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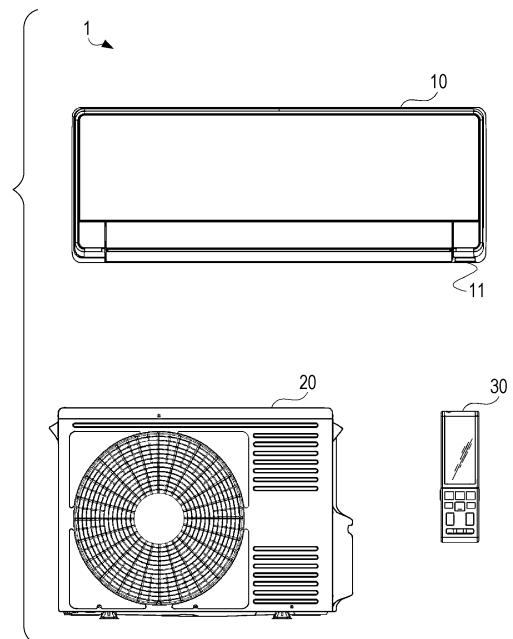
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(54) **AIR-CONDITIONER**

(57) Provided is an air-conditioner which includes: a housing; an air blowing fan configured to send air to an outdoor heat exchanger; a fixing member configured to fix the air blowing fan to the housing; and a control section configured to control an acceleration or the number of rotations per unit time in rotation of the air blowing fan. A rotation direction of the air blowing fan includes at least a first direction of loosening the fixing member due to the rotation of the air blowing fan.

FIG. 1



Description

BACKGROUND

1. Technical Field

[0001] The present disclosure relates to an air-conditioner.

2. Related Art

[0002] In some cases, in an outdoor unit, an air blowing fan outside a room is reversely rotated in a direction opposite to a rotation direction in normal operation. JP-A-2013-36716 discloses an outdoor unit configured such that an air blowing fan outside a room is reversely rotated until a lapse of predetermined time for the purpose of controlling entrance of water vapor generated due to defrosting operation into a control device.

SUMMARY

[0003] An air-conditioner according to an embodiment of the present disclosure includes: a housing; an air blowing fan configured to send air to an outdoor heat exchanger; a fixing member configured to fix the air blowing fan to the housing; and a control section configured to control an acceleration or the number of rotations per unit time in rotation of the air blowing fan. A rotation direction of the air blowing fan includes at least a first direction of loosening the fixing member due to the rotation of the air blowing fan.

DETAILED DESCRIPTION

[0004] In the following detailed description, for purpose of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed embodiments. It will be apparent, however, that one or more embodiments may be practiced without these specific details. In other instances, well-known structures and devices are schematically shown in order to simplify the drawing.

[0005] There is a probability that reverse rotation of the air blowing fan outside the room causes a problem that the air blowing fan is detached due to looseness of a nut fixing the air blowing fan.

[0006] For this reason, an air-conditioner according to the present embodiment is intended to reduce the probability of detaching an air blowing fan outside a room.

[0007] An air-conditioner according to the present embodiment includes: a housing; an air blowing fan configured to send air to an outdoor heat exchanger; a fixing member configured to fix the air blowing fan to the housing; and a control section configured to control an acceleration or the number of rotations per unit time in rotation of the air blowing fan. A rotation direction of the air blowing fan includes at least a first direction of loosening the fixing

member due to the rotation of the air blowing fan.

[0008] According to the air-conditioner of the embodiment of the present disclosure, the probability of detaching the air blowing fan outside the room can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Fig. 1 is an external view illustrating a configuration of an air-conditioner according to the present embodiment;

Fig. 2 is a diagram illustrating a refrigerant circuit of the air-conditioner according to the present embodiment;

Figs. 3A and 3B are views illustrating a configuration of an outdoor fan of the air-conditioner according to the present embodiment; and

Fig. 4 is a graph showing control profiles of the air-conditioner according to the present embodiment.

[0010] Hereinafter, the present embodiment will be described based on the drawings.

[0011] Fig. 1 is an external view illustrating a configuration of an air-conditioner 1 according to the present embodiment. The air-conditioner 1 circulates refrigerant in a refrigeration cycle (a heat pump cycle) to perform air conditioning. As illustrated in Fig. 1, the air-conditioner 1 includes an indoor unit 10 placed inside a room (an air-conditioning target space), an outdoor unit 20 placed outside (outside the room), and a remote controller 30 to be operated by a user.

[0012] The indoor unit 10 includes a remote controller communication section 11. The remote controller communication section 11 transmits a predetermined signal to the remote controller 30 or receives a predetermined signal from the remote controller 30 via, e.g., infrared communication. For example, the remote controller communication section 11 receives, from the remote controller 30, a signal of an operation command, a stop command, a set temperature change, an operation mode change, or a timer setting. Moreover, the remote controller communication section 11 transmits, e.g., an indoor temperature detection value to the remote controller 30. In other examples, the remote controller 30 may perform only transmission to the remote controller communication section 11, and the remote controller communication section 11 may perform only reception from the remote controller 30. That is, communication between the remote controller 30 and the remote controller communication section 11 may be only in one direction. Note that although not clearly illustrated in Fig. 1, the indoor unit 10 and the outdoor unit 20 are connected to each other through a refrigerant pipe, and are connected to each other through a communication line.

[0013] Fig. 2 is a diagram illustrating a refrigerant circuit Q of the air-conditioner 1 according to the embodiment. Note that solid arrows in Fig. 2 indicate the flow of

refrigerant in air-heating operation. Moreover, dashed arrows in Fig. 2 indicate the flow of refrigerant in air-cooling operation.

[0014] As illustrated in Fig. 2, the indoor unit 10 includes, in addition to the remote controller communication section 11, an indoor heat exchanger 12 and an indoor fan 14. In the indoor heat exchanger 12, heat is exchanged between refrigerant flowing in a heat transfer pipe (not shown) of the indoor heat exchanger 12 and indoor air sent from the indoor fan 14. The indoor heat exchanger 12 operates as a condenser or an evaporator by switching of a later-described four-way valve 25.

[0015] As illustrated in Fig. 2, the outdoor unit 20 includes a compressor 21, an outdoor heat exchanger 22, an outdoor fan 23, an outdoor expansion valve 24 (an expansion valve), the four-way valve 25, and a control board 26. The compressor 21 is equipment configured to compress low-temperature low-pressure gas refrigerant by drive of a compressor motor 21a to discharge the compressed gas refrigerant as high-temperature high-pressure gas refrigerant. In the outdoor heat exchanger 22, heat is exchanged between refrigerant flowing in a heat transfer pipe (not shown) of the outdoor heat exchanger 22 and external air sent from the outdoor fan 23. The outdoor heat exchanger 22 operates as the condenser or the evaporator by switching of the four-way valve 25. The outdoor fan 23 is one example of an air blowing fan.

[0016] The outdoor fan 23 is placed in the vicinity of the outdoor heat exchanger 22. The outdoor fan 23 sends the external air to the outdoor heat exchanger 22 by drive of an outdoor fan motor 23a. The outdoor expansion valve 24 has the function of depressurizing refrigerant condensed in the "condenser" (one of the outdoor heat exchanger 22 or the indoor heat exchanger 12). Note that the refrigerant depressurized in the outdoor expansion valve 24 is guided to the "evaporator" (the other one of the outdoor heat exchanger 22 or the indoor heat exchanger 12).

[0017] The four-way valve 25 is a valve configured to switch a refrigerant flow path according to an operation mode of the air-conditioner 1. In the refrigeration cycle of the air-cooling operation executed by switching of the four-way valve 25, refrigerant circulates through the compressor 21, the outdoor heat exchanger 22 (the condenser), the outdoor expansion valve 24, and the indoor heat exchanger 12 (the evaporator) in this order as indicated by the dashed arrows. Moreover, in the refrigeration cycle of the air-heating operation executed by switching of the four-way valve 25, refrigerant circulates through the compressor 21, the indoor heat exchanger 12 (the condenser), the outdoor expansion valve 24, and the outdoor heat exchanger 22 (the evaporator) in this order as indicated by the solid arrows. That is, in the refrigerant circuit Q illustrated in Fig. 2, refrigerant sequentially circulates through the compressor 21, the "condenser," the outdoor expansion valve 24, and the "evaporator." In the refrigerant circuit Q, one of the "condenser" or the "evaporator"

as described above is the outdoor heat exchanger 22, and the other one of the "condenser" or the "evaporator" is the indoor heat exchanger 12.

[0018] The control board 26 includes, for example, a not-shown compressor control circuit, a not-shown outdoor expansion valve control circuit, and a not-shown outdoor fan control circuit. The compressor control circuit controls operation of the compressor 21. The outdoor expansion valve control circuit transmits a pulse signal for driving a pulse motor of the outdoor expansion valve 24. The outdoor fan control circuit controls, e.g., drive of the outdoor fan motor 23a of the outdoor fan 23 attached to the outdoor heat exchanger 22. The control board 26 is one example of a control section.

[0019] Figs. 3A and 3B are views illustrating a configuration of the outdoor fan 23 of the air-conditioner according to the present embodiment. Fig. 3A is an exploded perspective view of the outdoor fan 23 and the like. Fig. 3B is a sectional view of the outdoor fan 23 and the like. The outdoor fan motor 23a is attached to a motor support 23c with screws 23b. The outdoor fan 23 is attached to a motor shaft of the outdoor fan motor 23a with a nut 23e. That is, the outdoor fan 23 is attached to the motor support 23c through the outdoor fan motor 23a, and is fixed with the nut 23e. Further, the motor support 23c is directly attached to a housing 28, or is attached to the housing 28 through other members. The nut 23e described herein is one example of a fixing member. Note that the fixing member for fixing the outdoor fan 23 may be a member configured to directly or indirectly fix the outdoor fan 23 to the housing. Thus, the above-described fixing member is not limited to the nut 23e. For example, a bolt or a screw may be used as other fixing members.

[0020] The outdoor unit 20 of the present embodiment performs air-conditioning operation, and further performs dust removal operation after the air-conditioning operation. The dust removal operation described herein is the operation of removing dust adhering to the outdoor fan 23. In the dust removal operation, the outdoor fan 23 rotates in a direction opposite to a rotation direction of the outdoor fan 23 in the air-conditioning operation. Hereinafter, rotation of the outdoor fan 23 in the air-conditioning operation will be referred to as "forward rotation." Moreover, rotation of the outdoor fan 23 in a rotation direction opposite to the rotation direction of the outdoor fan 23 in the air-conditioning operation, i.e., rotation of the outdoor fan 23 in the dust removal operation, will be referred to as "reverse rotation." The outdoor unit 20 of the present embodiment is designed such that the direction of the forward rotation of the fan and the direction of tightening the nut 23e are coincident with each other. That is, in the dust removal operation, the outdoor fan 23 rotates in the direction of loosening the nut 23e. On the other hand, the control board 26 of the outdoor unit 20 of the air-conditioner according to the present embodiment performs the following control to prevent loosening of the nut 23e.

[0021] Hereinafter, control of the reverse rotation of

the outdoor fan 23 by the control board 26 will be described. By operation of the remote controller 30, the user instructs stop of the air-conditioning operation of the indoor unit 10. Then, the control board 26 stops the air-conditioning operation to start the dust removal operation. More specifically, the control board 26 instructs the outdoor fan motor 23a to start the reverse rotation. Thereafter, the control board 26 performs control of the acceleration of the reverse rotation according to an acceleration control profile 401 illustrated in Fig. 4. The horizontal axis of a graph illustrated in Fig. 4 indicates time. The vertical axis of the graph indicates a rotation speed (the number of rotations per unit time). The graph of Fig. 4 shows not only the control profile 401 for the reverse rotation but also a control profile 402 for the forward rotation.

[0022] Note that in a case where both of the dust removal operation and other types of cleaning operation are executed after stop of the air-conditioning operation, the control board 26 starts the dust removal operation in advance of the other types of cleaning operation. The other types of cleaning operation indicate operation for which operation of equipment in the outdoor unit 20 is necessary. For example, the other types of cleaning operation include the operation of washing dust adhering to the outdoor heat exchanger 22 with dew condensation water generated in the outdoor heat exchanger 22. Cleaning operation for which the operation of the equipment in the outdoor unit 20 is not necessary may be performed at the same time as the dust removal operation. Alternatively, either one of the cleaning operation or the dust removal operation may be performed first.

[0023] The control board 26 controls, for certain time (until time t1 from start-up in an example of Fig. 4) after the start-up of the outdoor fan motor 23a, the outdoor fan motor 23a such that an equal acceleration is provided between the case of the forward rotation and the case of the reverse rotation.

[0024] After a lapse of the time t1, the control board 26 controls the outdoor fan motor 23a such that the acceleration in the case of the reverse rotation of the outdoor fan 23 is lower than that in the case of the forward rotation of the outdoor fan 23. Note that the acceleration for the forward rotation and the acceleration for the reverse rotation after a lapse of the time t1 can be set in advance. For example, in a case where the acceleration for the forward rotation is set to 24 rpm/s, the acceleration for the reverse rotation is set to 20 rpm/s. Thus, force (the force of tightening the nut 23e) on the nut 23e in the forward rotation is greater than force (the force of loosening the nut 23e) on the nut 23e in the reverse rotation. Consequently, the probability of detaching the outdoor fan 23 due to looseness of the nut 23e due to the reverse rotation can be reduced.

[0025] As described above, before a lapse of the time t1, the acceleration for the reverse rotation and the acceleration for the forward rotation are equal to each other. This is because in a case where a value smaller than the

acceleration for the forward rotation is set as the value of the acceleration for the reverse rotation upon the start-up, there is a probability that the acceleration becomes too low and poses a problem for the start-up.

[0026] Note that for the certain time (until the time t1 after the start-up in the example of Fig. 4) after the start-up, any of the acceleration for the forward rotation and the acceleration for the reverse rotation may be equal to or higher than a predetermined value. That is, the outdoor fan motor 23a is not necessarily controlled such that the acceleration for the forward rotation and the acceleration for the reverse rotation are equal to each other. Note that such a predetermined value is preferably greater than the acceleration for the reverse rotation for certain time (from the time t1 to time t2 in Fig. 4). That is, in the case of the reverse rotation of the outdoor fan 23, the control board 26 controls the outdoor fan motor 23a such that the acceleration from the start of rotation to the time t1 is higher than the acceleration from the time t1 to the time t2.

[0027] Further, the control board 26 controls, after stop of acceleration (after the time t2 in Fig. 4), the outdoor fan motor 23a such that the maximum number of rotations per unit time in the reverse rotation of the outdoor fan 23 is lower than that in the forward rotation of the outdoor fan 23. More specifically, a value lower than the preset maximum number of rotations per unit time in the forward rotation may be set in advance as the maximum number of rotations per unit time in the reverse rotation. Then, the control board 26 controls, during the reverse rotation, the outdoor fan motor 23a not to exceed the set maximum number of rotations per unit time in the reverse rotation. Accordingly, the probability of loosening the nut 23e due to the reverse rotation can be reduced.

[0028] Further, reverse rotation time for which the reverse rotation of the outdoor fan 23 is performed in the dust removal operation can be set in advance. The reverse rotation time described herein is a period shorter than minimum thermo-ON operation time. There are a thermo-ON period and a thermo-OFF period during the air-conditioning operation. Thermo-OFF indicates, for example, a period for which the compressor 21 and the outdoor fan 23 are stopped after a room temperature has reached a target value. On the other hand, thermo-ON indicates a period for which the compressor 21 or the outdoor fan 23 is driven. The minimum thermo-ON operation time can be set in advance. In the case of performing the reverse rotation, the control board 26 stops the reverse rotation after a lapse of the reverse rotation time. Thus, the reverse rotation time exceeds forward rotation time. Consequently, the probability of loosening the nut 23e can be reduced.

[0029] The control board 26 ends the dust removal operation when the reverse rotation of the outdoor fan 23 is performed with the above-described acceleration for certain time. At this point, the control board 26 controls the outdoor fan motor 23a such that a deceleration until stop of the reverse rotation of the outdoor fan 23 is higher

than the acceleration in the case of the reverse rotation of the outdoor fan 23. More specifically, the control board 26 stops power supply to the outdoor fan motor 23a at the end of the dust removal operation. That is, the control board 26 does not perform the deceleration control of gradually decreasing the speed in the case of stopping the reverse rotation of the outdoor fan 23. Thus, the outdoor fan 23 is suddenly decelerated. As described above, the control board 26 controls, upon deceleration of the reverse rotation, the outdoor fan motor 23a such that the deceleration is higher than the acceleration for the reverse rotation. Thus, loosening of the nut 23e due to the reverse rotation can be also prevented even upon deceleration of the reverse rotation.

[0030] As described above, in the air-conditioner 1 according to the present embodiment, the acceleration or the number of rotations per unit time in the reverse rotation of the outdoor fan 23 is controlled so that the probability of detaching the outdoor fan 23 can be reduced.

[0031] Note that the timing of performing the reverse rotation is not limited to timing at the end of the air-conditioning operation. For example, the reverse rotation may be executed at optional timing according to user's operation. Moreover, in the present embodiment, the dust removal operation has been described as an example of the control of the reverse rotation of the outdoor fan 23. Note that the example of the control of the reverse rotation of the outdoor fan 23 is not limited to the dust removal operation.

[0032] One example of embodiments of the present disclosure has been described above in detail. Note that the embodiments of the present disclosure are not limited to the above-described specific embodiment.

[0033] The foregoing detailed description has been presented for the purposes of illustration and description. Many modifications and variations are possible in light of the above teaching. It is not intended to be exhaustive or to limit the subject matter described herein to the precise form disclosed. Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims appended hereto.

Claims

1. An air-conditioner comprising:

a housing;
an air blowing fan configured to send air to an outdoor heat exchanger;
a fixing member configured to fix the air blowing fan to the housing; and
a control section configured to control an accel-

eration or the number of rotations per unit time in rotation of the air blowing fan,
wherein a rotation direction of the air blowing fan includes at least a first direction of loosening the fixing member due to the rotation of the air blowing fan.

2. The air-conditioner according to claim 1, wherein the rotation direction of the air blowing fan further includes a second direction opposite to the first direction, and the control section controls the acceleration or the number of rotations per unit time in the rotation of the air blowing fan such that the acceleration or the number of rotations per unit time in rotation of the air blowing fan in the first direction is less than the acceleration or the number of rotations per unit time in rotation of the air blowing fan in the second direction.
3. The air-conditioner according to claim 1 or 2, wherein the control section controls the acceleration or the number of rotations per unit time in the rotation of the air blowing fan such that the acceleration of the rotation of the air blowing fan in the first direction is lower than a deceleration for stopping the rotation of the air blowing fan in the first direction.
4. The air-conditioner according to any one of claims 1 to 3, wherein the control section controls the number of rotations per unit time in the rotation of the air blowing fan such that the maximum number of rotations per unit time in the rotation of the air blowing fan in the first direction is smaller than the maximum number of rotations per unit time in the rotation of the air blowing fan in the second direction.
5. The air-conditioner according to any one of claims 1 to 4, wherein the control section stops the air blowing fan before a lapse of minimum thermo-ON operation time after the rotation of the air blowing fan in the first direction has been started.
6. The air-conditioner according to any one of claims 1 to 5, wherein the control sections controls, during an air-conditioning operation, the acceleration or the number of rotations per unit time in the rotation of the air blowing fan in a second direction opposite to the first direction, and after an end of the air-conditioning operation, controls the acceleration or the number of rotations per unit time in the rotation of the air blowing fan in the first direction.
7. The air-conditioner according to any one of claims 1 to 6, wherein the control section controls the acceleration of the

rotation of the air blowing fan such that the acceleration of the rotation of the air blowing fan in the first direction until a lapse of first time after a start of the rotation of the air blowing fan in the first direction is higher than the acceleration of the rotation of the air blowing fan in the first direction after a lapse of the first time.

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FIG. 1

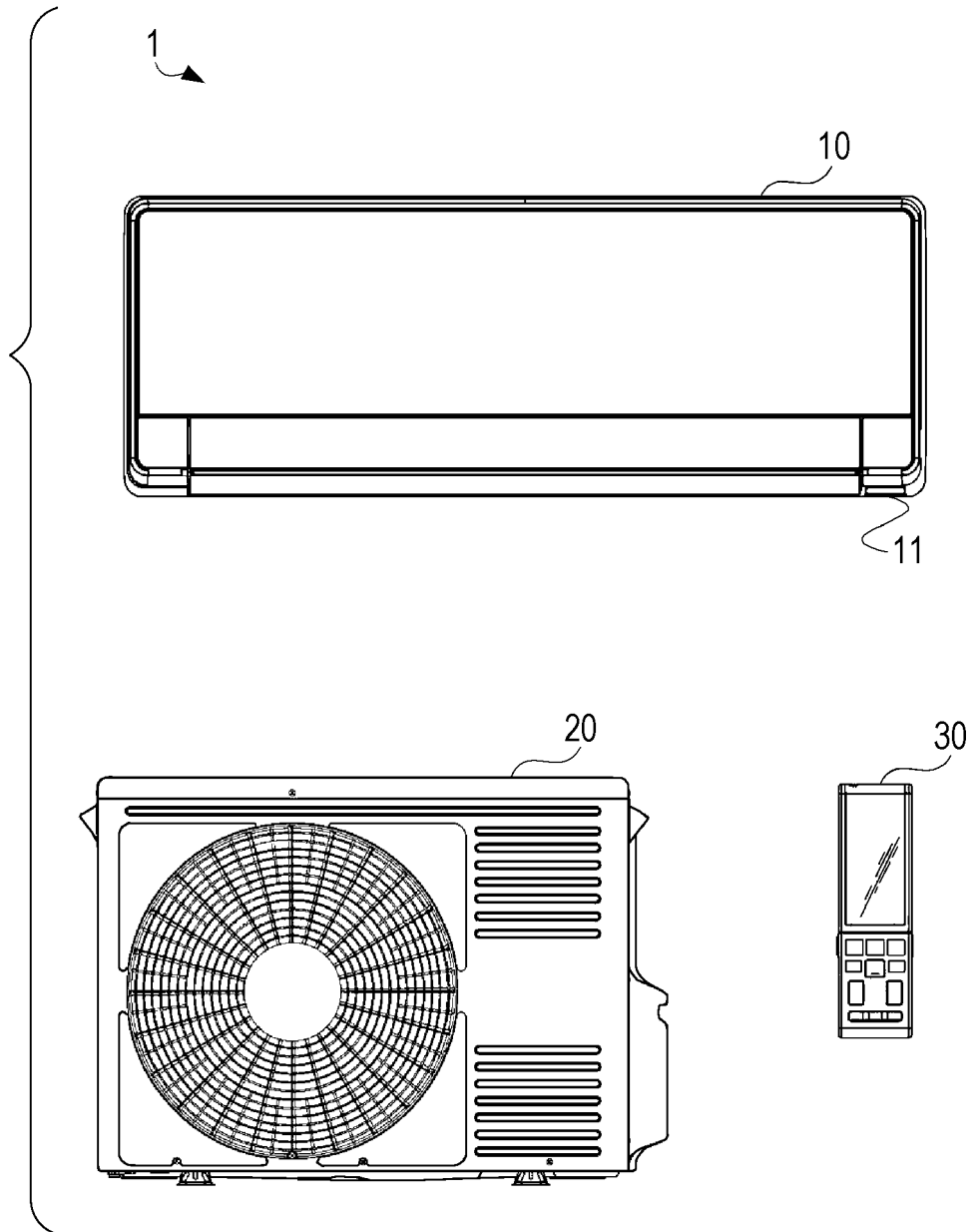


FIG. 2

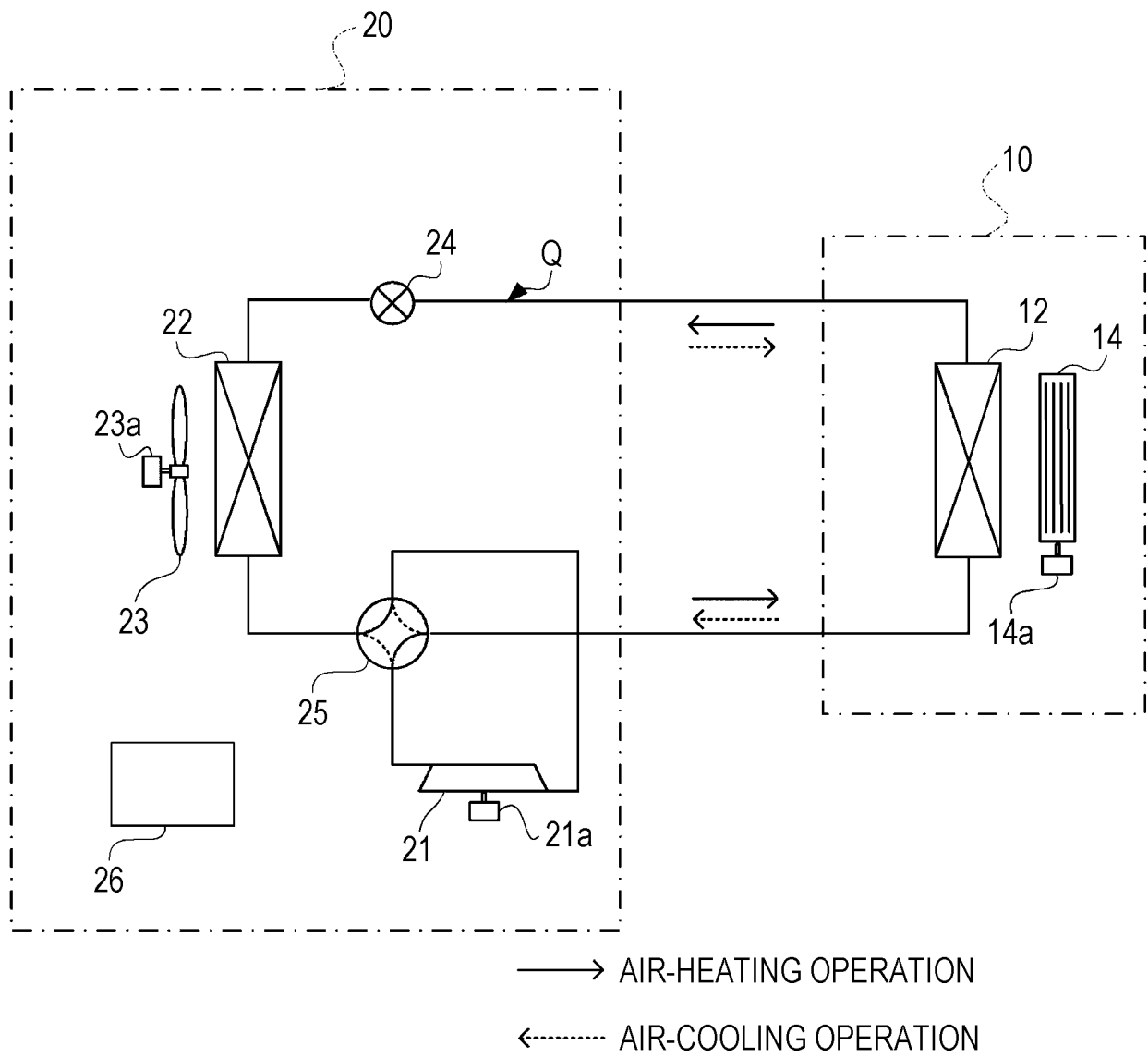


FIG. 3A

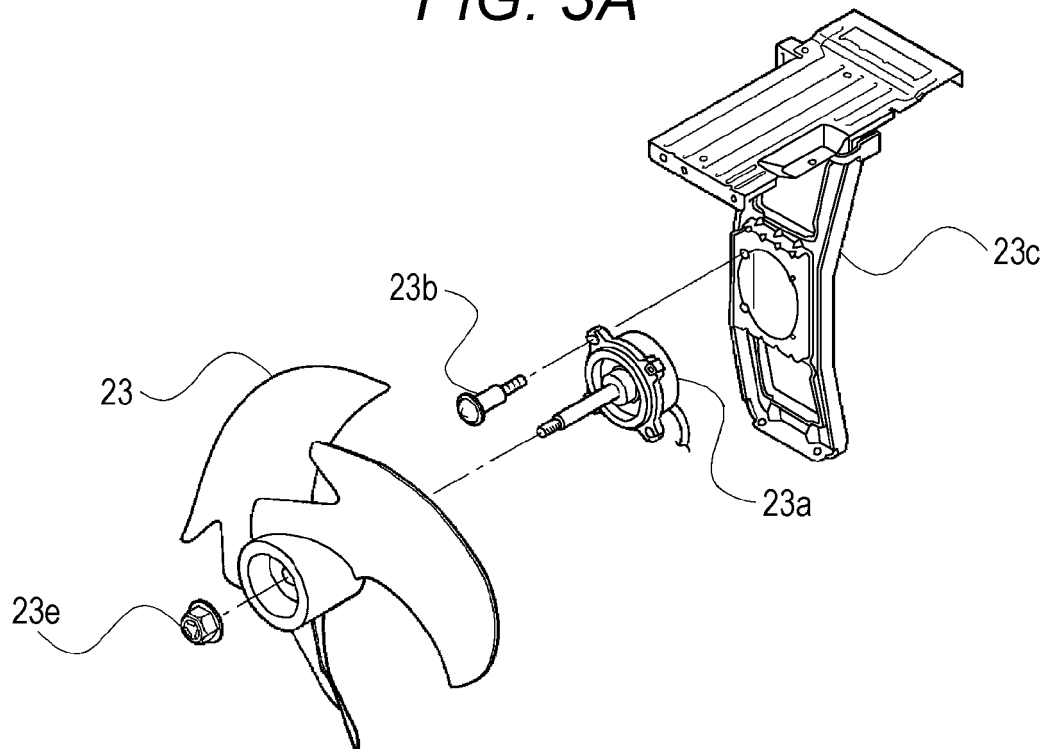


FIG. 3B

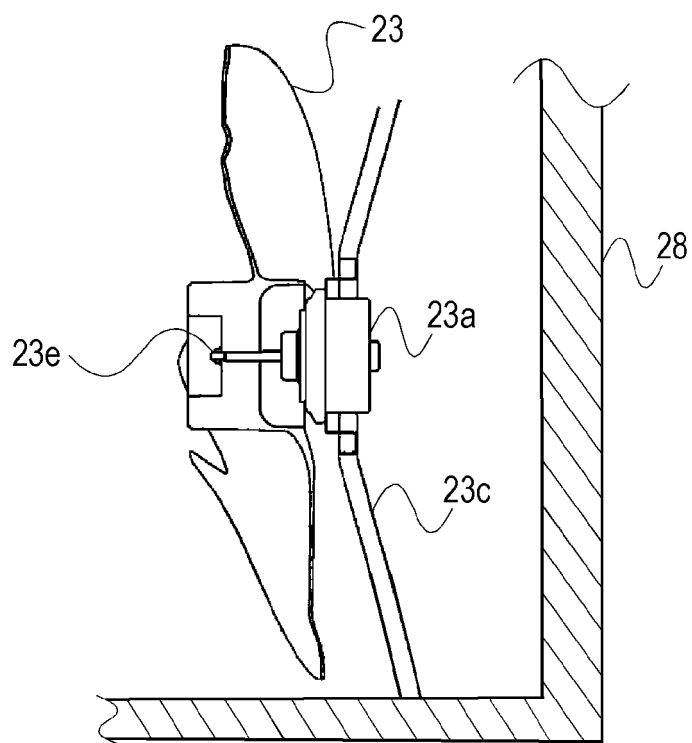
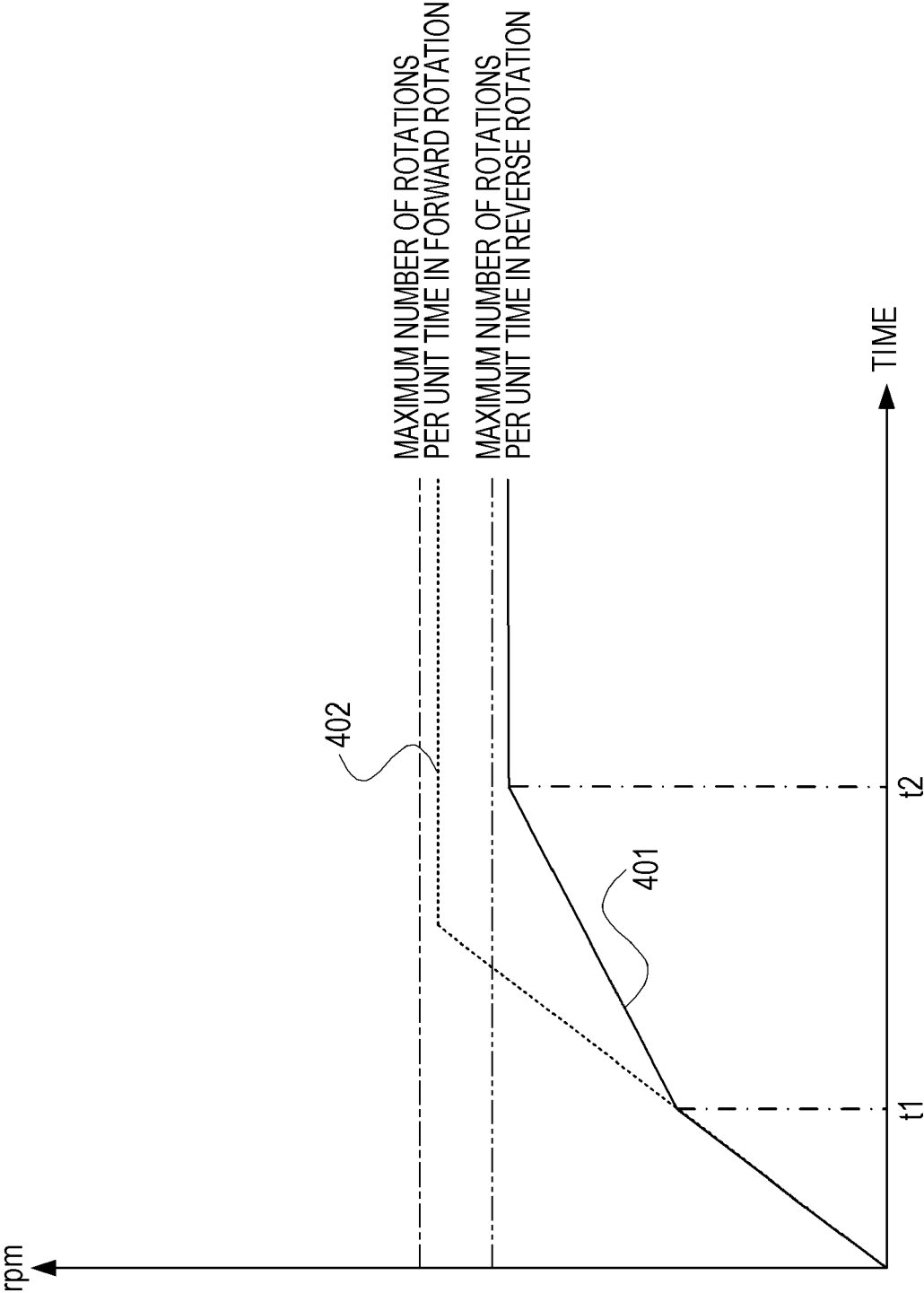


FIG. 4





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EP 20 17 3808

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