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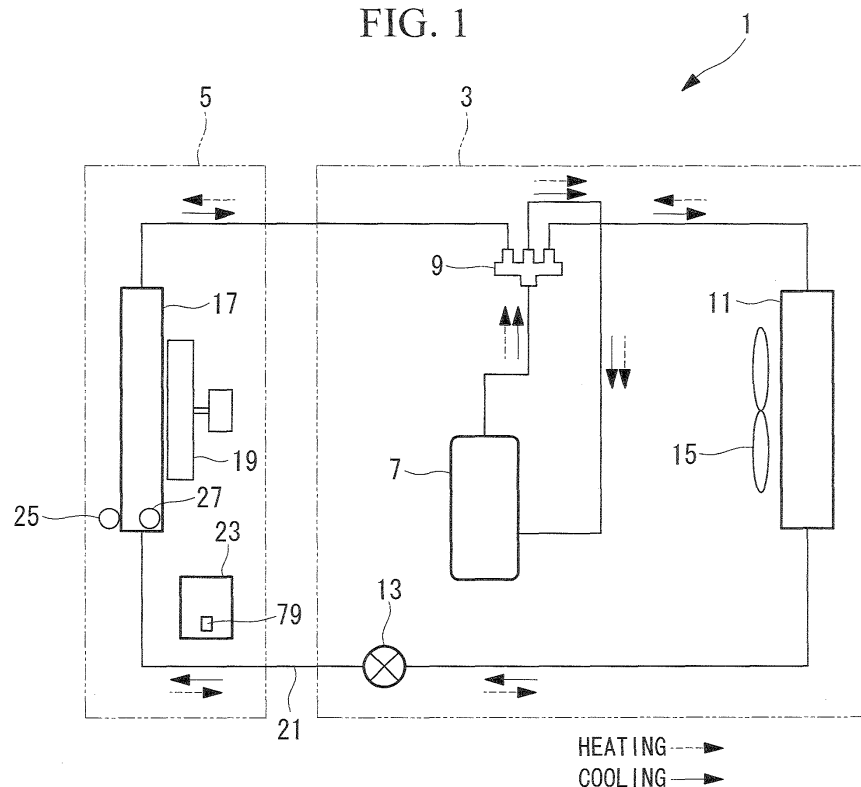
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(54) **Air conditioner**

(57) An object is to provide an air conditioner capable of providing superior reach of warm air upon starting up in a heating mode so that the user can immediately have a feeling of warmth. An air conditioner (1) includes vertically separated upper and lower outlets (41, 45) for blowing conditioned air supplied through an indoor heat exchanger (17) by a turbofan (19) into the interior of a

room; and a controller (23) for controlling operation. The controller (23) has a heating startup mode (79) that is entered upon starting up in a heating mode and in which the conditioned air is blown only from the lower outlet (45) for a predetermined period of time if the air volume is set to an automatic mode and the air direction is set to a mode in which the air is blown from both the upper outlet (41) and the lower outlet (45).

FIG. 1



Description

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

[0001] The present invention relates to air conditioners.

2. DESCRIPTION OF RELATED ART

[0002] A conventionally known air conditioner has vertically separated upper and lower outlets for blowing conditioned air into the interior of a room. This type is often used particularly for a floor-standing indoor unit.

[0003] For this type of air conditioner, the upper and lower outlets can be used alone or together, and the opening/closing thereof is controlled so that they deliver the optimum performance during, for example, a cooling mode or a heating mode. For example, in the heating mode, only the lower outlet is opened to supply heated conditioned air to the lower side of the interior of a room, thus improving the feeling of warmth.

[0004] An air conditioner is designed so that the user can designate, for example, the preset temperature, air volume, and choice of outlets. Generally, the user designates a desired indoor temperature as the preset temperature, and air conditioning is performed under control implemented in the air conditioner, that is, in an automatic mode.

[0005] Users demand that they have a feeling of coolness or warmth immediately upon starting up the air conditioner. To meet that demand, air conditioners employ various techniques.

[0006] For example, an air conditioner disclosed in Japanese Unexamined Patent Application, Publication No. 2007-198641 is designed to increase the air volume and to open upper and lower outlets to supply a large volume of conditioned air from both the upper and lower outlets into the interior of a room so that the user can immediately have a feeling of warmth upon, for example, starting up in the heating mode.

[0007] However, for an air conditioner that supplies warm air from both upper and lower outlets, such as the one disclosed in Japanese Unexamined Patent Application, Publication No. 2007-198641, the warm air from the upper outlet rises, and accordingly, the warm air from the lower outlet tends to rise as it is attracted by the warm air from the upper outlet. In addition, the volume of the warm air blown from the lower outlet is limited.

[0008] Accordingly, the reach of the warm air, particularly, the reach of the warm air toward the user's feet, is shortened. The air conditioner cannot therefore necessarily satisfy the user's demand for immediately having a feeling of warmth.

BRIEF SUMMARY OF THE INVENTION

[0009] In light of such circumstances, an object of the present invention is to provide an air conditioner capable of providing superior reach of warm air upon starting up in a heating mode so that the user can immediately have a feeling of warmth.

[0010] To solve the above problem, an air conditioner of the present invention employs the following solutions.

[0011] That is, an aspect of the present invention is an air conditioner including vertically separated upper and lower outlets for blowing conditioned air supplied through an indoor heat exchanger by a blower into the interior of a room; and a controller for controlling operation. The controller has a heating startup mode that is entered upon starting up in a heating mode and in which the conditioned air is blown only from the lower outlet for a predetermined period of time if the air volume is set to an automatic mode and the air direction is set to a mode in which the air is blown from both the upper outlet and the lower outlet.

[0012] According to the above aspect, the controller enters the heating startup mode upon starting up in the heating mode if the air volume is set to the automatic mode and the air direction is set to the mode in which the air is blown from both the upper outlet and the lower outlet, so that the conditioned air, namely, warm air, is blown only from the lower outlet for the predetermined period of time.

[0013] Thus, the conditioned air distributed to the upper outlet and the lower outlet is blown only from the lower outlet. This increases the volume of conditioned air blown from the lower outlet, even though some of the air remains inside. In addition, the conditioned air blown from the lower outlet is not affected by rising of conditioned air blown from the upper outlet. This prevents rising of the conditioned air blown from the lower outlet. Accordingly, the reach of the conditioned air, namely, warm air, is extended so that it can be blown farther away. In particular, the reach of the warm air is extended toward the user's feet.

[0014] In addition, if the conditioned air is blown only from the lower outlet, the total air volume becomes slightly lower than the case where the conditioned air is blown from the upper outlet and the lower outlet, and accordingly, the temperature of the conditioned air being blown is increased.

[0015] Thus, the heating startup mode allows conditioned air with a higher temperature to be blown far away, thus satisfying the user's demand for immediately having a feeling of warmth.

[0016] The predetermined period of time is, for example, a sufficient period of time for the user in the space being air-conditioned, such as the interior of a room, to have a feeling of warmth. The predetermined period of time is, for example, 10 to 30 minutes.

[0017] During the heating startup mode, the air direction apparently differs from the mode in which the con-

ditioned air is blown from the upper outlet and the lower outlet. This may mislead the user into thinking that a problem has occurred. Accordingly, for example, an indication such as "rapid heating in progress" may be displayed, or a high-power lamp may light up or blink.

[0018] In the above aspect, the blowing speed of the blower may increase in the heating startup mode.

[0019] Thus, because the blowing speed of the blower increases in the heating startup mode, the volume and speed of the conditioned air blown from the lower outlet can be increased.

[0020] This allows a larger volume of conditioned air to be blown farther away, thus more quickly satisfying the user's demand for immediately having a feeling of warmth.

[0021] In the above aspect, the heating startup mode may be terminated before the predetermined period of time has passed if the setting of the air volume or the air direction is changed.

[0022] If the air volume is changed from the automatic mode to, for example, "high", "med", or "low", the controller determines that the user demands that level of air volume and terminates the heating startup mode.

[0023] If the air direction is set to the upper outlet, the controller determines that the user does not demand blowing of the conditioned air from the lower outlet and terminates the heating startup mode.

[0024] Thus, the user's needs are given top priority so that user satisfaction can be improved.

[0025] In the above aspect, the air conditioner may further include intake-air-temperature detecting means for detecting the temperature of indoor air taken into the indoor heat exchanger and inputting the temperature to the controller, and the heating startup mode may be terminated before the predetermined period of time has passed if the temperature of the indoor air approaches a preset heating temperature.

[0026] If the temperature, detected by the intake-air-temperature detecting means, of the indoor air taken into the indoor heat exchanger approaches the preset heating temperature, the controller determines that the user has a feeling of warmth and terminates the heating startup mode.

[0027] In the above aspect, the air conditioner may further include indoor-heat-exchanger-temperature detecting means for detecting the temperature of the indoor heat exchanger and inputting the temperature to the controller, and the heating startup mode need not be entered if the temperature of the indoor heat exchanger does not exceed a predetermined temperature.

[0028] If the temperature of the indoor heat exchanger detected by the indoor-heat-exchanger-temperature detecting means does not exceed the predetermined temperature, the user has no feeling of warmth because conditioned air with low temperature is blown. In this case, therefore, the heating startup mode is not entered because it causes user discomfort.

[0029] According to the present invention, because the

controller has the heating startup mode that is entered upon starting up in the heating mode and in which the conditioned air is blown only from the lower outlet for the predetermined period of time if the air volume is set to the automatic mode and the air direction is set to the mode in which the air is blown from both the upper outlet and the lower outlet, the reach of warm air is extended so that it can be blown farther away, thus satisfying the user's demand for immediately having a feeling of warmth.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0030] Fig. 1 is a diagram of the refrigeration cycle of an air conditioner according to an embodiment of the present invention.

[0031] Fig. 2 is a perspective view showing the appearance of an indoor unit according to the embodiment of the present invention.

[0032] Fig. 3 is a cross-sectional view of the indoor unit according to the embodiment of the present invention.

[0033] Fig. 4 is a flowchart showing a heating startup mode according to the embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0034] An air conditioner 1 according to an embodiment of the present invention will now be described with reference to Figs. 1 to 4. This air conditioner 1 is an example of a floor-standing air conditioner that blows air in two directions, namely, upper and lower directions.

[0035] Fig. 1 shows a diagram of the refrigeration cycle of the air conditioner 1.

[0036] The air conditioner 1 includes an outdoor unit 3 and an indoor unit 5.

[0037] The outdoor unit 3 includes an inverter-driven compressor 7 for compressing a refrigerant, a four-way switch valve 9 for switching the direction in which the refrigerant is circulated, an outdoor heat exchanger 11 for heat exchange between the refrigerant and outdoor air, an expansion valve 13 functioning as a refrigerant-throttling mechanism, and an outdoor air fan 15 for introducing outdoor air and causing it to pass through the outdoor heat exchanger 11.

[0038] The indoor unit 5 includes an indoor heat exchanger 17 supplied with the refrigerant from the outdoor unit 3 and a turbofan (blower) 19 serving as an indoor air fan for introducing air from the interior of a room and, when the air passes through the indoor heat exchanger 17, blowing out conditioned air that has been subjected to heat exchange with the refrigerant.

[0039] The indoor heat exchanger 17 is, for example, of a plate-fin tube type.

[0040] The compressor 7, the four-way valve 9, the outdoor heat exchanger 11, and the expansion valve 13 in the outdoor unit 3 are coupled to the indoor heat ex-

changer 17 in the indoor unit 5 through refrigerant piping 21 to constitute a refrigeration cycle.

[0041] The indoor unit 5 includes a controller 23 for controlling the operation of the air conditioner 1.

[0042] The indoor unit 5 includes an indoor-air temperature sensor (intake-air-temperature detecting means) 25 for detecting the temperature of the indoor air introduced from the interior of the room and an indoor-heat-exchanger temperature sensor (indoor-heat-exchanger-temperature detecting means) 27 for detecting the temperature of the indoor heat exchanger 17.

[0043] The temperature of the indoor air detected by the indoor-air temperature sensor 25 and the temperature of the indoor heat exchanger 17 detected by the indoor-heat-exchanger temperature sensor 27 are input to the controller 23.

[0044] Fig. 2 is a perspective view showing the appearance of the indoor unit 5. Fig. 3 is a cross-sectional view of the indoor unit 5.

[0045] The indoor unit 5 is of a floor-standing type that blows air in two directions, namely, upper and lower directions, and includes a horizontally oriented, substantially rectangular casing 35 composed of a base 31 and a front panel 33.

[0046] The front panel 33 has two inlets 37 separated vertically in the front surface thereof to take in indoor air. The inlets 37 have inlet grilles 39.

[0047] An upper outlet 41 is provided horizontally in the longitudinal direction between the front and top surfaces of the front panel 33. The upper outlet 41 can be opened up and closed off by a horizontal louver 43 rotatably disposed at the opening thereof.

[0048] A lower outlet 45 is provided horizontally in the longitudinal direction at the bottom of the front panel 33. The lower outlet 45 can be opened up and closed off by a horizontal louver 47 rotatably disposed at the opening thereof.

[0049] In the casing 35, an air filter 49 is attachably/detachably disposed behind the inlet grilles 39, and the indoor heat exchanger 17 is fixed behind the air filter 49.

[0050] A drain pan 51 is disposed under the indoor heat exchanger 17 to catch drain water condensed on the surface of the indoor heat exchanger 17 and dropping therefrom during cooling and dehumidifying modes and to drain it to the outside through a drain hose (not shown).

[0051] A bellmouth 53 is disposed behind the indoor heat exchanger 17 (downstream in the airflow direction) to guide air communicated through the indoor heat exchanger 17 to the turbofan 19 disposed downstream thereof.

[0052] A circular-bell-shaped inlet 55 is disposed in the center of the bellmouth 53 so as to face the turbofan 19. In addition, the turbofan 19 is disposed downstream of the bellmouth 53 so as to face the inlet 55.

[0053] The turbofan 19 is composed of a base plate 57, a shroud 59, and a plurality of blades 61. The center of the base plate 57 is fixed to an end of a rotating shaft 65 of a motor 63 fixed to the base 31 so that the motor

63 rotates the turbofan 19 about a horizontal axis.

[0054] The conditioned air blown radially through the turbofan 19 is blown outward from the periphery of the turbofan 19 at a certain angle with respect to the tangential direction thereof.

[0055] An air-guiding channel 67 for guiding the conditioned air blown from the turbofan 19 to the upper outlet 41 is formed between the base 31 and the bellmouth 53.

[0056] An air-guiding channel 69 for guiding the conditioned air blown from the turbofan 19 to the lower outlet 45 is formed between the base 31 and the bellmouth 53.

[0057] Nose portions 71 and 73 for guiding the conditioned air blown from the turbofan 19 are formed integrally with the base 31 so as to constitute the air-guiding channels 67 and 69.

[0058] The upper air-guiding channel 67 has a plurality of vertical louvers 75 arranged in the longitudinal direction of the upper outlet 41. The vertical louvers 75 are each disposed so as to be rotatable about a vertical axis and are coupled together.

[0059] The lower air-guiding channel 69 has a plurality of vertical louvers 77 arranged in the longitudinal direction of the lower outlet 45. The vertical louvers 77 are each disposed so as to be rotatable about a vertical axis and are coupled together.

[0060] The controller 23 receives detected values input from the individual sensors and various settings designated by the user and outputs control signals based on a predetermined program to control the operation of the air conditioner 1.

[0061] The controller 23 controls, for example, the on/off state and the rotational speed of the compressor 7, flow switching by the four-way valve 9, the on/off state and the rotational speed of the turbofan 19 and the outdoor air fan 15, and the opening/closing of the upper outlet 41 and the lower outlet 45.

[0062] The controller 23 has a heating startup mode 79 that is entered upon starting up in a heating mode and in which the conditioned air blown from the turbofan 19 is blown into the interior of the room only from the lower outlet 45 for a predetermined period of time if the air volume is set to an automatic mode and the air direction is set to a mode in which the air is blown from both the upper outlet 41 and the lower outlet 45.

[0063] In the thus-configured air conditioner 1, the direction in which the refrigerant is circulated in the cooling mode and the heating mode is as follows.

[0064] In the cooling mode, the refrigerant is circulated in the direction indicated by the solid-line arrows in Fig. 1. As a result, the outdoor heat exchanger 11 functions as a heat radiator (evaporator), whereas the indoor heat exchanger 17 functions as a heat absorber (condenser). Accordingly, the refrigerant absorbs heat from the indoor air passing through the indoor heat exchanger 17 to decrease the temperature thereof before the conditioned air is blown into the interior of the room.

[0065] In the heating mode, the refrigerant is circulated in the direction indicated by the broken-line arrows in Fig.

1. As a result, the indoor heat exchanger 17 functions as a heat radiator (evaporator), whereas the outdoor heat exchanger 11 functions as a heat absorber (condenser). Accordingly, the refrigerant radiates heat into the indoor air passing through the indoor heat exchanger 17 to increase the temperature thereof before the conditioned air is blown into the interior of the room.

[0066] The conditioned air is blown from the turbofan 19 in the indoor unit 5 as follows.

[0067] As the turbofan 19 is rotated, the indoor air is taken into the casing 35 through the inlets 37 via the inlet grilles 39.

[0068] After dust is removed from the air by the air filter 49, the air is cooled or heated by heat exchange with the refrigerant while passing through the indoor heat exchanger 17, thus generating conditioned air.

[0069] While being guided by the bellmouth 53, the conditioned air is taken through the bell-shaped inlet 55 into the turbofan 19, which increases the pressure thereof.

[0070] The conditioned air whose pressure has been increased by the turbofan 19 is blown outward from the periphery of the turbofan 19 at a certain angle with respect to the tangential direction thereof.

[0071] The conditioned air flows to the upper outlet 41 and/or the lower outlet 45 through the air-guiding channels 67 and 69 while being guided by the nose portions 71 and 73 and is blown into the interior of the room, thus contributing to cooling or heating.

[0072] The conditioned air is selectively blown into the interior of the room via either or both of the upper outlet 41 and the lower outlet 45, depending on the preset blowing mode.

[0073] Next, the operation in the heating startup mode 79 will be described with reference to Fig. 4.

[0074] Fig. 4 is a flowchart showing the heating startup mode 79.

[0075] The user inputs the individual settings such as the preset temperature SP, the air volume, and the air direction to start a heating mode (Step S1).

[0076] In setting the air volume, the user specifically designates, for example, "high", "med", or "low", or designates "auto", in which the controller 23 determines the optimum air volume based on information from the individual sensors.

[0077] In setting the air direction, the user designates both the upper outlet 41 and the lower outlet 45 (bidirectional blowing) or either of them.

[0078] The controller 23 determines whether or not the criteria for starting the heating startup mode 79 are satisfied (Step S2).

[0079] The starting criteria are that the air volume is set to "auto" and that the air direction is set to bidirectional blowing.

[0080] If the starting criteria are not satisfied (NO), the controller 23 cancels the heating startup mode 79 (Step S10).

[0081] If the starting criteria are satisfied (YES), the

controller 23 determines whether the temperature Th2 of the indoor heat exchanger 17 detected by the indoor-heat-exchanger temperature sensor 27 is higher than a predetermined temperature Sh2 (Step S3).

[0082] The predetermined temperature Sh2 is the temperature of the indoor heat exchanger 17 required for the conditioned air passing therethrough to reach a desired temperature, and is set to, for example, 28°C.

[0083] If the detected temperature Th2 is lower than the predetermined temperature Sh2 (NO), the controller 23 suspends operation in the heating startup mode 79.

[0084] This prevents blowing of conditioned air with low temperature, thus avoiding user discomfort due to operation in the heating startup mode 79.

[0085] In addition, for example, if a warm-up timer causes the air conditioner 1 to operate in a warm-up (preset operation) mode, the controller 23 may suspend operation in the heating startup mode 79 and, if necessary, may start operation in the heating startup mode 79 after the preset time of the warm-up timer has passed.

[0086] If the detected temperature Th2 is higher than the predetermined temperature Sh2 (YES), the controller 23 starts operation in the heating startup mode 79 (Step S4).

[0087] That is, in the state shown in Fig. 2, in which both the upper outlet 41 and the lower outlet 45 are opened in the bidirectional blowing mode, the upper outlet 41 is closed off by rotating the horizontal louver 43. As a result, the conditioned air blows only from the lower outlet 45.

[0088] In addition, the rotational speed of the turbofan 19 is increased.

[0089] In this case, the conditioned air distributed to the upper outlet 41 and the lower outlet 45 is blown only from the lower outlet 45. This increases the volume of conditioned air blown from the lower outlet 45, even though some of the air remains inside.

[0090] In addition, the conditioned air blown from the lower outlet 45 is not affected by rising of conditioned air blown from the upper outlet 41. This prevents rising of the conditioned air blown from the lower outlet 45.

[0091] Accordingly, the reach of the conditioned air, namely, warm air, is extended so that it can be blown farther away. In particular, the reach of the warm air is extended toward the user's feet.

[0092] If the conditioned air is blown only from the lower outlet 45, the total air volume becomes slightly lower than the case where the conditioned air is blown from the upper outlet 41 and the lower outlet 45, and accordingly, the temperature of the conditioned air being blown is increased.

[0093] Thus, the operation in the heating startup mode 79 allows conditioned air with a higher temperature to be blown far away, thus satisfying the user's demand for immediately having a feeling of warmth.

[0094] During the operation in the heating startup mode 79, the air direction apparently differs from the mode in which the conditioned air is blown from the upper

outlet 41 and the lower outlet 45. This may mislead the user into thinking that a problem has occurred. To avoid such misunderstanding, for example, an indication such as "rapid heating in progress" may be displayed, or a high-power lamp may light up or blink.

[0095] Because the blowing speed of the turbofan 19 increases in the heating startup mode 79, the volume and speed of the conditioned air blown from the lower outlet 45 can be increased.

[0096] This allows a larger volume of conditioned air to be blown farther away, thus more quickly satisfying the user's demand for immediately having a feeling of warmth.

[0097] During the operation in the heating startup mode 79, the controller 23 sequentially or randomly executes the decisions in Steps S5 to S9 to determine whether the heating startup mode 79 should be cancelled based on the independent decisions in Steps S5 to S9.

[0098] In Step S5, the controller 23 determines whether or not the indoor mode is set to heating. If the indoor mode is set to another mode (NO), the controller 23 cancels the heating startup mode 79 because the prerequisite of currently performing the heating mode is missing.

[0099] In Step S6, the controller 23 determines whether or not the difference between the temperature Th1, detected by the indoor-air temperature sensor 25, of the indoor air introduced from the interior of the room and the preset temperature SP is 2°C or less (where the preset temperature SP is higher). If the indoor air temperature Th1 enters the above range (YES), the controller 23 determines that the user has a feeling of warmth and cancels the heating startup mode 79.

[0100] The above temperature difference, namely, 2°C, is merely illustrative of a temperature difference within which the indoor air temperature Th1 is close to the preset temperature SP. The temperature difference is not limited thereto and may be selected in the range of, for example, -1°C to 3°C, depending on particular situations.

[0101] In Step S7, the controller 23 determines whether or not the air volume is set to "auto". If the air volume is set to another mode (NO), the controller 23 cancels the heating startup mode 79.

[0102] That is, if the air volume is changed from "auto" to, for example, "high", "med", or "low", the controller 23 determines that the user demands that level of air volume and terminates the heating startup mode 79.

[0103] In Step S8, the controller 23 determines whether or not the air direction is set to upper blowing, in which the conditioned air is blown only from the upper outlet 41. If the air direction is set to upper blowing (YES), the controller 23 cancels the heating startup mode 79.

[0104] That is, if the air direction is set to upper blowing, the controller 23 determines that the user does not demand blowing of the conditioned air from the lower outlet 45 and terminates the heating startup mode 79.

[0105] As in Steps S7 and S8, the user's needs are given top priority so that user satisfaction can be im-

proved.

[0106] In Step S9, the controller 23 determines whether or not 20 minutes (predetermined period of time) have passed since starting to operate in the heating startup mode 79. If 20 minutes have passed (YES), the controller 23 determines that the user has a sufficient feeling of warmth and cancels the heating startup mode 79.

[0107] The above predetermined period of time, namely, 20 minutes, is merely illustrative of a sufficient period of time for the user in the space being air-conditioned, such as the interior of a room, to have a feeling of warmth. The predetermined period of time may be selected in the range of, for example, 10 to 30 minutes, depending on particular situations.

[0108] The present invention is not limited to the above embodiment; various modifications are permitted without departing from the spirit thereof.

[0109] For example, the advantages of the invention can be provided even if Steps S5 to S8 are not necessarily used as the determination criteria for canceling the heating startup mode 79; they may be used where needed.

Claims

1. An air conditioner comprising:

vertically separated upper and lower outlets for blowing conditioned air supplied through an indoor heat exchanger by a blower into the interior of a room; and
a controller for controlling operation,

wherein the controller has a heating startup mode that is entered upon starting up in a heating mode and in which the conditioned air is blown only from the lower outlet for a predetermined period of time if the air volume is set to an automatic mode and the air direction is set to a mode in which the air is blown from both the upper outlet and the lower outlet.

2. The air conditioner according to Claim 1, wherein the blowing speed of the blower increases in the heating startup mode.

3. The air conditioner according to Claim 1 or 2, wherein the heating startup mode is terminated before the predetermined period of time has passed if the setting of the air volume or the air direction is changed.

4. The air conditioner according to one of Claims 1 to 3, further comprising intake-air-temperature detecting means for detecting the temperature of indoor air taken into the indoor heat exchanger and inputting the temperature to the controller, wherein the heating startup mode is terminated before the predetermined period of time has passed if

the temperature of the indoor air approaches a pre-set heating temperature.

5. The air conditioner according to one of Claims 1 to 4, further comprising indoor-heat-exchanger-temperature detecting means for detecting the temperature of the indoor heat exchanger and inputting the temperature to the controller, wherein the heating startup mode is not entered if the temperature of the indoor heat exchanger does not exceed a predetermined temperature.

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FIG. 1

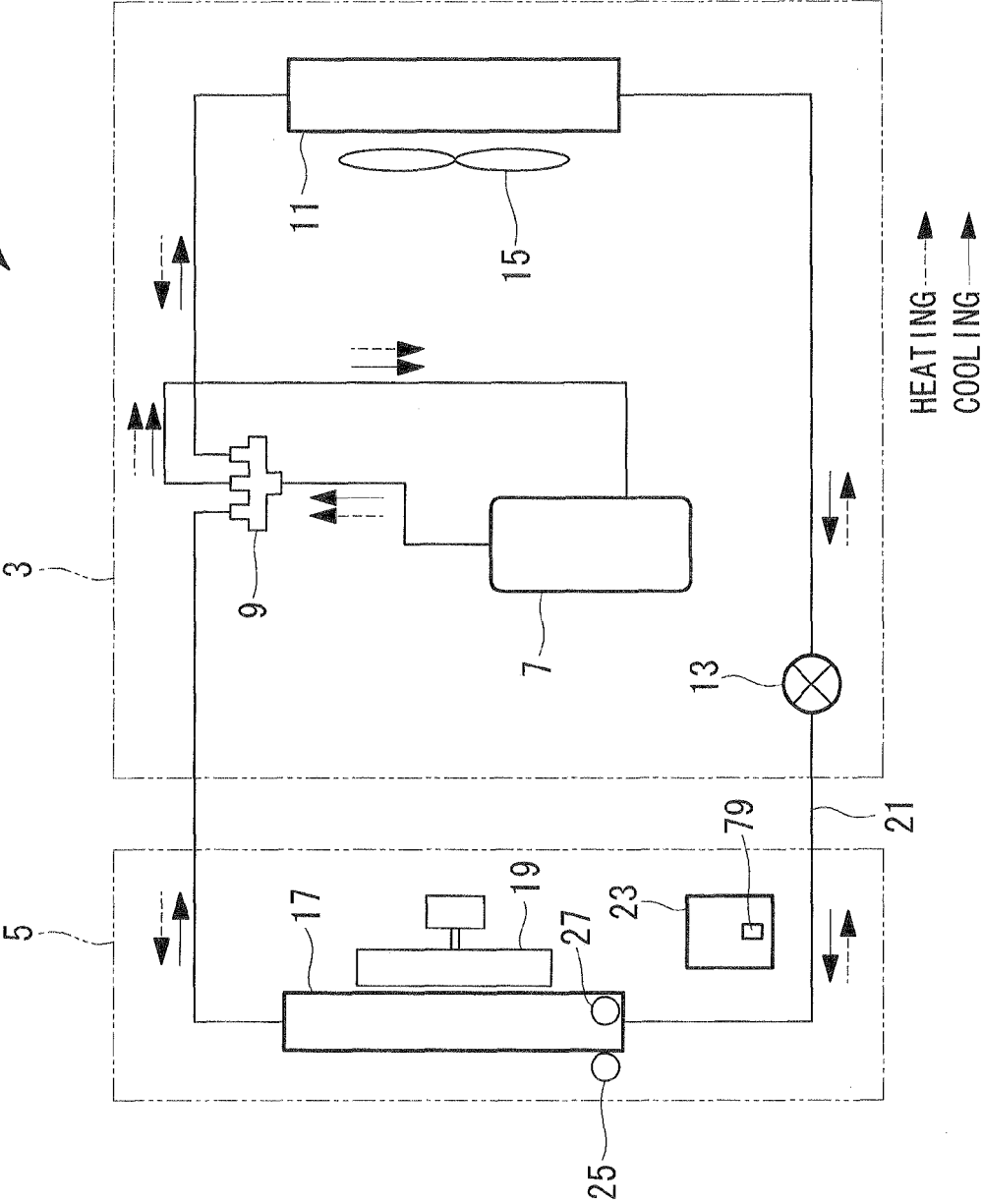


FIG. 2

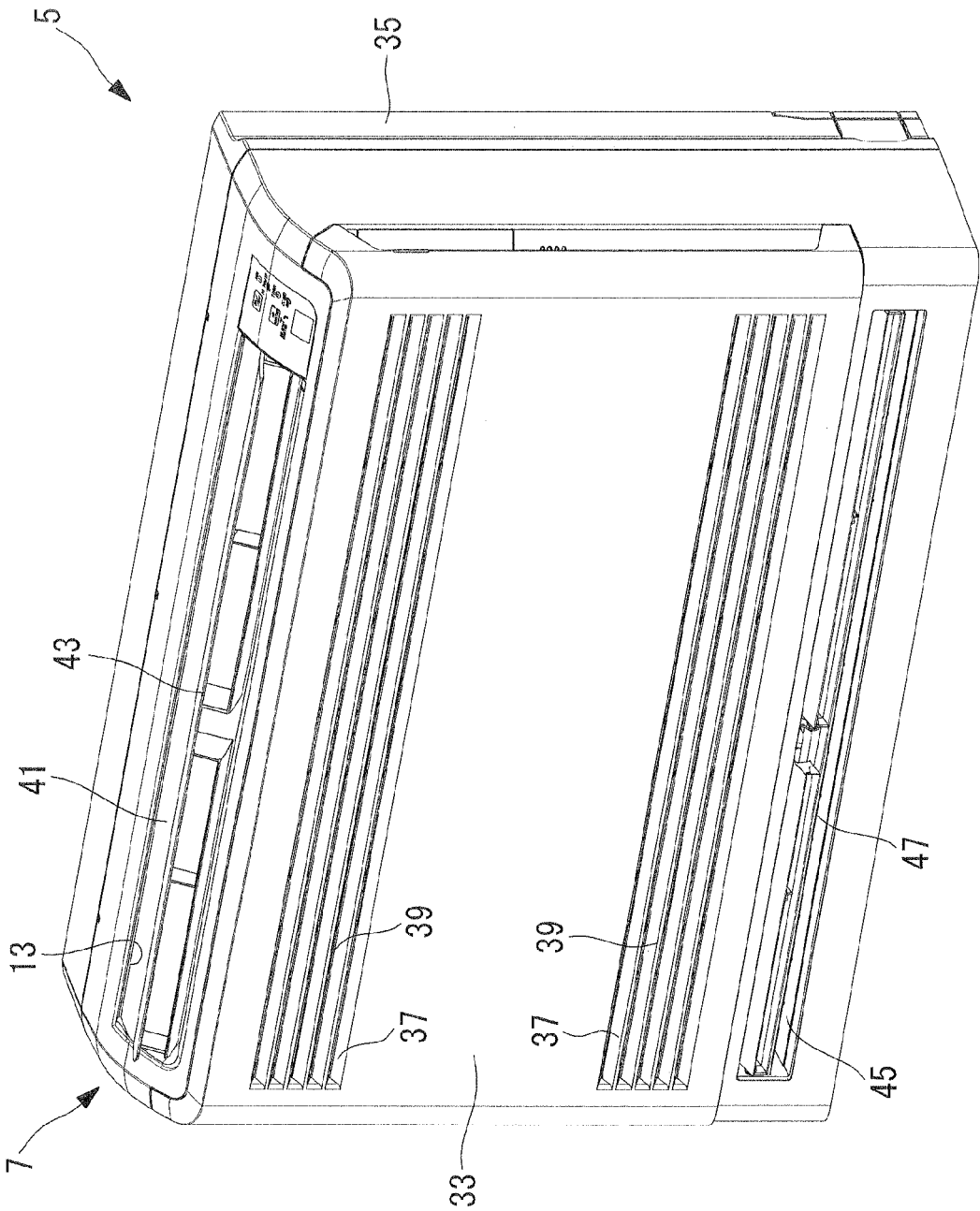


FIG. 3

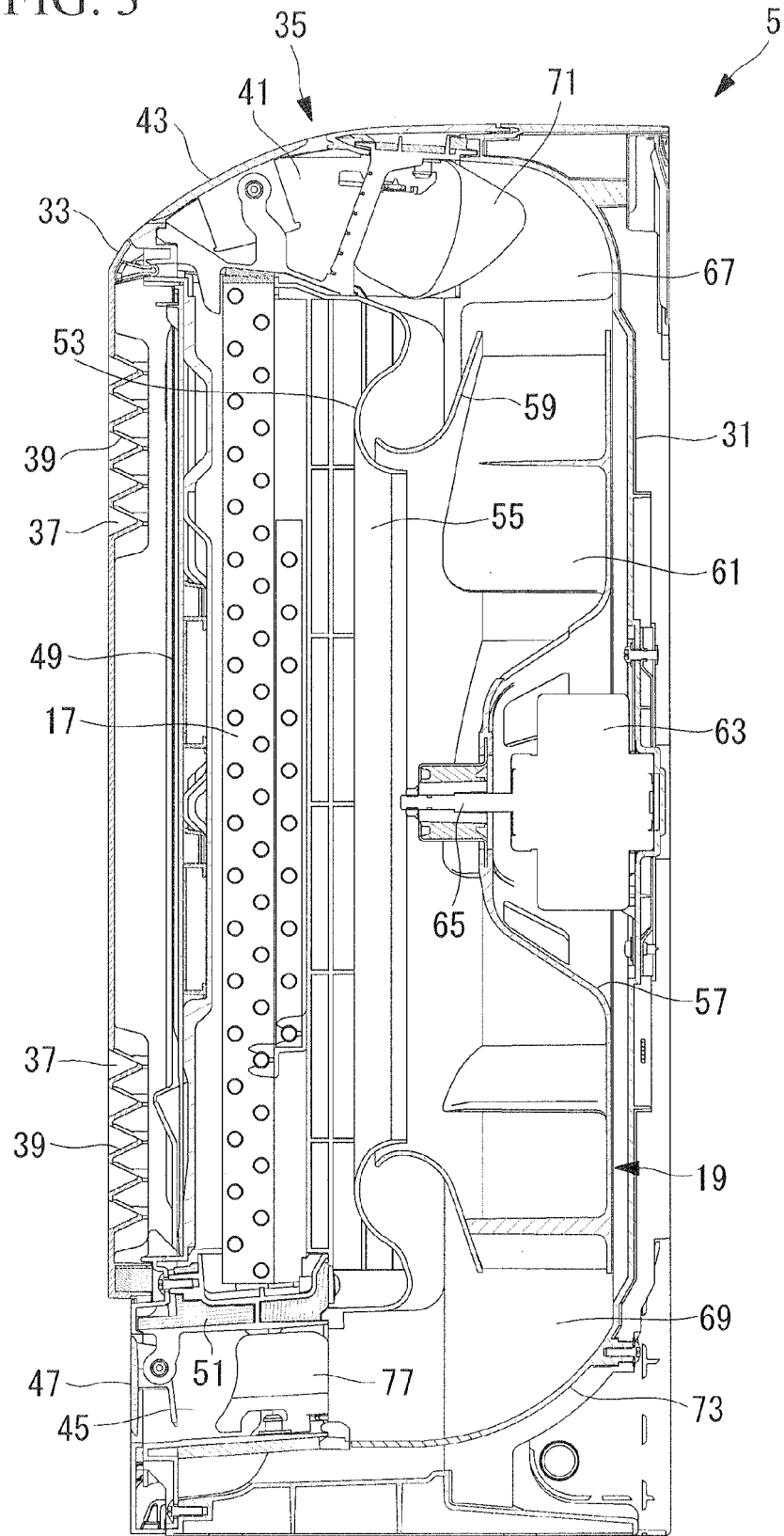
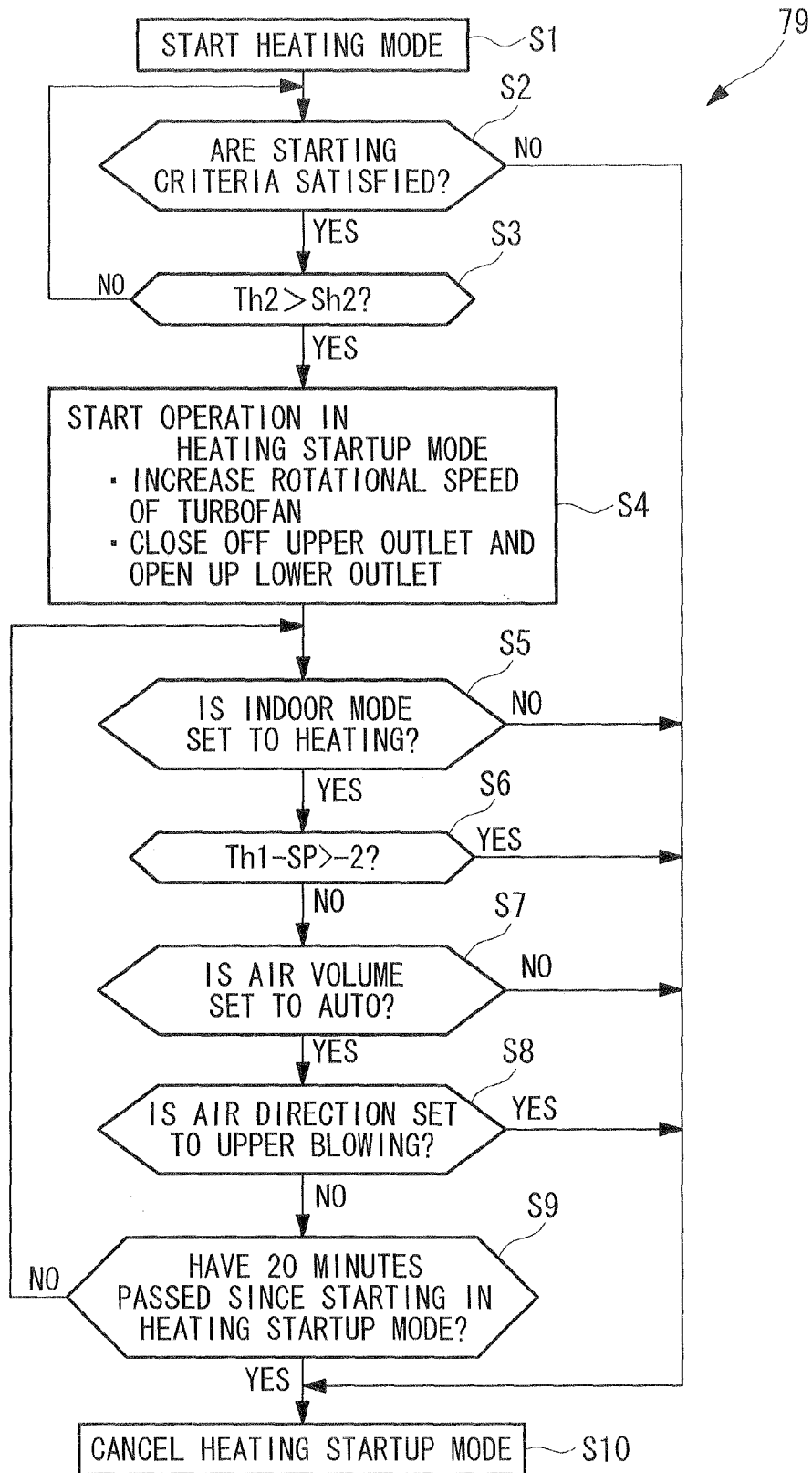


FIG. 4



REFERENCES CITED IN THE DESCRIPTION

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