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(54) AIR CONDITIONER AND METHOD OF CONTROLLING AN AIR CONDITIONER

(57) The present invention relates to an air conditioner 1, in particular an indoor unit of a separate type air conditioner, comprising: an indoor heat exchanger 4; an indoor fan 3 that circulates air, which has undergone heat exchange in the indoor heat exchanger 4, indoors; and a controller 30 that controls at least the indoor fan 3; wherein, the controller 30 is configured to have a first mode in which an air volume of the indoor fan 3 is controlled in dependence on a (present) temperature of the indoor heat exchanger 4 at a start of a heating operation, and a second mode in which the air volume of the indoor fan 3 is kept constant at a start of a heating operation, in particular independent of the temperature of the indoor heat exchanger 4, wherein the controller 30 is configured to activate the second mode when an indoor set temperature for heating operation is set below a predetermined temperature or a user selects the second mode. The present invention further relates to a computer-implemented method of controlling an air conditioner and a controller 30 of an air conditioner 1.

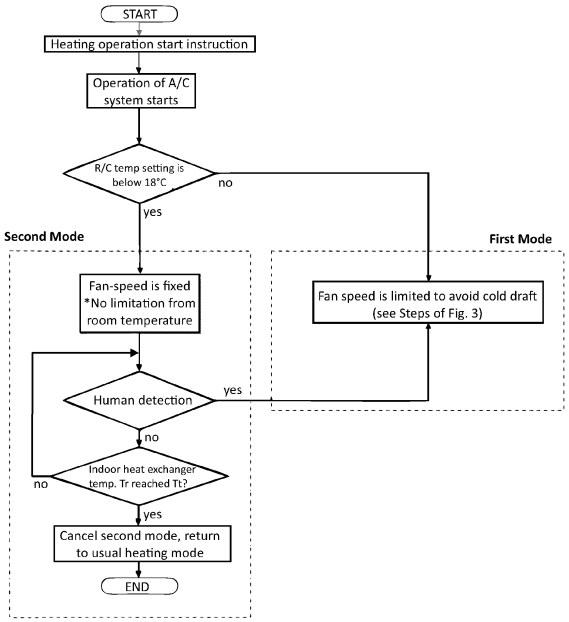

Fig. 5

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Description

Technical field

[0001] The present invention relates to an air conditioner. More particularly, the present invention relates to such air conditioner including a controller that controls at least an indoor fan. The present invention also relates to a computer-implemented method of controlling such air conditioner and a controller for such air conditioner.

Technical Background

[0002] Since an air conditioner uses a vapor compression refrigeration cycle, it takes time to initiate a heating operation. Accordingly, at the start of a heating operation, the temperature of an indoor heat exchanger is low. Thus, when an indoor fan is activated, cold air that would be annoying to a person in a room will be blown out. In the same manner as an air conditioning device described in Japanese Patent No. 3 080 187, conventional air conditioners employ a process that increases the flow rate of the blown air as the indoor heat exchanger temperature increases to increase the initiation speed of the heating operation while limiting the amount of the blown-out cold air. In the present specification, "start of a heating operation" refers to an operation period from when a heating operation is started to when the heating operation stabilizes as a normal heating operation.

[0003] Accordingly, conventional air conditioning devices reduce the blown-airflow rate while the indoor heat exchanger temperature is low at the start of a heating operation and increase the blown-airflow rate based on the temperature of the indoor heat exchanger. However, in case the user wants to use such a conventional air conditioning device for antifreeze protection, for example to prevent water pipes from freezing in winter when a building is temporarily not in use (e.g., a summer house), air circulation is more important than the temperature of the discharged air. Since conventional air conditioning devices impede air circulation in case of low heat exchanger temperature, these devices are not very efficient in terms of antifreeze protection.

Summary of the invention

[0004] In view of the above, there is the desire to provide an air conditioner, a computer-implemented method of controlling an air conditioner and a controller for such an air conditioner that are capable of increasing the efficiency of an air conditioner, in particular an indoor unit of a separate type air conditioner, during antifreeze operation or protection.

[0005] This aim may be achieved by an air conditioner as defined in claim 1, a computer-implemented method of controlling an air conditioner as defined in claim 12 and a controller of an air conditioner as defined in claim 15. Embodiments may be found in the dependent claims, the following description and the accompanying drawings.

[0006] In particular, in view of the limitations discussed above, the present inventors have devised, in accordance with a first aspect herein, an air conditioner, in particular an indoor unit of a separate type air conditioner, comprising: an indoor heat exchanger; an indoor fan that circulates air, which has undergone heat exchange in the indoor heat exchanger, indoors; and a controller that controls at least the indoor fan; wherein, the controller is configured to have a first mode in which an air volume of the indoor fan is controlled in dependence on a (present) temperature of the indoor heat exchanger at a start of a heating operation, and a second mode in which the air volume of the indoor fan is kept constant at a start of a heating operation, in particular independent of the (present) temperature of the indoor heat exchanger, wherein the controller is configured to activate the second mode when an indoor set temperature for heating operation is set below a predetermined temperature or a user selects the second mode (actively).

[0007] Hence, an air conditioner is provided, capable of increasing efficiency of the heating operation during start of a heating operation, namely an operation period from when a heating operation is started to when the heating operation stabilizes as a normal heating operation, particularly at low room temperatures. Accordingly, the air conditioner according to the present invention is capable of providing a more efficient antifreeze protection.

[0008] As used herein, the term "actively" refers to the fact that the user of the air conditioner activates a specific mode, in particular the second mode, by intentionally choosing said mode, for example by pushing a corresponding button on the controller, in particular the remote-control unit. Accordingly, in this case the respective mode, in particular the second mode, is not automatically activated by a logic of the controller, namely the requirement that the indoor set temperature for heating operation is set below the predetermined temperature, but is preselected by the user.

[0009] According to a further aspect of the present invention, the controller may be further configured to activate the second mode when the heating operation is started after the indoor set temperature is set below the predetermined temperature.

[0010] Furthermore, in some aspects of the present invention, the controller may be further configured to start the heating operation, when a room temperature of the room or space to be heated drops below a predetermined minimum room temperature, for example, for antifreeze protection. Accordingly, the heating operation is automatically started when the room temperature of the room or space to be heated drops below the predetermined minimum room temperature, which may be equal to or below the predetermined temperature for activating the second mode, and since generally the predetermined minimum room temperature is set below the predeter-

mined temperature for activating the second mode, the heating operation is started in the second mode.

[0011] Moreover, in some aspects of the present invention, the controller may be further configured to activate the second mode when a user selects or activates the second mode via a control unit, in particular a remote-control unit, or via a remote data transmission (cloud based).

[0012] In the context of the present invention, the term "cloud based" is to be understood such that respective control signal is not provided on side, in particular by the remote-control unit, but via a remote data transmission. In more detail, in order to provide this remote-control option to the user, a worldwide web server is provided allowing the user to send instructions from a portable device like a smartphone or tablet via the worldwide web server to the respective air conditioner. In this case, the user can for example change the indoor set temperature, the minimum room temperature, etc. remotely.

[0013] In some aspects, the air conditioner may further comprise: an indoor outlet that blows out the air, which has undergone heat exchange in the indoor heat exchanger, indoors; and a vertical deflector that is arranged in the indoor outlet to change an air direction in a vertical direction, wherein the controller is further configured to control the air direction of the vertical deflector in the vertical direction, in particular to restrict a position of the vertical deflector so that the vertical deflector is at least faced upward in a blow-out direction adjustment range at the start of the heating operation in the first mode.

[0014] According to a further aspect of the present invention, the controller is further configured to cancel any restriction or not restrict the position of the vertical deflector at the start of the heating operation in the second mode.

[0015] Moreover, the controller may be further configured to increase the air volume of the indoor fan in the first mode as the indoor heat exchanger temperature increases at the start of the heating operation.

[0016] In some aspects of the present invention, the air conditioner may further comprise a human detection sensor configured to detect people inside the room or space to be heated, wherein the controller may be configured to switch from the second mode to the first mode, if people are detected by the human detection sensor, in particular after the second mode is activated and before normal heating operation starts.

[0017] According to a further aspect of the present invention, the air conditioner may further comprise at least one means of feedback for indicating that the air conditioner is set into antifreeze protection operation, wherein the means of feedback may comprise at least one of a light-emitting diode or a liquid crystal display. Moreover, the at least one means of feedback may be provided in a casing of the air conditioner and/or in a remote-control unit.

[0018] Moreover, the controller may be further configured to switch from the first mode or the second mode into a normal heating operation when the indoor heat exchanger temperature reaches a pre-set target temperature, wherein in the normal heating operation preferably any air volume restriction and/or any air direction restriction is cancelled.

[0019] In some aspects of the present invention, the air conditioner may be a wall-mounted indoor unit of a separate type air conditioner, preferably comprising an indoor outlet that is arranged on a lower part of the wall-mounted indoor unit. The controller may be further configured to restrict the position of a vertical deflector so that the vertical deflector is located at an uppermost position in a blow-out direction adjustment range at the start of the heating operation in the first mode.

[0020] According to a further aspect of the present invention, the controller may be configured to keep the air volume of the indoor fan at the start of the heating operation in the second mode at at least 80% of the maximum air volume of the indoor fan, preferably at at least 90% of the maximum air volume of the indoor fan, more preferably at at least 95% of the maximum air volume of the indoor fan.

[0021] Moreover, the predetermined temperature for activating the second mode may be set to 18 degrees Celsius, preferably 15 degrees Celsius, more preferably 10 degrees Celsius.

[0022] The present inventors have further devised, in accordance with a second aspect herein, a computer-implemented method of controlling an air conditioner, in particular an indoor unit of a separate type air conditioner, the method comprising: a first mode in which an air volume of an indoor fan of the air conditioner is controlled in dependence on a (present) temperature of the indoor heat exchanger at a start of a heating operation, and a second mode in which the air volume of the indoor fan is kept constant at a start of a heating operation, in particular independent of the (present) temperature of the indoor heat exchanger, wherein the second mode is activated when an indoor set temperature for heating operation is set below a predetermined temperature or a user selects the second mode (actively).

[0023] Moreover, the second mode may be activated when the heating operation is started after the indoor set temperature is set below the predetermined temperature or when a user selects or activates the second mode via a control unit, in particular a remote-control unit, or via a remote data transmission (cloud based).

[0024] Furthermore, in some aspects of the present invention, the computer-implemented method may further comprise: monitoring the presence of a person inside the room or space to be heated, and switching from the second mode to the first mode if a person is detected, in particular after the second mode is activated and before normal heating operation starts.

[0025] The present inventors have further devised, in accordance with a third aspect herein, a controller of an air conditioner, in particular an indoor unit of a separate type air conditioner, having a control unit and means

adapted to execute the steps of the method according to any one of the above-described aspects.

[0026] The present invention further provides a computer program comprising instructions to cause a controller, in particular the above-described controller, to execute the steps of the computer-implemented method according to any one of the above-described aspects.

[0027] Moreover, a further aspect of the present invention is directed to a computer-readable medium having stored thereon the above-described computer program.

[0028] The use of the air conditioner of the present invention for antifreeze protection may use the computer-implemented method of controlling an air conditioner of the present invention or the controller of an air conditioner of the present invention. Therefore, the further features disclosed in connection with the above description of the air conditioner may also be applied to the computer-implemented method of controlling an air conditioner and vice-versa. The same applies to the controller and the computer program.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] A more complete appreciation of the present invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, in which:

Fig. 1 shows a schematic cross-sectional view of a wallmounted indoor unit of an air conditioner in accordance with one embodiment of the present invention;

Fig. 2 shows a functional block diagram of the air conditioner in accordance with one embodiment of the present invention;

Fig. 3 shows a flowchart illustrating an action in a blowout air control at the start of a heating operation of the air conditioner in a first mode in accordance with one embodiment of the present invention;

Fig. 4 shows a diagram illustrating a relationship of an indoor heat exchanger temperature and an air volume of an indoor fan in the blow-out air control at the start of the heating operation in the first mode of the air conditioner; and

Fig. 5 shows a flowchart illustrating an action in a blowout air control at the start of a heating operation of the air conditioner in a second mode in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

[0030] Embodiments of the present disclosure will now be explained with reference to the drawings. It will be apparent to those skilled in the field of air conditioning devices from this disclosure that the following description of the embodiments is provided for illustration only and not for the purpose of limiting the disclosure as defined by the appended claims. Features of the embodiments described below can also be used to further characterize the devices and method defined in the claims.

[0031] Modifications of features can be combined to form further embodiments. Features described in individual embodiments can be provided in a single embodiment if they are not incompatible. Likewise, features described in a single embodiment can be provided in several embodiments individually or in any suitable sub-combination. As used in the specification and the appended claims, the singular forms "a", "an", "the" and the like include plural referents unless the context clearly dictates otherwise.

[0032] The same reference numerals listed in different drawings refer to identical, corresponding or functionally similar elements. Moreover, where technical features in the drawings, detailed description or any claims are followed by reference signs, the reference signs have been included for the sole purpose of increasing the intelligibility of the drawings, detailed description, and claims. Accordingly, neither the reference signs nor their absence has any limiting effect on the scope of any claim elements.

[0033] As described hereinafter, example implementations of the present invention relate to an air conditioner. The air conditioner in accordance with the present embodiment includes a wall-mounted indoor unit 1 shown in Figure 1 and an outdoor unit 20 (refer to Figure 2) and performs heat-pump type cooling and heating operations.

[0034] The wall-mounted indoor unit 10 is entirely elongated in one direction and mounted on a wall surface of a room so that its longitudinal direction is horizontal. As shown in Fig. 1, the wall-mounted indoor unit 10 includes a casing 2, an indoor fan 3 accommodated in the casing 2, an indoor heat exchanger 4, sideward deflectors 5, a vertical deflector 6, an auxiliary vertical deflector 7, and the like.

[0035] The casing 2 includes a substantially box-shaped casing base 11 and a front panel 12. The casing base 11 is open at the front, and the front panel 12 covers the open front portion of the casing base 11. The casing base 11 includes an upper surface, in which an indoor inlet 13 is formed, and a lower surface, in which an indoor outlet 14 is formed. The indoor inlet 13 is a grid-like opening elongated in a sideward direction, and the indoor outlet 14 is a rectangular opening elongated in the sideward direction. When performing an air conditioning operation (cooling operation or heating operation), the indoor fan 3, which is arranged in an air flow path from the indoor

inlet 13 to the indoor outlet 14, is driven to draw in air through the indoor inlet 13 so that the air performs heat exchange (i.e., becomes heated or cooled) in the indoor heat exchanger 4 and is then blown out of the indoor outlet 14 into the room.

[0036] The sideward deflectors 5 are arranged at an inner side of the indoor outlet 14 to adjust an air direction of the air blown out of the indoor outlet 14 in the sideward direction.

[0037] The vertical deflector 6 adjusts the air direction of the air blown out of the indoor outlet 14 in a vertical direction. The vertical deflector 6 includes a pivot centre C1 at an intermediate position of the indoor outlet 14 in the vertical direction. The vertical deflector 6 indicated by the solid lines in Fig. 1 is located at the uppermost position in a blow-out direction adjustment range of the vertical deflector 6. Further, the vertical deflector 6 indicated by the double-dashed lines in Fig. 1 is located at the lowermost position in the blow-out direction adjustment range of the vertical deflector 6. The uppermost position in the blow-out direction adjustment range corresponds to a position at which the vertical deflector 6 is practically horizontal in the same manner as a typical wall-mounted indoor unit. Further, in response to an operation instruction of a user during a cooling operation or a heating operation, the vertical deflector 6 is configured to be swung by a drive motor (not shown) between the solid line position and the double-dashed line position and held at any position between the solid line position and the double-dashed line position.

[0038] The auxiliary vertical deflector 7 is arranged along an upper structural portion of the indoor outlet 14 to prevent water from collecting on the inner surface of the vertical deflector 6 during a cooling operation. The auxiliary vertical deflector 7 is configured to adjust the air direction of the blown-out air between a solid line position and a double-dashed line position in Fig. 1 about a pivot center C2. The auxiliary vertical deflector 7 is automatically controlled to be held at an optimal position in cooperation with the position of the vertical deflector 6 in the blow-out direction adjustment range during a cooling operation. However, during a heating operation, the auxiliary vertical deflector 7 is held at the uppermost position (solid line in Fig. 1) in a blow-out direction adjustment range. The description of the present embodiment is related to actions at the start of a heating operation. Thus, actions of the auxiliary vertical deflector 7 during a cooling operation will not be described.

[0039] Further, when a cooling operation and a heating operation are stopped, the vertical deflector 6 and the auxiliary vertical deflector 7 are each configured to be pivoted to a position located further upward from the uppermost position in the corresponding blow-out direction adjustment range so that the vertical deflector 6 and the auxiliary vertical deflector 7 are in contact with the upper structural portion of the indoor outlet 14 (that is, closed positions) to close the indoor outlet 14. In this manner, the vertical deflector 6 also serves as a cover member of the indoor outlet 14.

[0040] In the same manner as a typical wall-mounted indoor unit, an airflow resistance of the indoor outlet 14 becomes maximized when the vertical deflector 6 is at the uppermost position in the blow-out direction adjustment range. The air flow resistance of the indoor outlet 14 decreases at positions downward from the uppermost position and becomes minimized at a middle position between the uppermost position and the lowermost position. This effect is caused by the bending state of the air flow path and changes in the dimensions of the space between the two deflectors where air flows. Therefore, when the vertical deflector 6 is at an intermediate position in the blow-out direction adjustment range, the volume of blown-out air from the indoor outlet 14 is increased as compared to when the vertical deflector 6 is at the uppermost position in the blow-out direction adjustment range.

[0041] Figure 2 shows a functional block diagram of the air conditioner 1 in accordance with one embodiment of the present invention. As shown in Figure 2, the wall-mounted indoor unit 10 incorporates a controller 30 that entirely controls the operation of the air conditioner. The controller 30 is configured by a memory that stores predetermined control programs, a processor that runs on the control programs to perform various controls, and the like. Further, the controller 30 includes an air volume controller 31 and an air direction controller 32. The air volume controller 31 restricts the air volume produced by the indoor fan 3 at the start of a heating operation. The air direction controller 32 controls the vertical air direction with the vertical deflector 6 at the start of a heating operation. The controller 30 further includes a transmission/reception circuit unit 33, which performs communication with the outdoor unit 20, and the like.

[0042] The controller 30 may comprise one or more processing units or modules (e.g. a central processing unit (CPU) such as a microprocessor, or a suitably programmed field programmable gate array (FPGA) or application-specific integrated circuit (ASIC)). Additionally, or alternatively, the controller 30 may be provided with any memory sections (not shown) necessary to perform its function of controlling operation of the air conditioner 1. Such memory sections may be provided as part of (comprised in) the controller 30 (e.g. integrally formed or provided on the same chip) or provided separately, but electrically connected to the controller 30. By way of example, the memory sections may comprise both volatile and non-volatile memory resources, including, for example, a working memory (e.g. a random access memory). In addition, the memory sections may include an instruction store (e.g. a ROM in the form of an electrically-erasable programmable read-only memory (EEPROM) or flash memory) storing a computer program comprising computer-readable instructions which, when executed by the controller 30, cause the controller 30 to perform various functions described herein.

[0043] The computer program comprising the compu-

ter-readable instructions which, when executed by the controller 30, cause the controller 30 to perform various functions described herein may, for example, be a software or a firmware program.

[0044] The control device 30 is connected to the indoor fan 3 and an indoor heat-exchanger temperature sensor 41. The indoor fan 3 is an indoor circulation fan that circulates the air, which has undergone heat exchange in the indoor heat exchanger 4, indoors. The indoor fan 3 includes a drive motor, of which rotational speed is controlled based on an instruction from the air volume controller 31 for control of the air volume.

[0045] The indoor heat-exchanger temperature sensor 41 is attached to the indoor heat exchanger 4 at a position that allows for detection of an average temperature of the indoor heat exchanger 4 as an indoor heat exchanger temperature Tr. The indoor heat exchanger temperature Tr detected by the indoor heat-exchanger temperature sensor 41 is transmitted to the controller 30 and used as reference data for the air volume control of the indoor fan 3 by the air volume controller 31 and the air direction control of the vertical deflector 6 by the air direction controller 32.

[0046] Further, the controller 30 is connected to drive units of the vertical deflector 6, the auxiliary vertical deflector 7, and the sideward deflector 5 so that the deflectors are controlled by the air direction controller 32. In addition, the control device 30 is connected to an electric expansion valve 42 that controls a refrigerant to the indoor heat exchanger 4. An opening degree of the electric expansion valve 42 is controlled by an instruction from the controller 30.

[0047] Also, the wall-mounted indoor unit 10 includes a remote-control unit 43 as an accessory. The remote-control unit 43 functions as an operation unit of the air conditioner 1 and includes an operation switch, an operation mode selection portion, a setting portion, an air volume setting portion, a means of feedback (e.g., a display), and the like. The operation switch starts and ends operation of the air conditioner 1. The setting portion sets a set temperature for the indoor air. The air volume setting portion sets the air volume of the indoor fan during a normal heating operation. The display shows the indoor temperature or the air volume of the indoor fan. The remote-control unit 43 is configured to transmit operating information, which is selected or set, to the controller 30 through wireless communication.

[0048] The outdoor unit 20 includes a compressor 21, an outdoor fan 22, as well as an outdoor controller 23 that controls these devices. Further, the outdoor unit 20 includes a four-way switching valve (not shown) that switches a refrigerant circuit between a cooling cycle and a heating cycle. The switching of the four-way switching valve is controlled by the outdoor controller 23. Also, the controller 30 of the wall-mounted indoor unit 10 is electrically connected to the outdoor controller 23 via the transmit/receive circuit unit 33, and operating information from the remote-control unit 43 received by the controller 30 is also transmitted to the outdoor controller 23.

[First Mode]

[0049] With reference to Figures 3 and 4, the air volume control of the indoor fan 3 and the air direction control of the vertical deflector 6 at the start of a heating operation according to the first mode, that is, a blow-out air control at the start of a heating operation which will now be described as an operation of the air conditioner 1. Specifically, the air direction of the vertical deflector 6 and the air volume of the indoor fan 3 will be controlled in accordance with the flowchart, which is described later, and instructions from the remote-control unit 43 will be ignored until the indoor heat exchanger temperature Tr reaches a predetermined target set temperature Tt.

[0050] When a heating operation start instruction is output from the remote-control unit 43 (step S1), the refrigerant circuit is switched to heating cycle to start operating the compressor 21 and the outdoor fan 22. This starts a heating operation of the air conditioner. In this case, the vertical deflector 6 and the auxiliary vertical deflector 7 arranged in the indoor outlet 14 open from the closed positions, which close the indoor outlet 14, and are pivoted to the uppermost positions in the blow-out direction adjustment range. Then, the vertical deflector 6 is held at this position until the air direction restriction is canceled (step S2). The auxiliary vertical deflector 7 is held at the uppermost position in the blow-out direction adjustment range during a heating operation and does not perform any other specific controls in the blow-out air control at the start of a heating operation.

[0051] The indoor heat exchanger 4 is not heated when the heating operation has just started. Thus, the indoor heat exchanger temperature Tr is lower than a first switching temperature T1 shown in Fig. 4. That is, the air volume of the indoor fan 3 is restricted in a fan operation prohibition zone indicated in Fig. 4. Thus, when the indoor heat exchanger temperature Tr is lower than the first switching temperature T1, the compressor 21 is operated and the indoor fan 3 is stopped (step S3).

[0052] Subsequently, when the indoor heat exchanger temperature Tr increases to the first switching temperature T1 as time elapses (YES in step S4), the restriction on the air volume of the indoor fan 3 is switched to a minimum air volume zone indicated in Fig. 4. This operates the indoor fan 3 to generate the minimum air volume (step S5). When step S4 is NO, the control device 30 returns to step S3.

[0053] Then, when the indoor heat exchanger temperature Tr increases to a second switching temperature T2 as time elapses (YES in step S6), the restriction on the air volume of the indoor fan 3 is switched to an intermediate air volume zone indicated in Fig. 4. This operates the indoor fan 3 to generate an intermediate air volume (step S7). When step S6 is NO, the control device 30 returns to step S5.

[0054] Next, when the indoor heat exchanger temper-

ature Tr increases to a third switching temperature T3 as time elapses further (YES in step S8), the restriction on the volume of the indoor fan 3 is switched to a maximum air volume zone indicated in Fig. 4. This operates the indoor fan 3 to generate the maximum air volume (step S9). When step S8 is NO, the control device 30 returns to step S7.

[0055] In this manner, when the indoor heat exchanger temperature Tr increases further to the target set temperature Tt as time elapses (YES in step S10), it is assumed that the temperature of the blown-out air has been increased to a point where cold air that would be annoying to a person in a room will not be blown out. Thus, the restriction on the air direction of the vertical deflector 6 and the restriction on the air volume of the indoor fan 3 are canceled (step S11). This ends the blow-out air control at the start of a heating operation according to the first mode. In this manner, the heating operation stabilizes and becomes normal after the indoor heat exchanger temperature Tr reaches the target set temperature Tt. Specifically, when the restriction on the air direction of the vertical deflector 6 and the restriction on the air volume of the indoor fan 3 are canceled, the indoor fan 3 is operated at the air volume set by the remote-control unit 43 and the vertical deflector 6 is moved to the position set by the remote-control unit 43 for heating operation.

[0056] Here, the restriction on the air direction of the vertical deflector 6 is canceled when the indoor heat exchanger temperature Tr becomes equal to the target set temperature Tt, which is higher than the third switching temperature T3, instead of when the indoor heat exchanger temperature Tr becomes equal to the third switching temperature T3. This is because when the vertical deflector 6 is shifted to a position downward from the uppermost position in the blow-out direction adjustment range, the volume of the blown-out air will increase and the indoor heat exchanger temperature Tr may decrease in accordance with the increase. In the same manner, the restriction on the air volume of the indoor fan 3 is canceled when the indoor heat exchanger temperature Tr becomes equal to the target set temperature Tt, which is higher than the third switching temperature T3, instead of when the indoor heat exchanger temperature Tr becomes equal to the third switching temperature T3 in order to increase the initiation speed of the heating operation as soon as possible.

[0057] In the blow-out air control at the start of a heating operation, the switching temperatures T1, T2, and T3, which are set for the indoor heat exchanger temperature Tr indicated in Fig. 4, are set to be lower when the indoor heat exchanger temperature Tr is decreasing than when the indoor heat exchanger temperature Tr is increasing. This is to avoid chattering of the indoor heat-exchanger temperature sensor 41 and hunting of the air volume of the indoor fan 3.

[Second Mode]

[0058] Fig. 5 shows a flowchart illustrating an action in a blow-out air control at the start of a heating operation of the air conditioner in a second mode in accordance with one embodiment of the present invention.

[0059] Similar to the embodiment explained with respect to Figs. 3 and 4, the refrigerant circuit is switched to heating cycle to start operating the compressor 21 and the outdoor fan 22 when a heating operation start instruction is output from the remote-control unit 43. This starts a heating operation of the air conditioner.

[0060] After the heating operation is started, the air conditioner 1, in particular its controller 30, determines whether or not an indoor set temperature for the heating operation is set below a predetermined temperature, in the present case below 18°C, and switches to a first mode or a second mode depending thereon. In case the indoor set temperature is set above 18°C, the controller switches in the first mode in which a fan speed of the indoor fan 3 is limited to avoid cold draft. In other words, an air volume of the indoor fan 4 is controlled in dependence on a temperature of the indoor heat exchanger at the start of the heating operation. This first mode of operation has already been explained in detail above with reference to the embodiment shown in Figs. 3 and 4.

[0061] On the other hand, in case the indoor set temperature is set below 18°C, the controller switches in the second mode in which the air volume of the indoor fan is kept constant at a start of the heating operation. In other words, contrary to the first mode the air volume of the indoor fan is not controlled in dependence on the temperature of the indoor heat exchanger at the start of the heating operation. This means, at the start of the heating operation, when the indoor set temperature is set below 18°C, the indoor fan speed is set to a fixed speed or fixed air volume, and unlike the first mode, there are no restrictions on the position of the vertical deflector.

[0062] The air volume of the indoor fan 3 may be operated at the start of the heating operation at 80% of the maximum air volume of the indoor fan, preferably at 90% of the maximum air volume of the indoor fan.

[0063] Subsequently, or optionally, a human detection step is performed, which detects the presence of a person in the room or space to be heated. In case a person is detected in the room or space to be heated, the controller 30 switches into the first mode, in which the fan speed is limited to avoid cold draft.

[0064] Then, when the indoor heat exchanger temperature Tr increases as time elapses, the indoor heat exchanger temperature is continuously compared with the target set temperature Tt, and once the indoor heat exchanger temperature Tr reaches the target set temperature Ts as time elapses, the second mode is canceled and the controller 30 returns to the usual heating mode. In this manner, the heating operation stabilizes and becomes normal after the indoor heat exchanger temperature Tr reaches the target set temperature Tt.

[0065] The second mode is particularly interesting for the case that the heating operation is started after the indoor set temperature is set below the predetermined temperature, in the present case below 18°C. This may be for example the case, when the start of the heating operation is triggered by a drop of the room temperature below a predetermined minimum room temperature, for example for antifreeze protection.

[0066] Although detailed embodiments have been described, they only serve to provide a better understanding of the invention defined by the independent claims, and are not to be seen as limiting.

REFERENCE LIST

[0067]

1	Air conditioner
2	Casing
3	Indoor fan
4	Indoor heat exchanger
5	Sideward Deflector
6	Vertical Deflector
10	Indoor unit
11	Casing base
12	Front panel
13	Indoor inlet (Air)
14	Indoor outlet (Air)
C1	Pivot center C1
C2	Pivot center C2
20	Outdoor unit
21	Compressor
22	Outdoor fan
23	Outdoor controller
30	Controller (Indoor controller)
31	Air volume controller
32	Air direction controller
33	Transmission/Reception circuit unit
34	Remote-Control unit

Claims

1. An air conditioner (1), comprising:

an indoor heat exchanger (4);
an indoor fan (3) that circulates air, which has undergone heat exchange in the indoor heat exchanger (4), indoors; and
a controller (30) that controls at least the indoor fan (3); wherein,
the controller (30) is configured to have a first mode in which an air volume of the indoor fan (3) is controlled in dependence on a temperature of the indoor heat exchanger (4) at a start of a heating operation, and a second mode in which the air volume of the indoor fan (3) is kept constant at a start of a heating operation, independent of the temperature of the indoor heat exchanger (4), wherein
the controller (30) is configured to activate the second mode when an indoor set temperature for heating operation is set below a predetermined temperature or a user selects the second mode.

2. The air conditioner (1) according to claim 1, wherein the controller (30) is further configured to activate the second mode when the heating operation is started after the indoor set temperature is set below the predetermined temperature.

3. The air conditioner (1) according to claim 1 or 2, wherein the controller (30) is further configured to activate the second mode when a user selects or activates the second mode via a control unit.

4. The air conditioner (1) according to any one of the preceding claims, further comprising:

an indoor outlet (14) that blows out the air, which has undergone heat exchange in the indoor heat exchanger (4), indoors; and
a vertical deflector (6) that is arranged in the indoor outlet (14) to change an air direction in a vertical direction,
wherein the controller (30) is further configured to control the air direction of the vertical deflector (6) in the vertical direction, in particular to restrict a position of the vertical deflector (6) so that the vertical deflector (6) is at least faced upward in a blow-out direction adjustment range at the start of the heating operation in the first mode.

5. The air conditioner (1) according to claim 4, wherein the controller (30) is further configured to cancel any restriction or not restrict the position of the vertical deflector at the start of the heating operation in the second mode.

6. The air conditioner (1) according to any one of the preceding claims,
wherein the controller (30) is configured to increase the air volume of the indoor fan (3) in the first mode as the indoor heat exchanger temperature increases at the start of the heating operation.

7. The air conditioner (1) according to any one of the preceding claims,

further comprising a human detection sensor

configured to detect people inside the room to be heated,
wherein the controller (30) is configured to switch from the second mode to the first mode, if people are detected by the human detection sensor, after the second mode is activated and before normal heating operation starts.

8. The air conditioner (1) according to any one of the preceding claims,
wherein the controller (30) is configured to switch from the first mode or the second mode into a normal heating operation when the indoor heat exchanger temperature reaches a pre-set target temperature, wherein in the normal heating operation any air volume restriction and/or any air direction restriction is cancelled.

9. The air conditioner (1) according to any one of the preceding claims,

wherein the air conditioner (1) is a wall-mounted indoor unit (10) of a separate type air conditioner,
an indoor outlet (14) is arranged on a lower part of the wall-mounted indoor unit (1), and
the controller (30) is preferably configured to restrict the position of a vertical deflector (6) so that the vertical deflector (6) is located at an uppermost position in a blow-out direction adjustment range at the start of the heating operation in the first mode.

10. The air conditioner (1) according to any one of the preceding claims,
wherein the controller (30) is configured to keep the air volume of the indoor fan (3) at the start of the heating operation in the second mode at at least 80% of the maximum air volume of the indoor fan (3).

11. The air conditioner (1) according to any one of the preceding claims,
wherein the predetermined temperature for activating the second mode is set to 18 degrees Celsius.

12. A computer-implemented method of controlling an air conditioner (1), in particular an indoor unit (10) of a separate type air conditioner, the method comprising:

a first mode in which an air volume of an indoor fan (3) of the air conditioner is controlled in dependence on a temperature of the indoor heat exchanger (4) at a start of a heating operation, and
a second mode in which the air volume of the indoor fan (3) is kept constant at a start of a heating operation, independent of the temperature of the indoor heat exchanger (4), wherein
the second mode is activated when an indoor set temperature for heating operation is set below a predetermined temperature or a user selects the second mode.

13. The computer-implemented method according to claim 12, wherein the second mode is activated when the heating operation is started after the indoor set temperature is set below the predetermined temperature or when a user selects or activates the second mode via a control unit.

14. The computer-implemented method according to claim 12 or 13, further comprising:

monitoring the presence of a person inside the room to be heated, and
switching from the second mode to the first mode if a person is detected, after the second mode is activated and before normal heating operation starts.

15. A controller (30) of an air conditioner (1), having a control unit and means adapted to execute the steps of the method of claims 12 to 14.

Amended claims in accordance with Rule 137(2) EPC.

1. An air conditioner (1), comprising:

an indoor heat exchanger (4);
an indoor fan (3) that circulates air, which has undergone heat exchange in the indoor heat exchanger (4), indoors; and
a controller (30) that controls at least the indoor fan (3); wherein,
the controller (30) is configured to have a first mode in which an air volume of the indoor fan (3) is controlled in dependence on a temperature of the indoor heat exchanger (4) at a start of a heating operation, and a second mode in which the air volume of the indoor fan (3) is kept constant at a start of a heating operation, independent of the temperature of the indoor heat exchanger (4), wherein
the controller (30) is configured to activate the second mode when an indoor set temperature for heating operation is set below a predetermined temperature.

2. The air conditioner (1) according to claim 1,
wherein the controller (30) is further configured to activate the second mode when the heating operation is started after the indoor set temperature is set below the predetermined temperature.

3. The air conditioner (1) according to claim 1 or 2, wherein the controller (30) is further configured to activate the second mode when a user selects or activates the second mode via a control unit.

4. The air conditioner (1) according to any one of the preceding claims, further comprising:

an indoor outlet (14) that blows out the air, which has undergone heat exchange in the indoor heat exchanger (4), indoors; and
a vertical deflector (6) that is arranged in the indoor outlet (14) to change an air direction in a vertical direction,
wherein the controller (30) is further configured to control the air direction of the vertical deflector (6) in the vertical direction, in particular to restrict a position of the vertical deflector (6) so that the vertical deflector (6) is at least faced upward in a blow-out direction adjustment range at the start of the heating operation in the first mode.

5. The air conditioner (1) according to claim 4, wherein the controller (30) is further configured to cancel any restriction or not restrict the position of the vertical deflector at the start of the heating operation in the second mode.

6. The air conditioner (1) according to any one of the preceding claims,
wherein the controller (30) is configured to increase the air volume of the indoor fan (3) in the first mode as the indoor heat exchanger temperature increases at the start of the heating operation.

7. The air conditioner (1) according to any one of the preceding claims,

further comprising a human detection sensor configured to detect people inside the room to be heated,
wherein the controller (30) is configured to switch from the second mode to the first mode, if people are detected by the human detection sensor, after the second mode is activated and before normal heating operation starts.

8. The air conditioner (1) according to any one of the preceding claims,
wherein the controller (30) is configured to switch from the first mode or the second mode into a normal heating operation when the indoor heat exchanger temperature reaches a pre-set target temperature, wherein in the normal heating operation any air volume restriction and/or any air direction restriction is cancelled.

9. The air conditioner (1) according to any one of the preceding claims,

wherein the air conditioner (1) is a wall-mounted indoor unit (10) of a separate type air conditioner,
an indoor outlet (14) is arranged on a lower part of the wall-mounted indoor unit (1), and
the controller (30) is preferably configured to restrict the position of a vertical deflector (6) so that the vertical deflector (6) is located at an uppermost position in a blow-out direction adjustment range at the start of the heating operation in the first mode.

10. The air conditioner (1) according to any one of the preceding claims,
wherein the controller (30) is configured to keep the air volume of the indoor fan (3) at the start of the heating operation in the second mode at at least 80% of the maximum air volume of the indoor fan (3).

11. The air conditioner (1) according to any one of the preceding claims,
wherein the predetermined temperature for activating the second mode is set to 18 degrees Celsius.

12. A computer-implemented method of controlling an air conditioner (1), in particular an indoor unit (10) of a separate type air conditioner, the method comprising:

a first mode in which an air volume of an indoor fan (3) of the air conditioner is controlled in dependence on a temperature of the indoor heat exchanger (4) at a start of a heating operation, and
a second mode in which the air volume of the indoor fan (3) is kept constant at a start of a heating operation, independent of the temperature of the indoor heat exchanger (4), wherein the second mode is activated when an indoor set temperature for heating operation is set below a predetermined temperature or a user selects the second mode.

13. The computer-implemented method according to claim 12, wherein the second mode is activated when the heating operation is started after the indoor set temperature is set below the predetermined temperature or when a user selects or activates the second mode via a control unit.

14. The computer-implemented method according to claim 12 or 13, further comprising:

monitoring the presence of a person inside the room to be heated, and
switching from the second mode to the first

mode if a person is detected, after the second mode is activated and before normal heating operation starts.

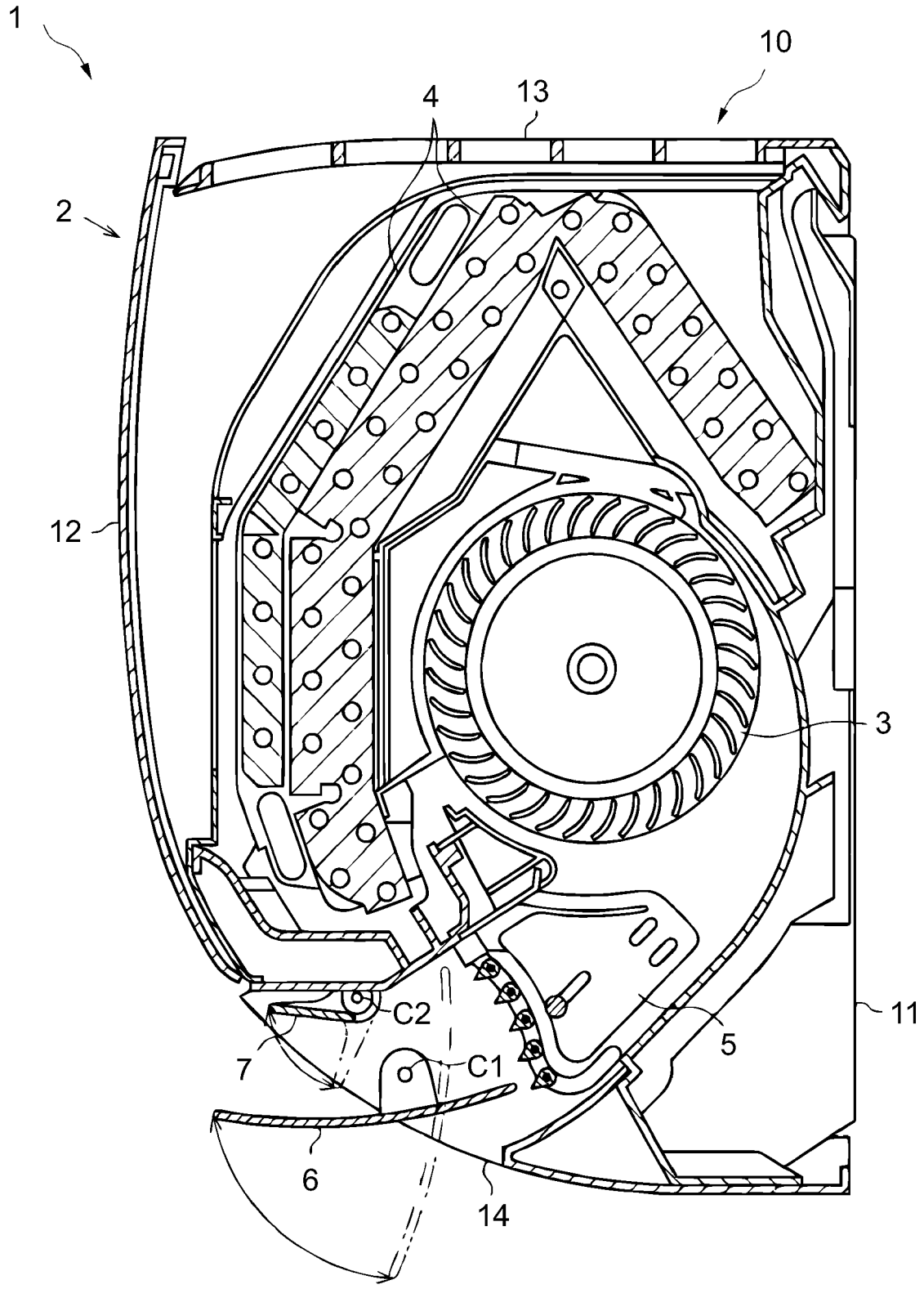

Fig. 1

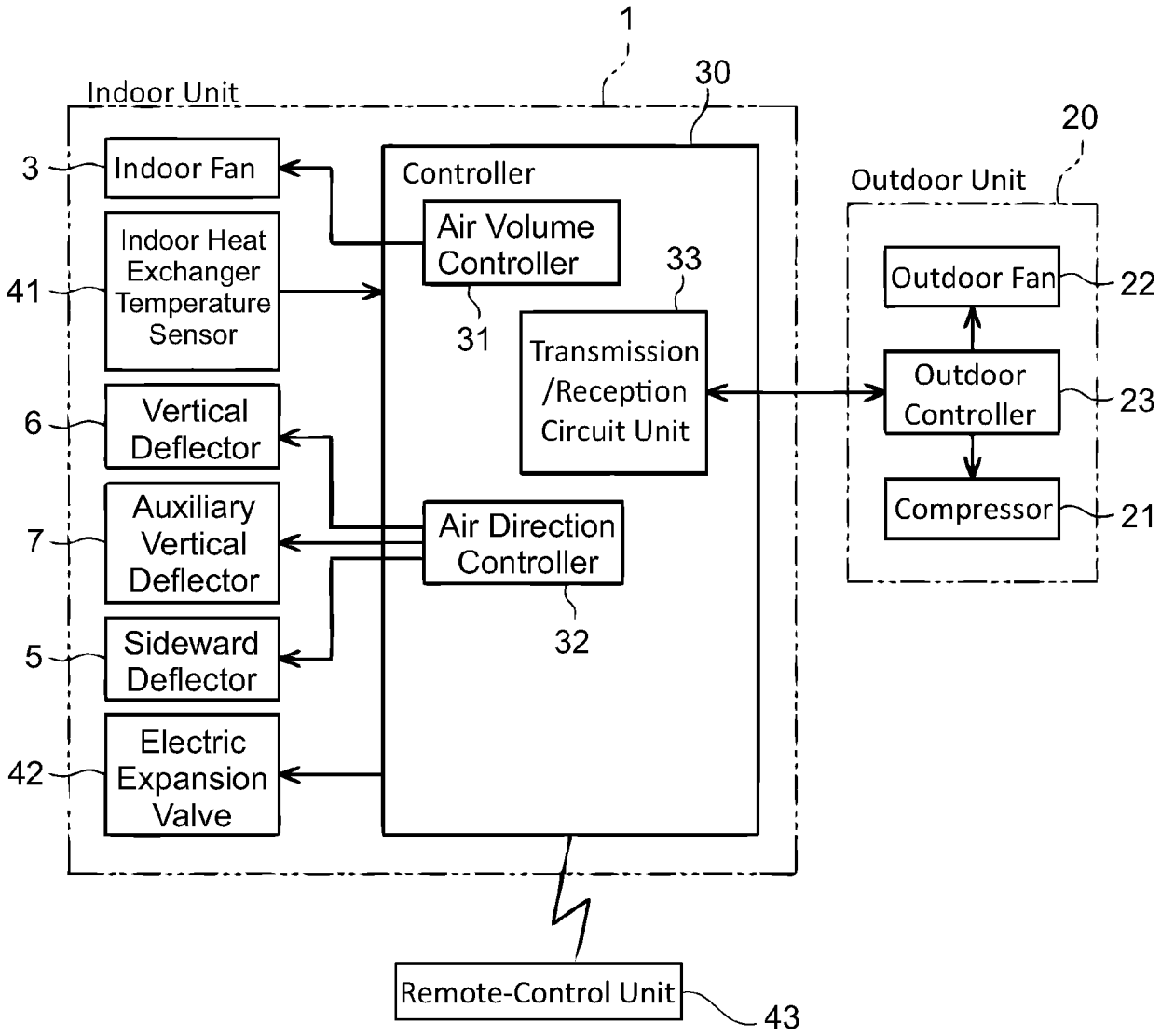
1
30
Indoor Unit
20
3
Indoor Fan
Controller
Outdoor Unit
Air Volume Controller
Indoor Heat Exchanger Temperature Sensor
41
33
Outdoor Fan
22
31
Transmission /Reception Circuit Unit
Outdoor Controller
23
6
Vertical Deflector
Auxiliary Vertical Deflector
7
Air Direction Controller
Compressor
21
32
5
Sideward Deflector
Electric Expansion Valve
42
Remote-Control Unit
43

Fig. 2

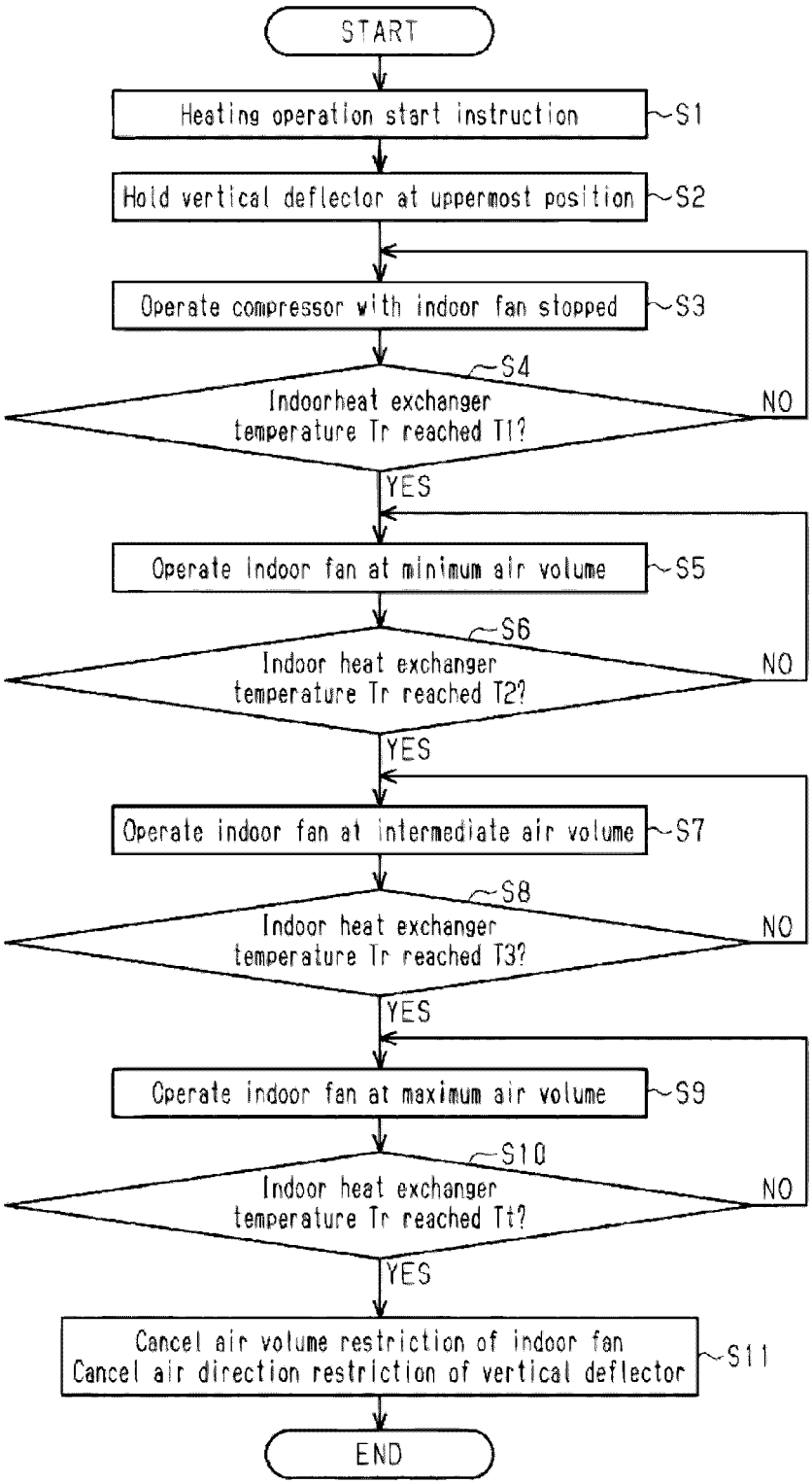
START
Heating operation start instruction
S1
Hold vertical deflector at uppermost position
S2
Operate compressor with indoor fan stopped
S3
S4
Indoorheat exchanger temperature Tr reached T1?
NO
YES
Operate indoor fan at minimum air volume
S5
S6
Indoor heat exchanger temperature Tr reached T2?
NO
YES
Operate indoor fan at intermediate air volume
S7
S8
Indoor heat exchanger temperature Tr reached T3?
NO
YES
Operate indoor fan at maximum air volume
S9
S10
Indoor heat exchanger temperature Tr reached Tt?
NO
YES
Cancel air volume restriction of indoor fan
Cancel air direction restriction of vertical deflector
S11
END

Fig. 3

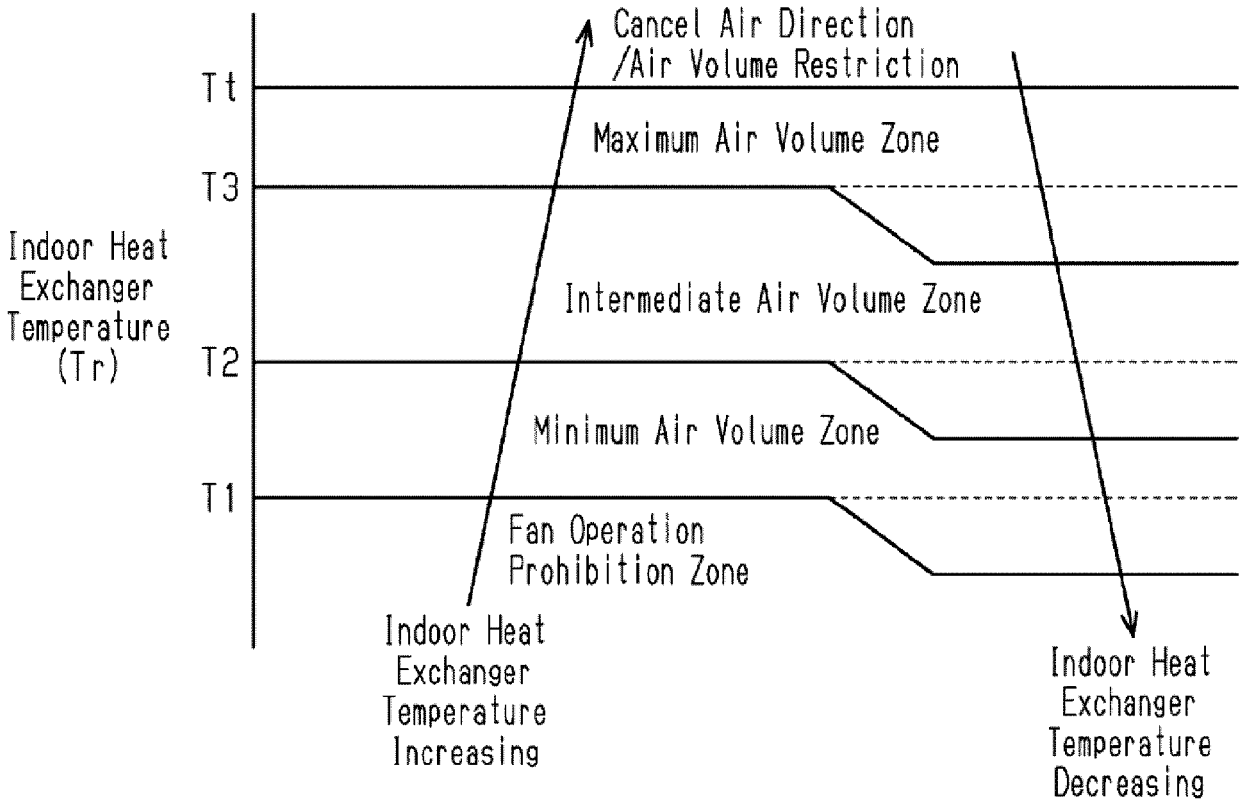
Cancel Air Direction
/Air Volume Restriction
Tt
Maximum Air Volume Zone
T3
Indoor Heat
Exchanger
Temperature
(Tr)
Intermediate Air Volume Zone
T2
Minimum Air Volume Zone
T1
Fan Operation
Prohibition Zone
Indoor Heat
Exchanger
Temperature
Increasing
Indoor Heat
Exchanger
Temperature
Decreasing

Fig. 4

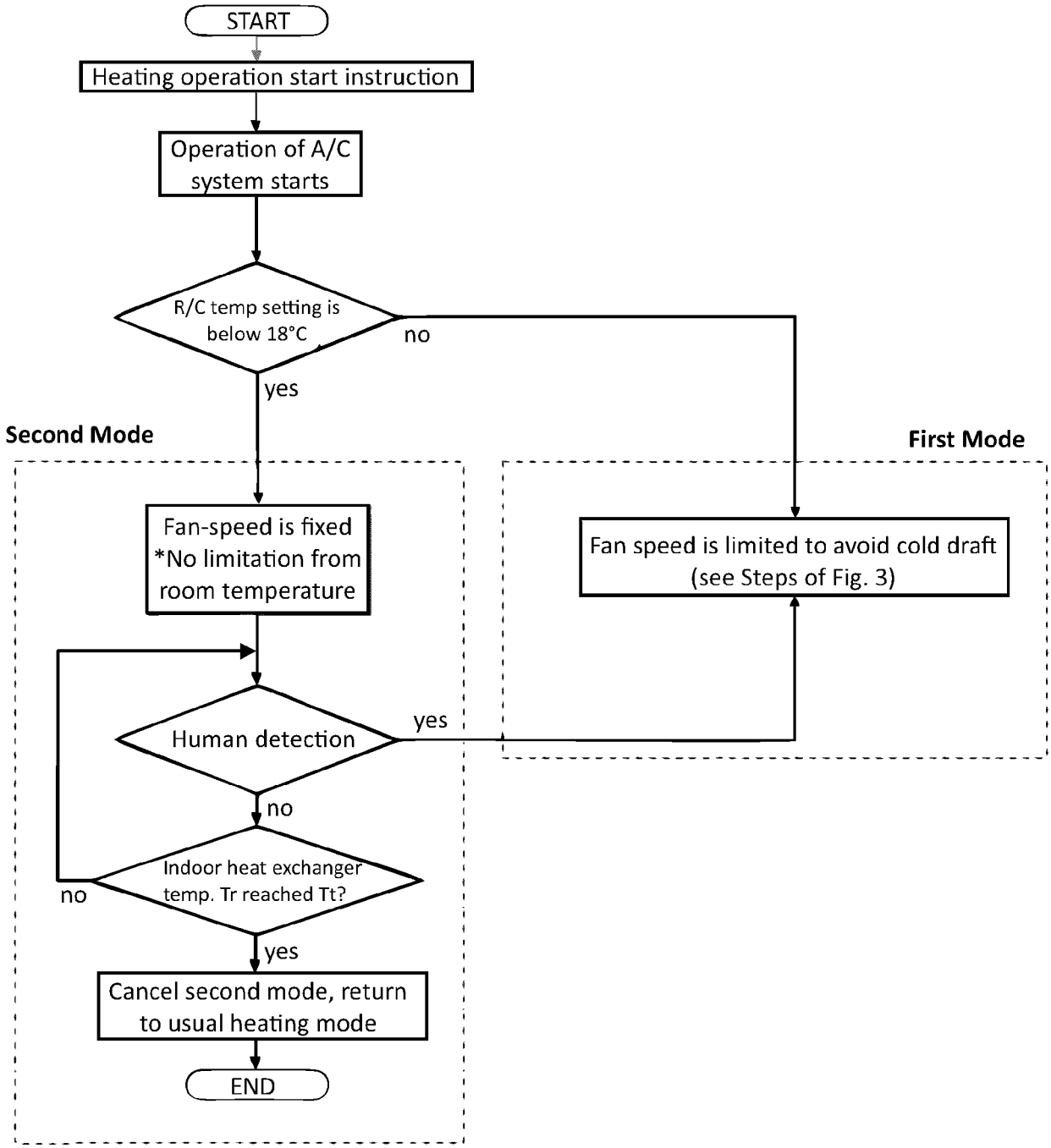
START
Heating operation start instruction
Operation of A/C system starts
R/C temp setting is below 18°C
no
yes
Second Mode
First Mode
Fan-speed is fixed *No limitation from room temperature
Fan speed is limited to avoid cold draft (see Steps of Fig. 3)
Human detection
yes
no
Indoor heat exchanger temp. Tr reached Tt?
no
yes
Cancel second mode, return to usual heating mode
END

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 23 15 5734

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 3 705 801 B1 (DAIKIN IND LTD [JP]) 19 January 2022 (2022-01-19) * paragraphs [0007] - [0051]; figures 1-4 *	1-15	INV. F24F1/0011 F24F11/74 F24F11/79
A	CN 102 563 806 B (GUANGDONG MIDEA ELECTRIC APLNC) 29 October 2014 (2014-10-29) * figure 1 *	1-15	
A	EP 0 840 071 A2 (TOSHIBA KK [JP]) 6 May 1998 (1998-05-06) * claim 1; figures 1-13 *	1-15	
A	JP 2008 292034 A (PANASONIC CORP) 4 December 2008 (2008-12-04) * figures 1-32 *	1-15	
A	JP H05 87391 A (TOSHIBA CORP) 6 April 1993 (1993-04-06) * figures 1-5 *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC) F24F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 June 2023	Ismail, Youssef

CATEGORY OF CITED DOCUMENTS

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& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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