging due to foreign matter has occurred, the controller transmits the signal to the display device to display an indication that the clogging due to foreign matter has occurred.

6. The air-conditioning apparatus of any one of claims 1 to 5, wherein the controller further determines, based on the command voltage, whether frosting has occurred.

FIG. 1

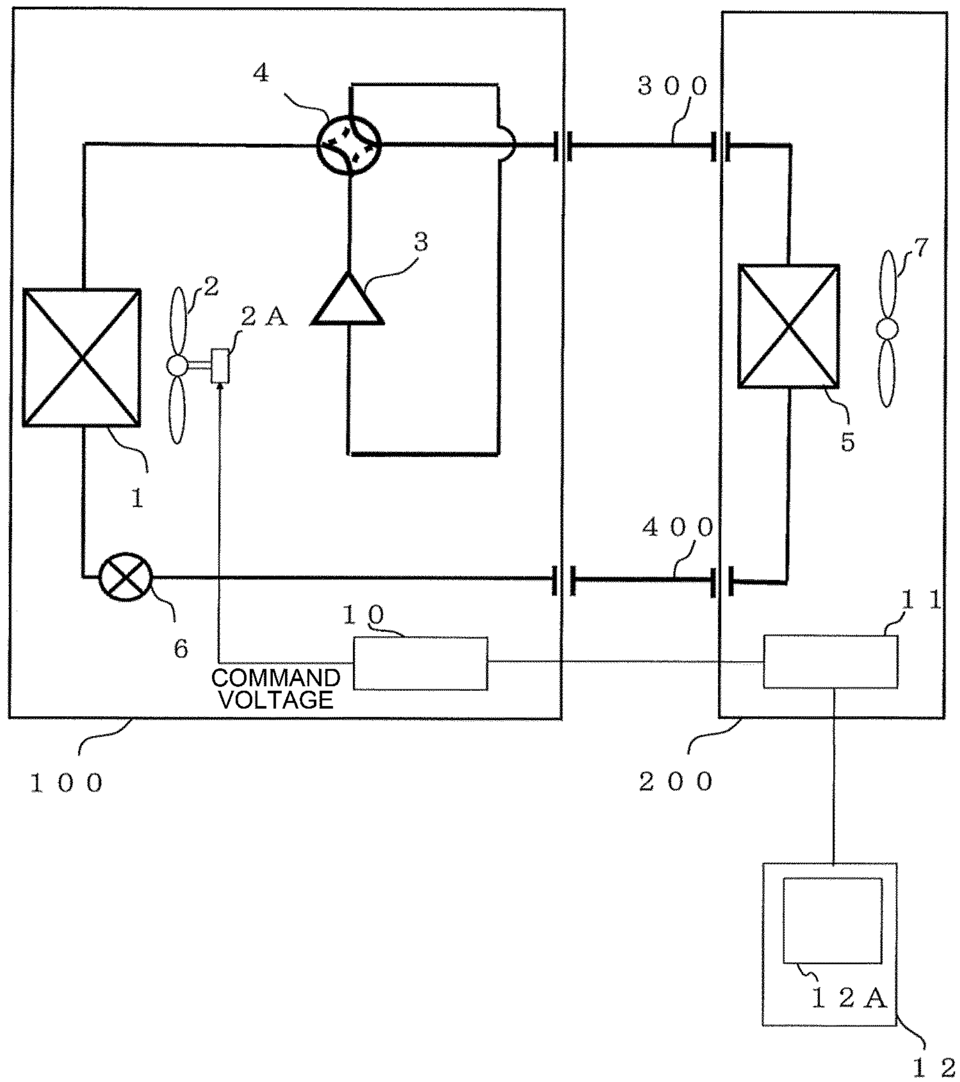


FIG. 2

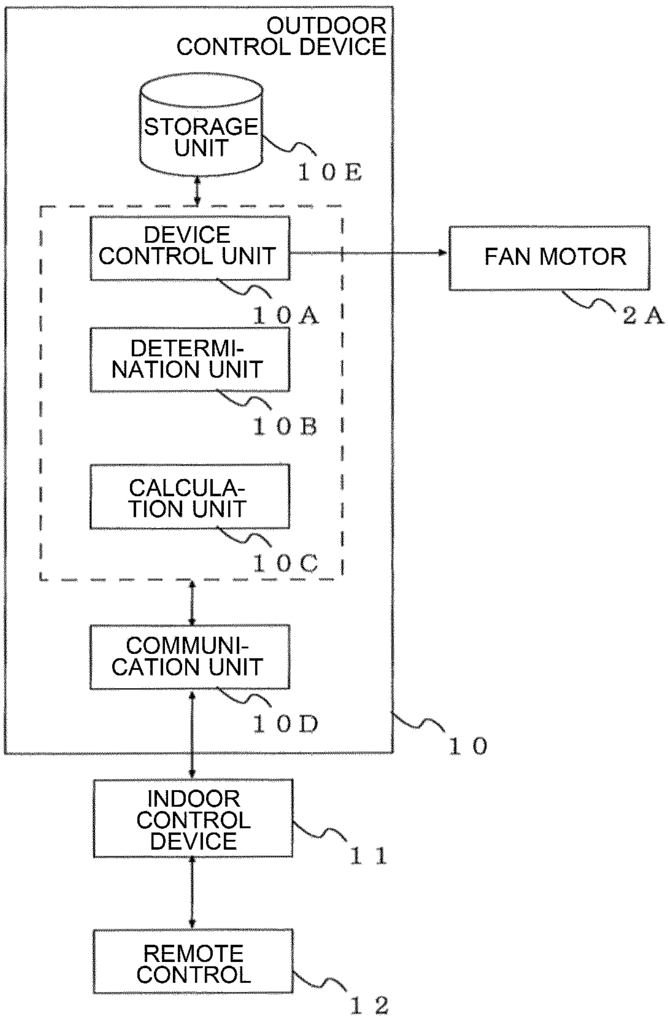

OUTDOOR
CONTROL DEVICE
STORAGE
UNIT
10E
DEVICE
CONTROL UNIT
10A
FAN MOTOR
2A
DETERMI-
NATION UNIT
10B
CALCULA-
TION UNIT
10C
COMMUNI-
CATION UNIT
10D
10
INDOOR
CONTROL
DEVICE
11
REMOTE
CONTROL
12

FIG. 3

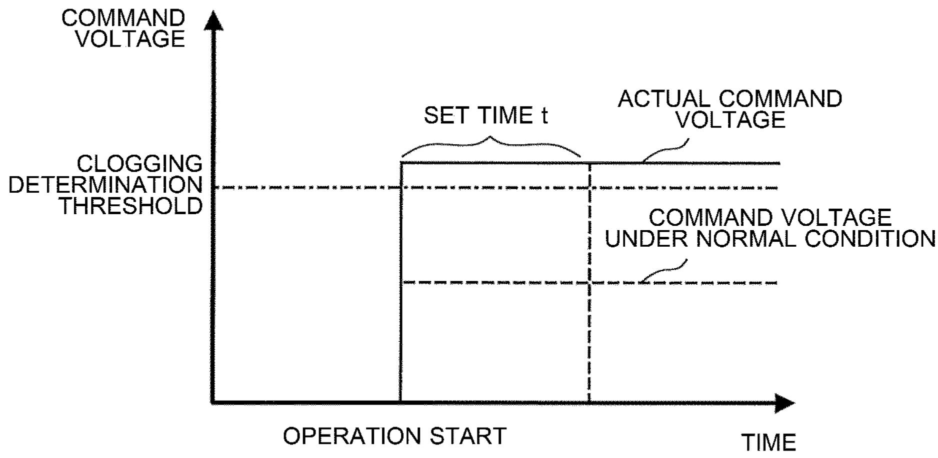

COMMAND
VOLTAGE
SET TIME t
ACTUAL COMMAND
VOLTAGE
CLOGGING
DETERMINATION
THRESHOLD
COMMAND VOLTAGE
UNDER NORMAL CONDITION
OPERATION START
TIME

FIG. 4

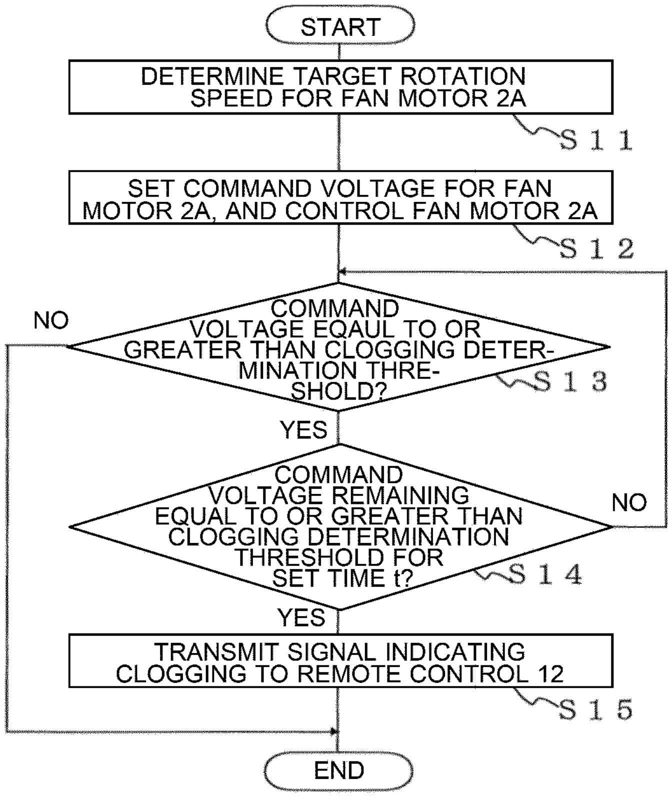

START
DETERMINE TARGET ROTATION SPEED FOR FAN MOTOR 2A
S11
SET COMMAND VOLTAGE FOR FAN MOTOR 2A, AND CONTROL FAN MOTOR 2A
S12
COMMAND VOLTAGE EQAUL TO OR GREATER THAN CLOGGING DETER-MINATION THRE-SHOLD?
S13
NO
YES
COMMAND VOLTAGE REMAINING EQUAL TO OR GREATER THAN CLOGGING DETERMINATION THRESHOLD FOR SET TIME t?
S14
NO
YES
TRANSMIT SIGNAL INDICATING CLOGGING TO REMOTE CONTROL 12
S15
END

FIG. 5

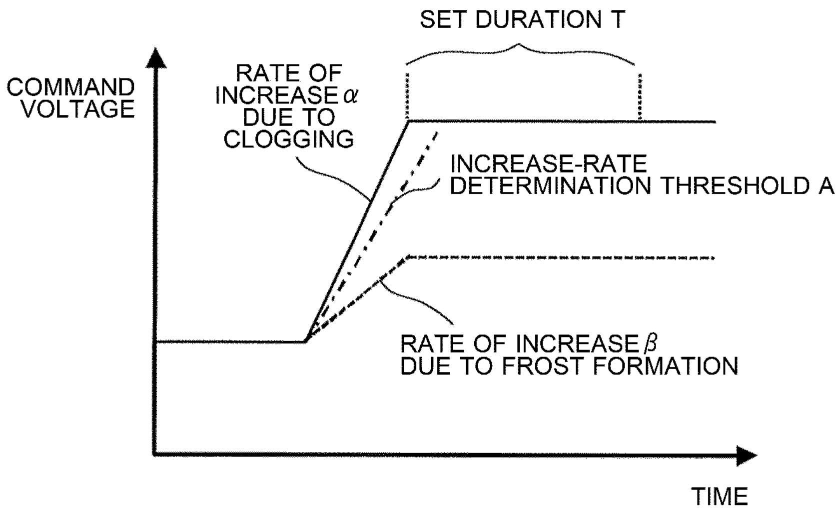

SET DURATION T
COMMAND VOLTAGE
RATE OF INCREASE α DUE TO CLOGGING
INCREASE-RATE DETERMINATION THRESHOLD A
RATE OF INCREASE β DUE TO FROST FORMATION
TIME

FIG. 6

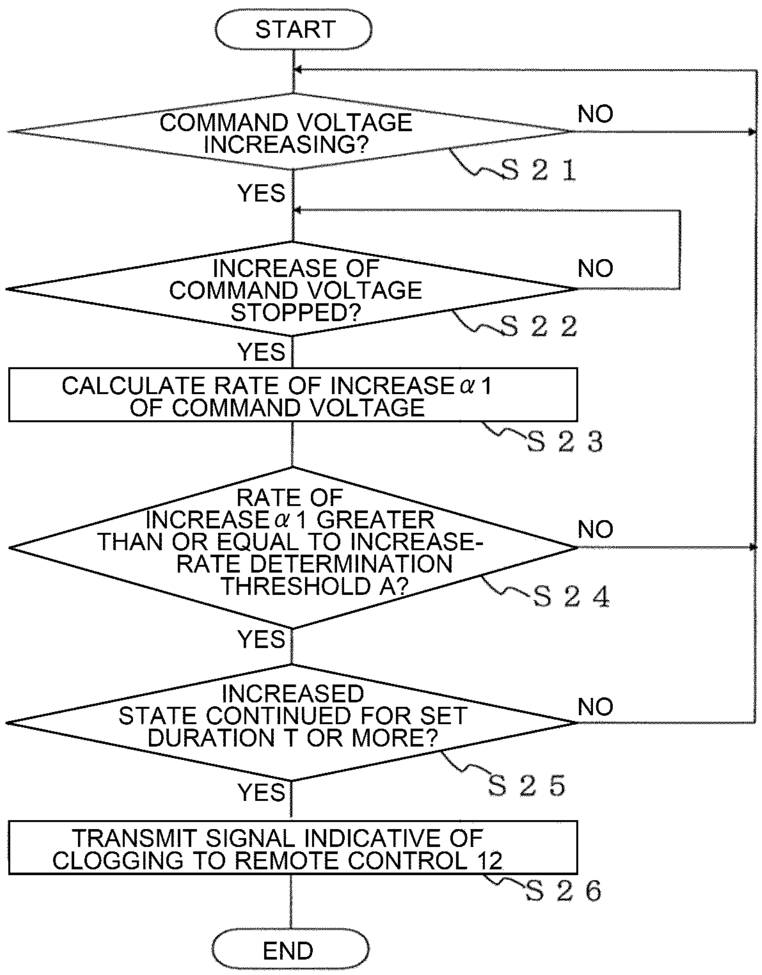
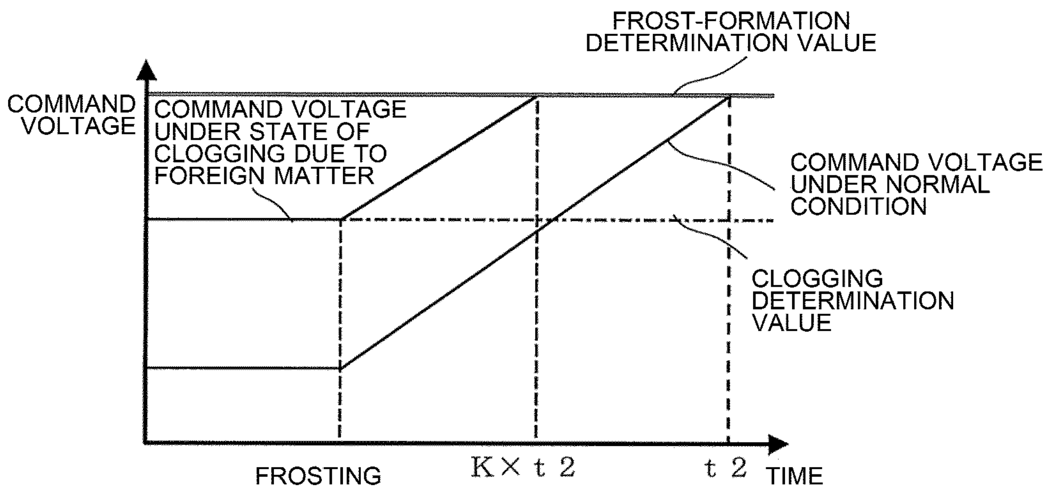

START
COMMAND VOLTAGE INCREASING?
NO
S21
YES
INCREASE OF COMMAND VOLTAGE STOPPED?
NO
S22
YES
CALCULATE RATE OF INCREASE α1 OF COMMAND VOLTAGE
S23
RATE OF INCREASE α1 GREATER THAN OR EQUAL TO INCREASE-RATE DETERMINATION THRESHOLD A?
NO
S24
YES
INCREASED STATE CONTINUED FOR SET DURATION T OR MORE?
NO
S25
YES
TRANSMIT SIGNAL INDICATIVE OF CLOGGING TO REMOTE CONTROL 12
S26
END

FIG. 7


FROST-FORMATION DETERMINATION VALUE
COMMAND VOLTAGE
COMMAND VOLTAGE UNDER STATE OF CLOGGING DUE TO FOREIGN MATTER
COMMAND VOLTAGE UNDER NORMAL CONDITION
CLOGGING DETERMINATION VALUE
FROSTING
K× t 2
t 2
TIME

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2018/018146

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F24F11/38(2018.01)i, F24F11/41(2018.01)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)
Int. Cl. F24F11/38, F24F11/41

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

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 10-246542 A (MATSUSHITA SEIKO CO., LTD.) 14 September 1998, paragraphs [0005]-[0034], fig. 1, 2 (Family: none)	1, 5-6 2-4
A	JP 2004-218936 A (HITACHI, LTD.) 05 August 2004, entire text, all drawings (Family: none)	1-6
A	JP 2008-232500 A (MITSUBISHI ELECTRIC CORP.) 02 October 2008, entire text, all drawings (Family: none)	1-6
A	JP 2003-269772 A (SANYO ELECTRIC CO., LTD.) 25 September 2003, entire text, all drawings (Family: none)	1-6

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

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09.07.2018	17.07.2018

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

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2016084139 A **[0003]**