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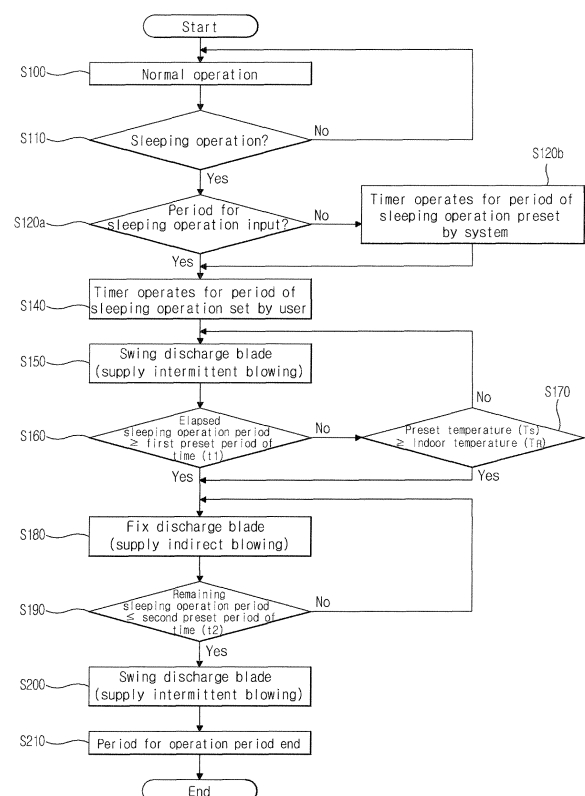
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(54) **Method of controlling blowing direction in sleeping operation mode of air conditioner**

(57) Disclosed herein is a method of controlling a blowing direction in a sleeping operation of an air conditioner. The air conditioner comprises a main body having at least one discharge port through which heat-exchanged air is discharged. The method comprises determining whether or not a current operation mode is the sleeping operation, determining whether or not a sleeping operation period is input if it is determined that the current operation mode is the sleeping operation, and controlling flow of air discharged through the discharge port according to subdivided modes of the sleeping operation if it is determined that the sleeping operation period is input, the subdivided modes comprising an initial sleeping mode corresponding to an initial stage of the sleeping operation, an in-sleeping mode corresponding to a middle stage of the sleeping operation, and an awaking mode corresponding to a final stage of the sleeping operation.

Fig.4



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a method of controlling a blowing direction in a sleeping operation mode of an air conditioner, and, more particularly, to a method of controlling a blowing direction for sound sleep operation in a sleeping operation mode of an air conditioner, by which a stream and direction of air discharged with an elapse of a sleeping operation mode period is appropriately controlled, thereby providing a pleasant sleeping condition.

2. Description of the Related Art

[0002] A sleeping operation mode of an air conditioner refers to a state of the air conditioner operated while a user sleeps. In Korean Patent Laid-open No. 2002-0002796, a method of controlling a blowing direction in the sleeping operation mode of the air conditioner is disclosed, by which the blowing direction of air discharged to a room is controlled in the sleeping operation mode of the air conditioner.

[0003] In this disclosure, the method comprises: controlling an angle of a blowing direction adjustor corresponding to a blowing direction set by a user at an initial stage of the sleeping operation mode of the air conditioner; controlling the angle of the blowing direction adjustor by a controller after a predetermined period of time is elapsed, such that air can be discharged in an indirect blowing manner in which discharged air is not directly blown to the user; and continuing the sleeping operation mode after the angle of the blowing direction adjuster is changed to the indirect blowing manner.

[0004] Furthermore, the method of the disclosure comprises releasing the angle of the blowing direction adjuster set to the indirect blowing manner, followed by operating the air conditioner according to a blowing direction set by the user or operating the air conditioner in an initial operation mode for cooling the room, in response to an input signal for re-adjustment of the blowing direction or for re-setting of the air conditioner into a cooling operation mode by the user via a key input part or a remote controller signal receipt part, while the sleeping operation mode is continued with the angle of the blowing direction adjuster changed to the indirect blowing manner.

[0005] According to the conventional method of the disclosure, however, the blowing direction of air discharged through a discharge port is controlled simply to the indirect blowing manner after the predetermined period of time. Thus, although it is assumed that the user is in a sleeping state a predetermined period of time after going to bed, it is not assumed that the user is in an initial sleeping state wherein the user does not completely fall asleep, and that the user is in an awaking state wherein

the user awakes from sleep.

[0006] In particular, according to the conventional method of the disclosure, the air is discharged in a predetermined direction set by the user at the initial stage of the sleeping operation mode of the air conditioner. Thus, if the air conditioner is set by the user to blow air in a direct blowing manner wherein discharged air is directly transferred to the user, a cold stream of air is directly blown to the user, in particular, to the face of the user, making it difficult for the user to fall asleep in the initial sleeping state, and causing unpleasantness of the user in the awaking state.

[0007] If the air conditioner is set by the user to blow air in the indirect blowing manner wherein the discharged air is not directly transferred to the user, a cool breeze is not directly transferred to the user on a hot, humid summer night, making it difficult for the user to fall asleep due to hot weather.

[0008] In particular, since it generally takes about 30 minutes for a person to fall into a deep sleep according to experiments, it is very important to provide an environment to the user at an initial stage in the sleeping operation mode of the air conditioner, which allows the user to fall asleep more pleasantly and comfortably at the initial sleeping state wherein the user begins to fall asleep.

SUMMARY OF THE INVENTION

[0009] Accordingly, it is an aspect of the present invention to provide a method of controlling a blowing direction for sound sleep operation in a sleeping operation mode of an air conditioner, which can provide a pleasant sleeping condition by appropriately controlling a stream and direction of discharged air according to sleeping stages of a user, including an in-sleeping stage of the user a predetermined period of time after going to bed, an initial sleeping stage wherein the user does not completely fall asleep, and an awaking stage wherein the user awakes from sleeping.

[0010] Additional aspects and/or advantages of the invention will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the invention.

[0011] The foregoing and other aspects of the present invention are achieved by providing a method of controlling a blowing direction in a sleeping operation of an air conditioner comprising a main body having at least one discharge port through which heat-exchanged air is discharged, and at least one discharge blade positioned at the at least one discharge port to control a blowing direction of the air discharged through the discharge port, the method comprising: determining whether or not a current operation mode is the sleeping operation; performing a swing operation to cause the discharge blade to swing in order to help a user go to sleep while performing the sleeping operation, if it is determined that the current operation mode is the sleeping operation; determining

whether or not a sleeping operation period has elapsed a first predetermined period of time t1; and performing a fixing operation to fix the discharge blade to help the user have a sound sleep, if it is determined that the sleeping operation period has elapsed the first predetermined period of time t1.

[0012] The method may further comprise: determining whether or not a remaining sleeping operation period is a second predetermined period of time t2; and performing the swing operation to cause the discharge blade to swing in order to help the user wake, if it is determined that the remaining sleeping operation period is less than or equal to the second predetermined period of time t2.

[0013] The method may further comprise: comparing a preset temperature with an indoor temperature, if it is determined that the sleeping operation period has not elapsed the first predetermined period of time t1; and fixing the discharge blade to provide indirect blowing of air to the user even though the sleeping operation period has not elapsed the first predetermined period of time t1, if it is determined that the indoor temperature is less than the preset temperature.

[0014] The swing operation to cause the discharge blade to swing in order to help the user to sleep or wake may be performed under a condition that the discharge blade is positioned at an angle to cause indirect blowing of air to be supplied for a longer period of time than direct blowing of air.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings, of which:

FIG. 1 is a perspective view illustrating an indoor unit of an air conditioner according to one embodiment of the present invention;

FIG. 2 is a diagram illustrating a refrigerant cycle of the air conditioner according to the embodiment;

FIG. 3 is a block diagram illustrating the construction of a controller for controlling a blowing direction for sound sleep operation in a sleeping operation mode of the air conditioner according to the present invention; and

FIG. 4 is a flow chart illustrating operation of a method of controlling a blowing direction for sound sleep operation in a sleeping operation mode of the air conditioner according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] Reference will now be made in detail to the embodiments of the present invention, examples of which are illustrated in the accompanying drawings. The em-

bodiments are described below to explain the present invention by referring to the figures.

[0017] FIG. 1 is a perspective view illustrating an indoor unit of an air conditioner according to one embodiment of the present invention. Referring to FIG. 1, an air conditioner according to the present invention is a stand type three-face discharge air conditioner, which comprises a box-shaped main body 10, an indoor heat exchanger 11 positioned within the main body 10, and an indoor fan 12 to blow cold air having passed the indoor heat exchanger 11 to a room.

[0018] The main body 10 has a side suction port 13 formed at a lower portion on either side to suck air from the room.

[0019] The main body 10 has side discharge ports 14a and 14b formed at an upper portion of opposite sides thereof, and a front discharge port 15 formed at a front side thereof, through which the cold air is discharged to the room after being blown by the indoor fan 12 and passing the indoor heat exchanger 11.

[0020] The side discharge ports 14a and 14b are provided with side discharge blades 16a and 16b rotatably installed thereto to adjust a stream and direction of air discharged therethrough, and with step motors 18a and 18b to rotate the side discharge blades 16a and 16b, respectively.

[0021] The front discharge port 15 is provided with a front blade 17 rotatably installed thereto to adjust a stream and direction of air discharged therethrough, and with a step motor (not shown) to rotate the front blade 17.

[0022] The air conditioner further comprises an indoor temperature sensor (not show) positioned inside the side suction ports 13 to detect the temperature of indoor air sucked into the main body 10 through the side suction ports 13.

[0023] The air conditioner constructed as above can be used for both cooling and heating the room. Specifically, when heating the room, a 4-way valve 21 is turned on, and a refrigerant flows along a refrigerant cycle in which the refrigerant circulates in sequence of compressor 20 → 4-way valve 21 → indoor heat exchanger 11 → expansion valve 22 → expansion valve 23 for heating → outdoor heat exchanger 24 → 4-way valve 21 → compressor 20 in the air conditioner.

[0024] When cooling the room, the 4-way valve 21 is turned off, and the refrigerant flows along another refrigerant cycle in which the refrigerant circulates in sequence of compressor 20 → 4-way valve 21 → outdoor heat exchanger 24 → one-way valve 26 → expansion valve 22 → indoor heat exchanger 11 → 4-way valve 21 → compressor 20 in the air conditioner.

[0025] For the air conditioner capable of heating and cooling the room according to selection of the user and having the refrigerant cycle described as above, when an operation key is turned on after inputting a desired operation mode (cooling or heating), a preset temperature and a preset air volume, indoor air is sucked into an indoor unit of the air conditioner through the suction ports

13 while the indoor fan 12 rotates according to the preset air volume.

[0026] The compressor 20 is driven to perform cooling or heating of the room by controlling an operation frequency of the compressor 20 according to a difference between the indoor temperature and the preset temperature obtained by comparing the temperature of the indoor air sucked through the suction ports 13 with the preset temperature.

[0027] In FIG. 2, reference numeral 25 indicates an outdoor fan to force external air to be induced into an outdoor unit (not shown) and to be heat exchanged through the outdoor heat exchanger 24.

[0028] FIG. 3 is a block diagram illustrating the construction for a blowing direction control for a sound sleep operation in a sleeping operation mode of the air conditioner according to the present invention. The construction for blowing direction control comprises a power source 110, a signal input unit 110, an indoor temperature detection unit 120, a display unit 130, a controller 140, a compressor driving unit 150, an outdoor fan driving unit 160, an indoor fan driving unit 170, a front discharge blade driving unit 180, and a side discharge blade driving unit 190.

[0029] The signal input unit 110 comprises a handling part and other components which are used to input information, including operation modes (for example, cooling, heating, normal or sleeping operations), a preset temperature T_s , a period for sleeping operation, a preset air volume, a preset blowing direction, first and second preset period t_1 and t_2 set to change the blowing direction of air discharged during the sleeping operation, and the like.

[0030] The indoor temperature detection unit 120 comprises an indoor temperature sensor (not shown) to detect an indoor temperature T_r from air sucked through the suction ports 13 into the body 10 of the indoor unit.

[0031] The controller 140 comprises a timer to measure a sleeping operation period when the sleeping operation mode is selected and the period for sleeping operation is input, and an indoor unit microcomputer to control angles of the discharge blades to adjust the stream and blowing direction of discharged air according to an elapse of the sleeping operation period, in particular, in such a way that the angles of the discharge blades can be controlled by comparing the indoor temperature T_r with the preset temperature T_s at an initial stage of the sleeping operation, even though the sleeping operation mode has not elapsed the first preset period of time t_1 set by the user.

[0032] In addition, the controller 140 is electrically connected at an output side thereof to the front discharge blade driving unit 180 to swing the front blade 17, and to the side discharge blade driving unit 190 to swing the side discharge blades 16a and 16b. The side discharge blade driving unit 190 comprises a first step motor 18a to swing the right side discharge blade 16a, and a second step motor 18b to swing the left side discharge blade 16b

in order to control the stream and blowing direction of air discharged through the side discharge ports 14a and 14b. The front discharge blade driving unit 180 comprises a third step motor (not shown) to swing the front blade 17 in order to control the stream and blowing direction of air discharged through the front discharge port 15.

[0033] The power source 100 supplies power to the controller 140, the display unit 130 shows a current operation state, and the compressor driving unit 150 controls driving of the compressor according to a compressor controlling signal from the controller 140. The outdoor fan driving unit 160 drives the outdoor fan 25 according to an outdoor fan controlling signal from the controller 140, and the indoor fan driving unit 170 drives an indoor fan 12 according to an indoor fan controlling signal from the controller 140.

[0034] According to the present invention, the controller serves to control the stream and blowing direction of air discharged through the discharge ports along with an elapse of the sleeping operation period when the sleeping operation mode and the period for sleeping operation are input by the user. More specifically, the controller of the present invention is characterized by adjusting the angles of the discharge blades positioned at the discharge ports to differently control the stream and blowing direction of air discharged through the discharge ports according to subdivisions of the sleeping operation mode, which comprise an initial sleeping mode corresponding to an initial stage of the sleeping operation mode, an in-sleeping mode corresponding to a middle stage of the sleeping operation mode, and an awaking mode corresponding to a final stage of the sleeping operation mode.

[0035] Operation and advantageous effects of a method of controlling a blowing direction in the sleeping operation mode of the air conditioner constructed as above will be described hereinafter.

[0036] FIG. 4 is a flow chart illustrating operation of a method of controlling a blowing direction for sound sleep operation in a sleeping operation mode of the air conditioner according to the present invention.

[0037] Hereinafter, the terms "direct blowing" means that, when air is discharged through the discharge ports after being heat exchanged through the indoor heat exchanger, the air is blown directly to the body of a user. The term "indirect blowing" means that, the air is discharged so as not to be blown directly to the body of the user. In addition, the term "intermittent blowing" means that discharged air is intermittently supplied to the body of the user, that is, the direct blowing and the indirect blowing are repetitively supplied to the user at predetermined time intervals. The method according to the present invention will be described hereinafter in connection with an example in which the method is applied to a cooling operation.

[0038] When an operation switch is turned on via a remote controller or the like in order to operate the air conditioner for cooling a room, power is supplied to the

controller 140 from the power source 100 via a turn-on signal applied from the operation switch, and the controller 140 applies an operation signal to the compressor driving unit 150 to operate the compressor 20, thereby performing a normal cooling operation of the air conditioner (S100).

[0039] When the compressor 20 begins to operate at S100, heat exchange of air is performed while a refrigerant discharged from the compressor 35 circulates between the indoor heat exchanger 11 and the outdoor heat exchanger 24, and then the heat exchanged air is discharged to the room, thereby cooling the room. In addition, the controller 140 controls the outdoor fan driving unit 160 and the indoor fan driving unit 170 to operate the indoor fan 12 and the outdoor fan 25.

[0040] While the normal cooling operation is performed, the controller 140 determines whether or not a sleeping operation mode is set according to a command of the user from the signal input unit 110 (S110), and allows the air conditioner to continuously perform the normal operation if it is determined that the sleeping operation mode is not set.

[0041] If it is determined at S110 that the sleeping operation mode is set, the controller 140 controls the air conditioner to perform the sleeping operation, and determines whether or not a period for sleeping operation is input from the signal input unit 110 by the user (S120a). If it is determined that the period for sleeping operation is input from the signal input unit 110, the timer measures a sleeping operation period corresponding to the period for sleeping operation set by the user (S140). In addition, if it is determined that the period for sleeping operation is not input from the signal input unit 110 (S120b), the timer measures another sleeping operation period corresponding to a period of sleeping operation preset by a system (S140).

[0042] At an initial sleeping mode of the air conditioner corresponding to an initial stage of the sleeping operation in which the sleeping operation and the period for the sleeping operation are set and the timer begins to measure the sleeping operation period at S110 ~ 140, the controller 140 applies an operation signal to the front discharge blade driving unit 180, and drives the third step motor (not shown) to swing the front discharge blade 17 up and down in order to help the user sleep by supplying intermittent blowing of air to the user for a predetermined period of time. In addition, the controller 140 applies the operation signal to the side discharge blade driving unit 190 to swing the right and left side discharge blades 16a and 16b left and right (S150).

[0043] As such, at the initial sleeping mode of the air conditioner corresponding to the initial stage of the sleeping operation, during which the user begins to fall asleep, the discharge blades are swung for a predetermined period of time such that air discharged through the discharge ports provides the user with a rhythmical sensation of breeze, thereby helping the user easily fall into a deep sleep under a more pleasant sleeping condition.

[0044] After swinging of the discharge blades at S150 is performed for a predetermined period of time, the controller 140 determines whether or not the sleeping operation period has elapsed a first preset period of time t_1 by comparing the first preset period time t_1 set by the user with the sleeping operation period measured by the timer (S160).

[0045] If it is determined at S160 that the sleeping operation period has elapsed the first preset period of time t_1 , the controller 140 applies an operation signal to the front discharge blade driving unit 180 to stop the third step motor (not shown), thereby fixing the front discharge blade 17, in order to help the user have a sound sleep by supplying the indirect blowing to the user. In addition, the controller 140 applies the operation signal to the side discharge blade driving unit 190 to stop the first and second step motors 18a and 18b, thereby fixing the right and left side discharge blades 16a and 16b (S180).

[0046] At this time, the discharge blades are fixed in directions to prevent cold air from being directly blown to the user. Specifically, the front discharge blade 17 is fixed to face in a horizontal direction or in an upward direction. In other words, the front discharge blade 17 is fixed such that air discharged through the front discharge port 15 is directed in the horizontal direction or to the ceiling of the room. Furthermore, the right and left side discharge blades 16a and 16b are fixed to face in directions perpendicular to the sides of the body 10 or to face the rear side where the body 10 of the indoor unit is positioned. In other words, right and left side discharge blades 16a and 16b are fixed such that air discharged through the side discharge ports 14a and 14b is directed to the sides or the rear side where the body 10 of the indoor unit is positioned.

[0047] If it is determined at S160 that the sleeping operation period has not elapsed the first preset period of time t_1 , the controller 140 compares an indoor temperature T_R detected by the indoor temperature detection unit 120 with a preset temperature T_S set by the user (S170). Then, if it is determined that the indoor temperature T_R is lower than the preset temperature T_S , the controller 140 controls to fix the respective discharge blades 16a, 16b and 17 even though the sleeping operation period has not elapsed the first preset period of time t_1 , since the indoor temperature T_R lower than the preset temperature T_S can disturb deep sleeping of the user due to excessive transfer of cold air to the user. On the contrary, if it is determined that the indoor temperature T_R is higher than the preset temperature T_S , the controller 140 allows the respective discharge blades 16a, 16b and 17 to continuously swing.

[0048] Here, although the first preset period of time t_1 is set by the user, it is possible to determine using a period of time preset to about 30 minutes, which is evaluated as an average time required for a person to enter deep sleep according to experiments, unless the user does not set the first preset period of time t_1 .

[0049] While the indirect blowing of air is supplied to

the user at S180, the controller 140 compares a second preset period time t2 set by the user with the sleeping operation period measured by the timer (S190). If it is determined that a remaining sleeping operation period is less than or equal to the second predetermined period of time t2, the controller 140 applies an operation signal to the discharge blade driving units 170 and 180 to swing the respective discharge blades 16a, 16b and 17 as in the initial sleeping mode in order to help the user wake by supplying the indirect blowing of air to the user upon awaking of the user (S200).

[0050] As such, the respective discharge blades 16a, 16b and 17 are swung upon awaking of the user, providing a rhythmical sensation of breeze to the user, so that the user can awake from sleeping with ease and comfort.

[0051] When the sleeping operation period measured by the timer simultaneously with the sleeping operation of the air conditioner becomes equal to the period for sleeping period set by the user, the controller 140 stops the sleeping operation (S210).

[0052] Furthermore, when the discharge blades are swung to supply the intermittent blowing of air to the user at S150 and S200, each of the discharge blades is positioned at an angle to cause the indirect blowing of air to be supplied for a longer period of time than the direct blowing of air in order to reduce a period of time during which the cold air is directly supplied to the user.

[0053] The above description is set forth by using the embodiments to practice the method of controlling the blowing direction for the sound sleep operation in the sleeping operation mode of the air conditioner according to the present invention. Thus, the present invention is not limited to the above embodiments, and it would be appreciated by those skilled in the art that various modifications, additions and substitutions may be made in the embodiments without departing from the principle and spirit of the invention, the scope of which is defined in the claims and their equivalents.

[0054] For example, although the above description is set forth only for the stand type air conditioner, it is needless to say that the present invention can be applied to a wall-mounted type air conditioner and a ceiling type air conditioner.

[0055] As apparent from the above description, the method according to the present invention can provide a pleasant and comfortable sleeping condition for the user by appropriately controlling a stream and direction of discharged air according to sleeping stages of the user, including an initial sleeping stage wherein the user begins to fall asleep and an awaking stage wherein the user awakes from sleeping at a final sleeping state, as well as an in-sleeping stage.

[0056] In other words, at the initial sleeping stage of the user, the air conditioner is controlled to supply the intermittent blowing of air, thereby providing relief from hot humid summer nights while providing a rhythmical sensation of breeze to the user so as to help the user to easily fall into deep sleep.

[0057] At the awaking stage of the user, the air conditioner is also controlled to supply the intermittent blowing of air, thereby providing a rhythmical sensation of breeze to the user so as to help the user to easily awake from sleeping.

[0058] In addition, at the in-sleeping stage of the user, the air conditioner is controlled to provide the indirect blowing of air so as to prevent cold air from being directly supplied to the user, whereby the user is not kept from sleeping due to excessive cooling of the room.

Claims

1. A method of controlling a blowing direction in a sleeping operation of an air conditioner comprising a main body having at least one discharge port through which heat-exchanged air is discharged, and at least one discharge blade positioned at the at least one discharge port to control a blowing direction of the air discharged through the discharge port, the method comprising:

determining whether or not a current operation mode is the sleeping operation;
performing a swing operation to cause the discharge blade to swing in order to help a user go to sleep while performing the sleeping operation, if it is determined that the current operation mode is the sleeping operation;
determining whether or not a sleeping operation period has elapsed a first predetermined period of time t1; and
performing a fixing operation to fix the discharge blade to help the user have a sound sleep, if it is determined that the sleeping operation period has elapsed the first predetermined period of time t1.

2. The method according to claim 1, further comprising:

determining whether or not a remaining sleeping operation period is a second predetermined period of time t2; and
performing the swing operation to cause the discharge blade to swing in order to help the user wake, if it is determined that the remaining sleeping operation period is less than or equal to the second predetermined period of time t2.

3. The method according to claim 1 or 2, further comprising:

comparing a preset temperature with an indoor temperature, if it is determined that the sleeping operation period has not elapsed the first predetermined period of time t1; and
fixing the discharge blade to provide indirect

blowing of air to the user even though the sleeping operation period has not elapsed the first predetermined period of time t_1 , if it is determined that the indoor temperature is less than the preset temperature.

4. The method according to claim 2, wherein the sleeping operation period is set by the user, and if the sleeping operation period is not set by the user, the air conditioner is operated according to a sleeping operation period preset by a system of the air conditioner.

5. The method according to claim 2, wherein the swing operation to cause the discharge blade to swing in order to help the user to sleep or wake is performed under a condition that each of the discharge blades is positioned at an angle to cause indirect blowing of air to be supplied for a longer period of time than direct blowing of air.

6. The method according to claim 1, wherein the first and second predetermined periods of time t_1 and t_2 are set by the user.

7. The method according to claim 1, wherein the air conditioner is a three-face discharge type air conditioner comprising a plurality of discharge ports positioned at a front surface and opposite sides of the body, respectively, and a plurality of discharge blades positioned at the respective discharge ports to adjust the blowing direction of air discharged through the discharge ports.

8. A method of controlling a blowing direction in a sleeping operation of an air conditioner comprising a main body having at least one discharge port through which heat-exchanged air is discharged, the method comprising:

determining whether or not a current operation mode is the sleeping operation;
 determining whether or not a sleeping operation period is input, if it is determined that the current operation mode is the sleeping operation; and
 controlling flow of air discharged through the discharge port according to subdivided modes of the sleeping operation if it is determined that the sleeping operation period is input, the subdivided modes comprising an initial sleeping mode corresponding to an initial stage of the sleeping operation, an in-sleeping mode corresponding to a middle stage of the sleeping operation after a predetermined period of the sleeping operation elapses, and an awaking mode corresponding to a final stage of the sleeping operation.

9. The method according to claim 8, wherein the flow

of air discharged through the discharge port is controlled by at least one discharge blade positioned at the discharge port such that the at least one discharge blade can swing in the discharge port.

10. The method according to claim 8 or 9, wherein the discharge blade swings to supply intermittent blowing of air to the user upon the initial sleeping mode and the awaking mode.

11. The method according to claim 10, wherein the discharge blade is fixed to supply indirect blowing of air to the user upon the in-sleeping mode.

Fig.1

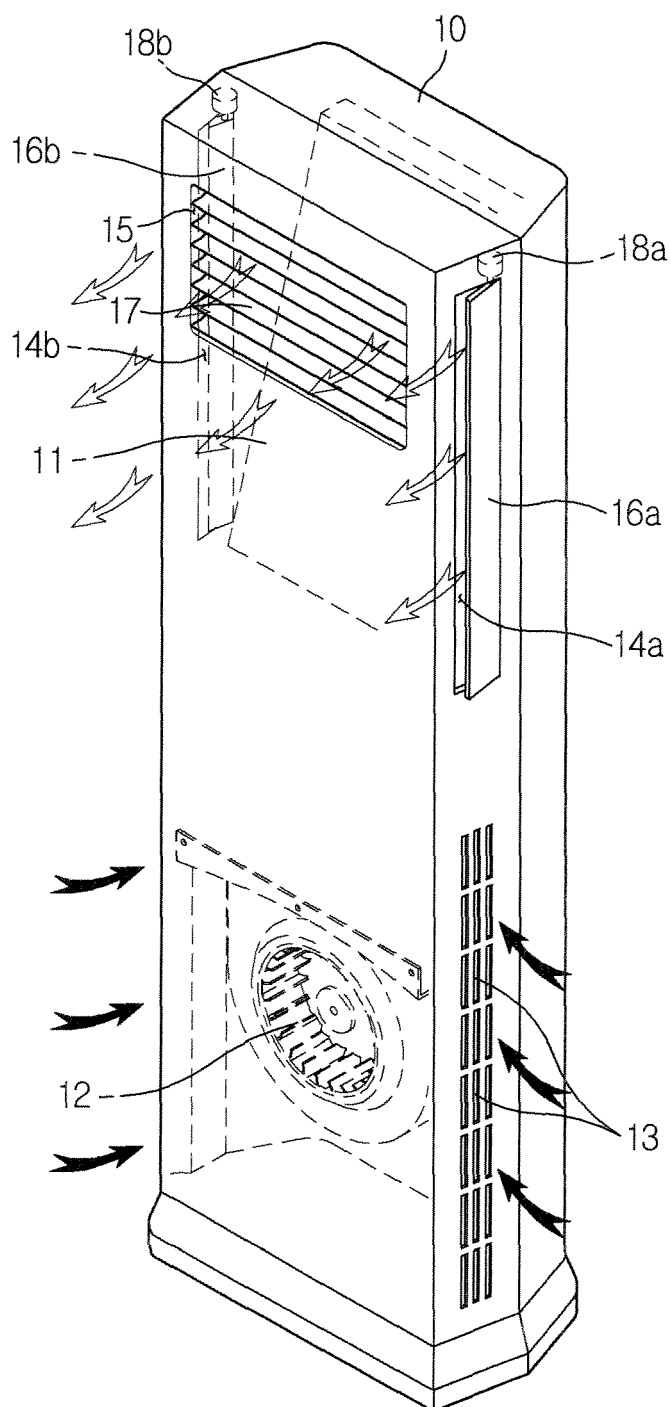


Fig.2

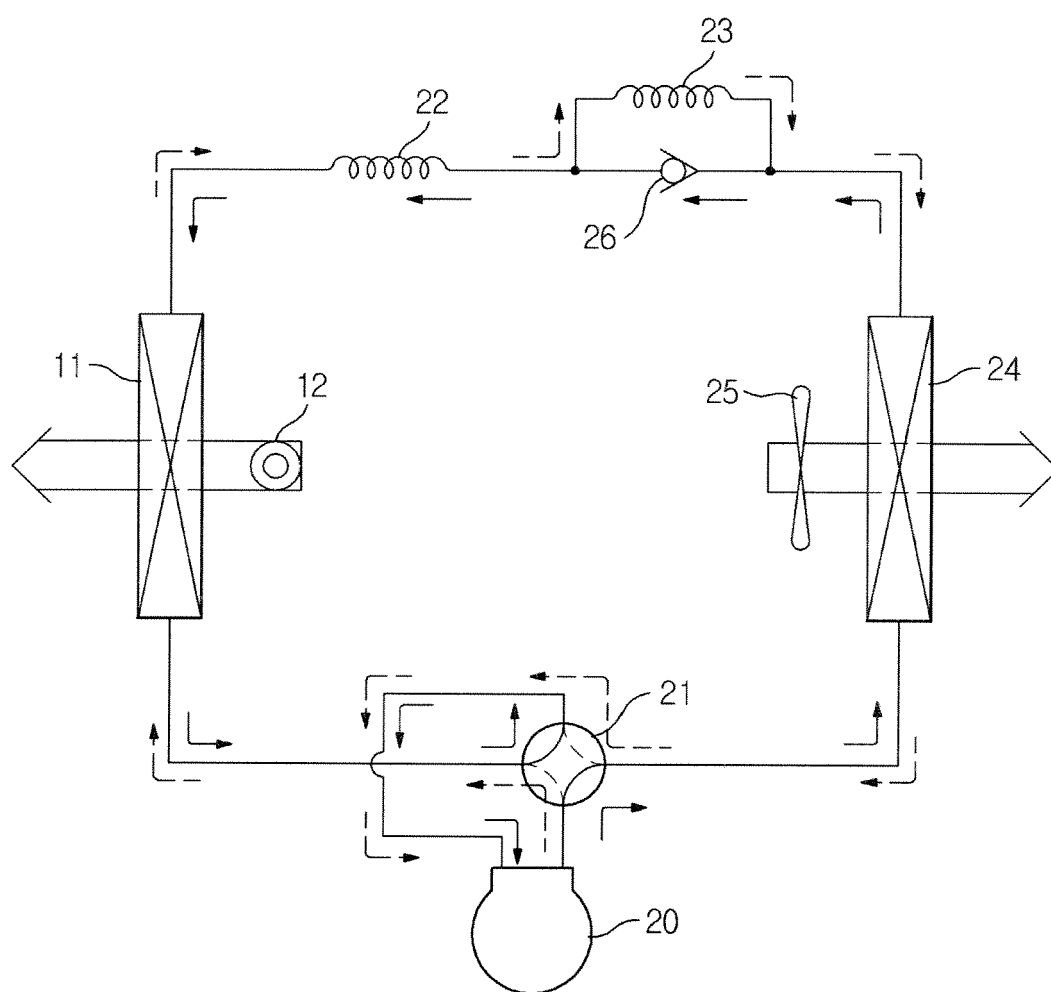


Fig.3

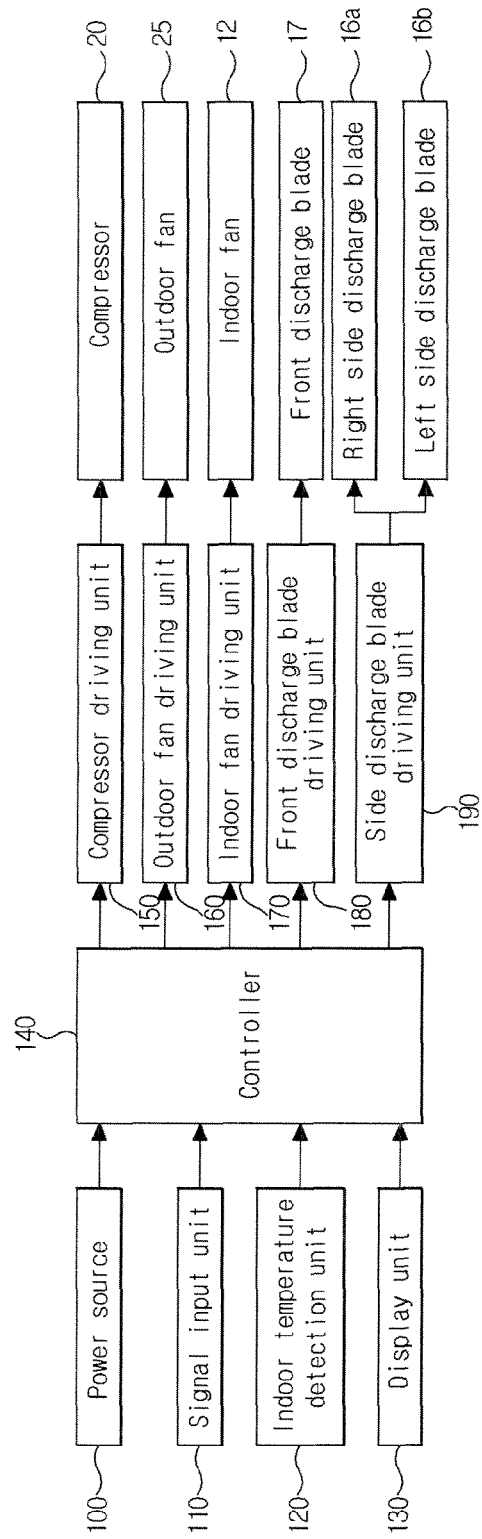
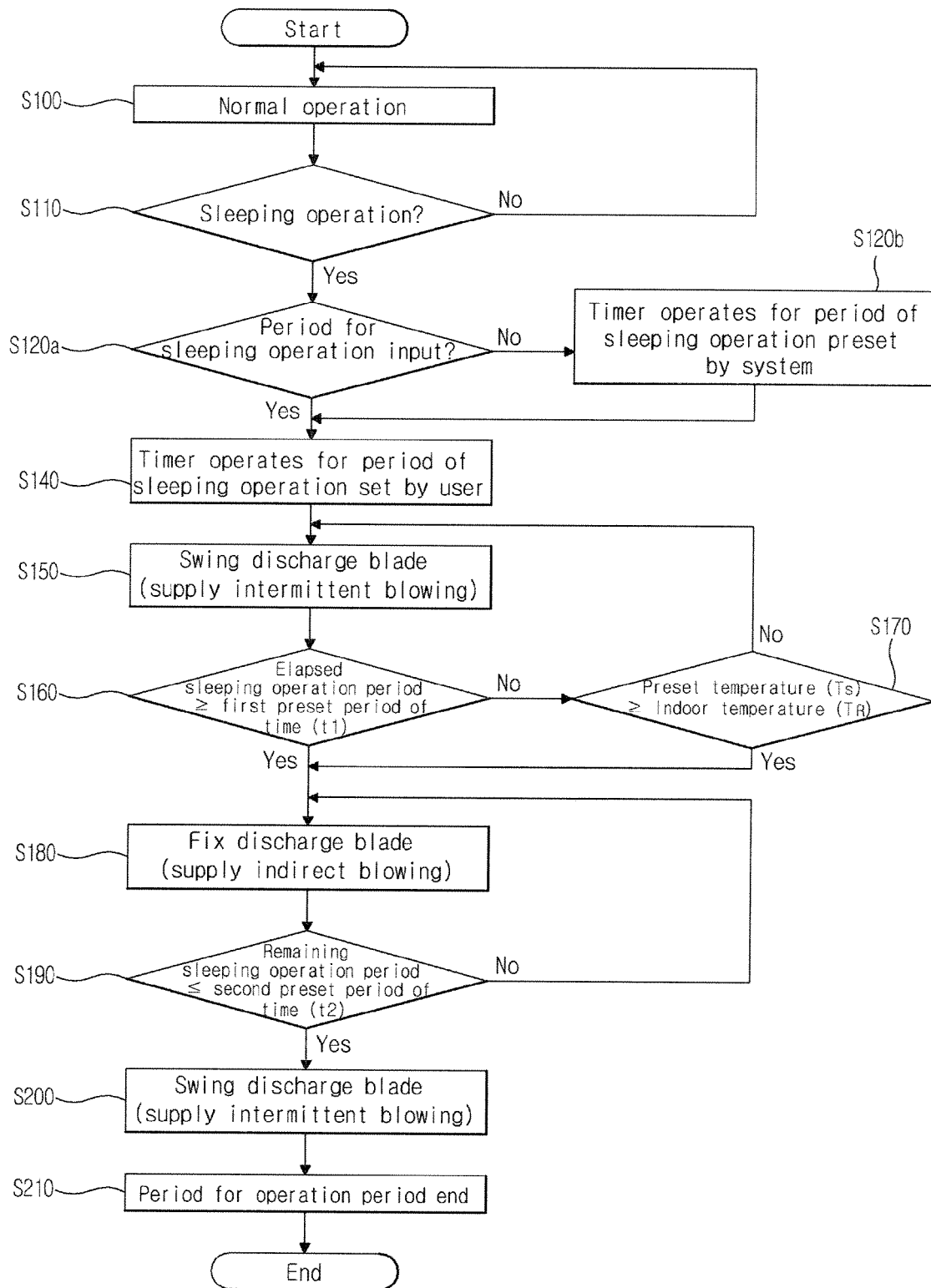


Fig.4



REFERENCES CITED IN THE DESCRIPTION

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