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(54) **AIR CONDITIONING DEVICE**

KLIMATISIERUNGSVORRICHTUNG

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Description

TECHNICAL FIELD

[0001] The present invention relates to an air-conditioning apparatus and particularly to control of blowing of air by an indoor unit.

BACKGROUND ART

[0002] In a heating operation by an air-conditioning apparatus, warm air moves upward because of its light specific gravity and a temperature at a floor surface tends to lower. Therefore, in conventional heating operations by the air-conditioning apparatus, comfort has been enhanced by carrying warm air toward feet with the use of a fan. In order to further enhance comfort during heating, an air-conditioner as described, for example, in Japanese Patent Laying-Open No. 2010-60250 (PTL 1) has been proposed.

[0003] The air-conditioner described in Japanese Patent Laying-Open No. 2010-60250 provides a more efficiently and comfortably air-conditioned space by controlling a direction and a volume of sent air in accordance with a position of a person in a room and an intention of a user.

CITATION LIST

PATENT LITERATURE

[0004]

PTL 1: Japanese Patent Laying-Open No. 2010-60250
 PLT2: JP 2007 040554
 PLT3: JP H08 94158
 PLT4: JP 2013 217550

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0005] With higher insulation and air-tightness of current houses, heating load tends to lower. Under such a condition as low heating load, heating capability of the air-conditioner is also set low. A problem as below arises in the air-conditioner described in Japanese Patent Laying-Open No. 2010-60250.

(1) In an attempt to ensure a volume of blown air while heating capability of an indoor heat exchanger is low, a temperature of blown air becomes low. Therefore, a temperature of air carried toward feet becomes low.

(2) When a volume of blown air is decreased, a temperature of blown air increases. The volume of air, however, is low, and therefore blown air light in spe-

cific gravity (warm air) soars due to cold air around feet heavier in specific gravity. Warm air thus cannot be carried toward feet.

[0006] The present invention was made to solve the problems as above. An object of the present invention is to provide an air-conditioning apparatus capable of supplying warm air toward feet by controlling a fan of an air-conditioner in order to make a temperature of indoor air uniform during a heating operation at a low load.

SOLUTION TO PROBLEM

[0007] An air-conditioning apparatus according to this invention is defined in claim 1. Preferred embodiments are defined in the dependent claims. The inventive air-conditioning apparatus includes a refrigerant circuit, a condensing temperature sensor, an air blower, an air-conditioning load sensor device, and a controller. Refrigerant circulates through the refrigerant circuit in an order of a compressor, a condenser, an expansion mechanism, and an evaporator. The condensing temperature sensor is configured to sense a condensing temperature which represents a refrigerant temperature in the condenser. The air blower is configured to regulate a volume of air sent to the condenser. The air-conditioning load sensor device is configured to sense air-conditioning load in an air-conditioned space. The controller has a first mode used during normal operation and a second mode different from the first mode as operation modes, and it is configured to control a volume of air sent by the air blower. In the second mode, the controller is configured to have the air blower operate to vary a volume of air between a first volume of air and a second volume of air larger than the first volume of air with variation in condensing temperature. In the first mode, the controller is configured to change the first mode to the second mode when the air-conditioning load sensed by the air-conditioning load sensor device becomes lower than a first threshold value. In the second mode, the controller is configured to change a volume of air sent by the air blower from the first volume of air to the second volume of air when the condensing temperature becomes higher than a first temperature, a change of volume of air sent by the air blower from the second volume of air to the first volume of air when the condensing temperature becomes lower than a second temperature lower than the first temperature.

ADVANTAGEOUS EFFECTS OF INVENTION

[0008] According to the present invention, by performing a fan intermittent operation (FIO) during a heating operation at a low load, a thermal boundary layer formed around a floor is destroyed and warm air can be supplied toward feet while soaring of warm air is prevented. Consequently, temperature oscillation around feet can be lessened and comfort in a room can be improved.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

Fig. 1 is a diagram showing one example of an air-conditioning apparatus 101 in a first embodiment.
 Fig. 2 is a diagram showing one example of arrangement of components of an indoor unit 103.
 Fig. 3 is a diagram showing one example of a flow of air in a room under FIO control in a heating operation.
 Fig. 4 is a flowchart showing one example of a flow of control in the first embodiment.
 Fig. 5 is a diagram for illustrating switching of an operation mode in step S2.
 Fig. 6 is a diagram for illustrating variation in operation frequency of a compressor in step S3.
 Fig. 7 is a diagram showing one example of a state of operation by an indoor air blower 113 in the first embodiment.
 Fig. 8 is a diagram for illustrating variation in condensing temperature during a fan intermittent operation (FIO).
 Fig. 9 is a diagram showing a part of Fig. 8 as being enlarged.
 Fig. 10 is a diagram showing one example of an operation of each component before and after entry into a second mode (FIO) in the first embodiment.
 Fig. 11 is a diagram showing one example of a control system in a second embodiment.
 Fig. 12 is a diagram showing one example of an operation of each component before and after entry into the second mode (FIO) in the second embodiment.
 Fig. 13 is a diagram showing a difference in timing of entry into the second mode (FIO).

DESCRIPTION OF EMBODIMENTS

[0010] An embodiment of the present invention will be described below in detail with reference to the drawings. Though a plurality of embodiments will be described below, combination as appropriate of features described in each embodiment is originally intended. The same or corresponding elements in the drawings have the same reference characters allotted and description thereof will not be repeated.

[First Embodiment]**(Construction of Air-Conditioning Apparatus 101)**

[0011] Fig. 1 is a diagram showing one example of an air-conditioning apparatus 101 in a first embodiment of the present invention. As shown in Fig. 1, air-conditioning apparatus 101 includes an indoor unit 103, an outdoor unit 104, and a controller 130.

[0012] Indoor unit 103 includes an indoor air blower

113, an indoor heat exchanger 115, an infrared sensor 110, a pipe temperature sensor 111, and an indoor temperature sensor 121. Outdoor unit 104 includes an outdoor air blower 114, an outdoor heat exchanger 116, an expansion valve 117, a four-way valve 118, and a compressor 119. A refrigerant circuit 102 is implemented by ring-like connection of outdoor heat exchanger 116, expansion valve 117, four-way valve 118, compressor 119, and indoor heat exchanger 115 through a refrigerant pipe 120. A heat pump is formed by circulation of refrigerant through refrigerant circuit 102 with compression and expansion being repeated. Air-conditioning apparatus 101 air-conditions a room in an operation mode such as cooling/heating/air blow under the control by controller 130 of four-way valve 118, compressor 119, air blowers 113 and 114, and the like.

[0013] Fig. 1 shows a state that four-way valve 118 is set to heating. In this case, a port H and a port G communicate with each other and a port E and a port F communicate with each other in four-way valve 118. Refrigerant flows sequentially from a discharge port B of compressor 119 in the order of indoor heat exchanger 115, expansion valve 117, and outdoor heat exchanger 116 and reaches a suction port A of compressor 119.

[0014] Though not shown, during cooling, port H and port E communicate with each other and port G and port F communicate with each other in four-way valve 118. Refrigerant flows sequentially from discharge port B of compressor 119 in the order of outdoor heat exchanger 116, expansion valve 117, and indoor heat exchanger 115 and reaches suction port A of compressor 119.

(Construction of Indoor Unit 103)

[0015] Fig. 2 is a diagram showing one example of arrangement of components of indoor unit 103 in the first embodiment. In a main body of indoor unit 103, indoor heat exchanger 115, indoor air blower 113, pipe temperature sensor 111, infrared sensor 110, and a wind direction plate (louver) 112 are arranged. Indoor heat exchanger 115 is arranged on an upstream side of an air flow from indoor air blower 113.

[0016] An air outlet forms a passage for air on a downstream side of indoor air blower 113. A direction of air flow can be adjusted by changing an angle of wind direction plate (louver) 112 attached to the air outlet.

(Operation of Equipment in Heating Operation)

[0017] An indoor space is cooled and heated by cold air and warm air blown from indoor unit 103 of air-conditioning apparatus 101. Air-conditioning apparatus 101 incorporates a vapor compression refrigeration cycle, and indoor unit 103 and outdoor unit 104 are connected to each other through refrigerant pipe 120.

[0018] Compressor 119 compresses refrigerant at a low temperature and a low pressure and discharges refrigerant at a high temperature and a high pressure from

discharge port B. Compressor 119 is driven by a not-shown inverter and an operation capacity thereof is controlled in accordance with a state of air-conditioning.

[0019] Outdoor heat exchanger 116 exchanges cold and warm heat supplied by refrigerant which flows through the refrigerant cycle with outdoor air. As described above, outdoor air is supplied to outdoor heat exchanger 116 by outdoor air blower 114. Expansion valve 117 is connected between indoor heat exchanger 115 and outdoor heat exchanger 116 and expands refrigerant by decompressing the same. Expansion valve 117 is implemented by a valve of which position is variably controlled, such as an electronic expansion valve. Four-way valve 118 is connected to discharge port B and suction port A of compressor 119 and switches a flow of refrigerant in accordance with an operation of air-conditioning apparatus 101 (a cooling operation and a heating operation).

(Indoor Air Blower 113 and Outdoor Air Blower 114)

[0020] Outdoor air blower 114 and indoor air blower 113 are implemented by fans which can vary flow rates of air supplied to outdoor heat exchanger 116 and indoor heat exchanger 115, respectively. A centrifugal fan or a multi-blade fan driven by a motor such as a DC fan motor can be employed as such a fan.

<Operation by Equipment>

[0021] In the present embodiment, in order to enhance comfort around feet while heating load is low, fan intermittent operation (FIO) control is carried out. FIO control refers to control for producing a flow of air for sending warm air toward feet by using a fan. In the description below, an operation mode in which a volume of air is determined based on setting made by a user through a remote controller is denoted as a normal operation mode (a first mode (fan common operation: FCO) below) and an operation mode in which a fan is intermittently turned on while air-conditioning load is low is denoted as an intermittent operation mode (a second mode (FIO) below).

[0022] Fig. 3 is a diagram showing one example of a flow of air in a room under FIO control in a heating operation in the first embodiment. Referring to Figs. 1 to 3, when heating load in an air-conditioned space R is low, controller 130 sets a downward direction of wind blow from indoor unit 103 by changing an angle of wind direction plate (louver) 112.

[0023] When a condensing temperature CT sensed by pipe temperature sensor 111 provided in indoor heat exchanger 115 is equal to or higher than a certain value (T1), controller 130 starts an operation of indoor air blower 113 at a fan rotation speed (N2). When condensing temperature CT sensed by pipe temperature sensor 111 becomes lower than a certain value (T2), controller 130 turns off indoor air blower 113 or has indoor air blower

113 operate at a low volume of air. Regardless of the operation by indoor air blower 113, controller 130 allows continued operations by compressor 119.

[0024] Therefore, when a surface temperature of indoor heat exchanger 115 increases and a condensing temperature sensed by pipe temperature sensor 111 is again equal to or higher than the certain value (T1) while indoor air blower 113 is turned off or operates at a low volume of air, indoor air blower 113 resumes its operation at the rotation speed (N2).

<Control Operation>

[0025] An operation by the air-conditioner constructed as above will be described with reference to a flowchart. Fig. 4 is a flowchart showing one example of a flow of control in the first embodiment of the present invention. Controller 130 which performs processing in the flowchart can be implemented by hardware such as a circuit device which performs these functions or by software read from a memory into a computing device such as a microcomputer or a CPU and executed by the computing device.

[0026] Referring to Fig. 4, when processing in the flowchart is started, initially in step S1, controller 130 senses air-conditioning load Q (kW). For example, in determining whether or not air-conditioning load Q is lower than a prescribed value Q2, a surface temperature of an object (a wall, a floor, or a human) present in an air-conditioned space can serve as a criterion.

[0027] Air-conditioning load sensor device 125 senses a surface temperature (a radiative temperature Tr) of an object present in the air-conditioned space with infrared sensor 110. When the surface temperature becomes lower than a first threshold value (YES in S2), controller 130 changes the first mode (FCO) to the second mode (FIO).

[0028] In another example, air-conditioning load Q is estimated based on radiative temperature Tr in a room detected by infrared sensor 110 shown in Fig. 2. Infrared sensor 110 may detect radiative temperatures Tr at a plurality of locations in a room. In such a case, a weighted average value can be adopted. For example, relation between radiative temperature Tr and air-conditioning load Q may be defined in a predetermined map, and air-conditioning load Q may be found based on radiative temperature Tr by referring to the map in step S1.

[0029] In estimating air-conditioning load Q, a difference between an outdoor air temperature and an indoor temperature, a difference between a temperature at a floor surface or an indoor temperature and a set temperature, an amount of solar radiation, and an indoor temperature may also be taken into consideration.

[0030] In succession, controller 130 determines in step S2 whether or not air-conditioning load Q is lower than prescribed value Q2 ($Q < Q2$). When a condition of $Q < Q2$ is satisfied in step S2 (YES in S2), the process proceeds to step S3. When the condition is not satisfied (NO

in S2), the process proceeds to step S14.

[0031] Fig. 5 is a diagram for illustrating switching of an operation mode in step S2. Referring to Fig. 5, a condition that air-conditioning load Q estimated based on a radiative temperature with the use of infrared sensor 110 is lower than prescribed value Q_2 ($Q < Q_2$) is a condition for air-conditioning apparatus 101 to enter the second mode (FIO). A condition that air-conditioning load Q is lower than a prescribed value Q_1 ($Q < Q_1$) is a condition for turning off the compressor.

[0032] By thus comparing air-conditioning load Q and prescribed value Q_2 defined as a criterion value with each other, controller 130 switches the operation mode between the second mode (FIO) and the first mode (FCO) as appropriate.

[0033] Though air-conditioning load sensor device 125 determines air-conditioning load based on a surface temperature in a room or a radiative temperature in the example in Fig. 1, it may determine air-conditioning load based on a rotation speed of compressor 119. In this case, air-conditioning load sensor device 125 senses a rotation speed of compressor 119 and controller 130 changes the first mode (FCO) to the second mode (FIO) when the rotation speed of compressor 119 becomes lower than a first threshold value (a set lower limit value F_1 in a normal operation).

[0034] When the process proceeds from step S2 to step S3, controller 130 changes also an operation frequency of compressor 119. Fig. 6 is a diagram for illustrating variation in operation frequency of the compressor in step S3. Referring to Figs. 4 and 6, in step S3, controller 130 sets an operation frequency of the compressor to an operation frequency F_2 approximately half of lower limit frequency F_1 in the normal operation. When transition from the first mode (FCO) to the second mode (FIO) is made at time t_1 , the operation frequency of compressor 119 is changed from frequency F_1 at the set lower limit value in the normal operation to frequency F_2 approximately half of frequency F_1 . When air-conditioning load Q is equal to or higher than prescribed value Q_2 in step S2, transition to the first mode (FCO) is made, and hence the operation frequency returns to frequency F_1 at time t_2 .

[0035] In step S3, controller 130 changes a direction of air sent from indoor air blower 113 simultaneously with variation in operation frequency of compressor 119. In order to change the direction of air blow, air-conditioning apparatus 101 includes wind direction plate (louver) 112. Controller 130 then controls wind direction plate 112 to set the direction of air blow to a prescribed wind direction (corresponding to an angle θ_2) in the second mode (FIO).

[0036] Though controller 130 sets an angle θ of wind direction plate (louver) 112 to an arbitrary angle θ_1 set by a user in the first mode (FCO), it changes the angle to angle θ_2 in the second mode (FIO). As shown in Fig. 2, angle θ_2 indicating a prescribed wind direction is equal to or greater than 45° with angle θ of wind direction plate (louver) 112 in a direction vertical to the floor surface

being defined as 90° and with an angle horizontal thereto being defined as 0° . Preferably, angle θ_2 is within a range from 60° to 85° .

[0037] Thereafter, in succession to step S3, processing for intermittent operation of indoor air blower 113 is performed in steps S4 to S10.

[0038] Fig. 7 is a diagram showing one example of a state of operation by indoor air blower 113 in the first embodiment. During a heating operation at low capability by an air-conditioner, with downward angle θ of wind direction plate (louver) 112 being set, a volume of air is intermittently increased and decreased between a first volume of air and a second volume of air during a period from time t_1 to t_2 as shown. A rotation speed of the fan is set either to rotation speed N_2 or 0 (rpm) and timing to switch the rotation speed from N_2 to 0 and timing to switch the rotation speed from 0 to N_2 are determined based on condensing temperature CT of indoor heat exchanger 115.

[0039] In the example shown in Fig. 7, a volume of air corresponding to rotation speed N_2 is defined as the second volume of air and a volume of air (a volume of air = 0) corresponding to a state that indoor air blower 113 is turned off is defined as the first volume of air. The first volume of air should only be lower than the second volume of air and it does not necessarily have to be set to zero.

[0040] Fig. 8 is a diagram for illustrating variation in condensing temperature in the second mode (FIO). Two types of a temperature T_1 and a temperature T_2 are set as criteria for condensing temperature CT for turning on and off indoor air blower 113. In the second mode (FIO), condensing temperature CT is varied as increasing and decreasing between temperature T_1 and temperature T_2 . Indoor air blower 113 is turned off during a period of increase t_r and indoor air blower 113 is turned on during a period of decrease t_f .

[0041] Fig. 9 is a diagram showing a part of Fig. 8 as being enlarged. While indoor air blower 113 is off, condensing temperature CT of indoor heat exchanger 115 increases from T_2 to T_1 .

[0042] When condensing temperature CT reaches temperature T_1 at time t_3 , indoor air blower 113 starts operating. During an operation of indoor air blower 113 from time t_3 to t_4 , indoor heat exchanger 115 is cooled by sent air and therefore condensing temperature CT is lowered from T_1 to T_2 . When condensing temperature CT is lowered to temperature T_2 at time t_4 , indoor air blower 113 is turned off. Thereafter, turn-on and turn-off of operation of indoor air blower 113 is repeated also at times t_5 and t_6 .

[0043] When condensing temperature CT becomes higher than first temperature T_1 in the second mode (FIO) as shown in Fig. 9, controller 130 changes a volume of air sent from indoor air blower 113 from the first volume of air (a rotation speed of the fan = 0) to the second volume of air (a rotation speed of the fan = N_2). When condensing temperature CT becomes lower than second

temperature T_2 ($< T_1$), controller 130 changes a volume of air sent from indoor air blower 113 from the second volume of air (a rotation speed of the fan = N_2) to the first volume of air (a rotation speed of the fan = 0).

[0044] Turn-on and turn-off of the fan is controlled based on a condensing temperature in steps S4 to S10 in Fig. 4. Control will be described below again with reference to Fig. 4.

[0045] In succession to step S3, in step S4, controller 130 senses condensing temperature CT with pipe temperature sensor 111.

[0046] In succession, in step S5, controller 130 determines whether or not indoor air blower 113 is operating (= ON). When indoor air blower 113 is ON in step S5 (YES in S5), the process proceeds to step S6, and when indoor air blower 113 is OFF (NO in S5), the process proceeds to step S8.

[0047] In step S6, controller 130 determines whether or not condensing temperature CT measured with pipe temperature sensor 111 is lower than prescribed value T_2 . When a condition of $CT < T_2$ is satisfied in step S6 (YES in S6), controller 130 turns off indoor air blower 113 in step S7 and the process proceeds to step S10. When the condition of $CT < T_2$ is not satisfied in step S6 (NO in S6), controller 130 does not perform processing in step S7 but the process proceeds to step S10.

[0048] In step S8, controller 130 determines whether or not condensing temperature CT measured with pipe temperature sensor 111 is higher than prescribed value T_1 . When a condition of $CT > T_1$ is satisfied in step S8 (YES in S8), controller 130 turns on indoor air blower 113 in step S9 and the process proceeds to step S10. When the condition of $CT > T_1$ is not satisfied in step S8 (NO in S8), controller 130 does not perform processing in step S9 but the process proceeds to step S10.

[0049] In step S10, controller 130 senses a temperature in a room T_a with indoor temperature sensor 121. When temperature in a room T_a is higher than a prescribed value T_{a_min} (YES in S11), the process proceeds to step S12. When temperature in a room T_a is lower than prescribed value T_{a_min} (NO in S11), the process proceeds to step S14.

[0050] In step S12, controller 130 senses a sensory temperature T_{a_t} of a human body. A surface temperature in the room is measured with infrared sensor 110 as a guideline for the sensory temperature, and it can be defined as sensory temperature T_{a_t} .

[0051] When sensory temperature T_{a_t} is higher than a prescribed value T_{a_set} (YES in S13), the process returns to step S1 and controller 130 repeats the operations described above. When sensory temperature T_{a_t} is lower than prescribed value T_{a_set} (NO in S13), the process proceeds to step S14. In step S14, controller 130 sets the operation mode to the first mode (FCO) and has air-conditioning apparatus 101 normally operate.

[0052] The normal operation performed in the first mode should only be processing different from an intermittent operation of an indoor fan for repeating process-

ing in steps S3 to S13, and various operations are assumed so long as processing is performed for controlling a volume of air or a temperature in a room in accordance with setting made by a user.

[0053] In steps S11 and S13, determination as to switching of the operation mode from the second mode to the first mode is made. Air-conditioning load sensor device 125 in Fig. 1 includes infrared sensor 110 which senses a surface temperature of an object present in an air-conditioned space and indoor temperature sensor 121 which senses an indoor temperature. When at least one of a first condition that indoor temperature T_a is lower than second threshold value T_{a_min} and a second condition that a surface temperature (sensory temperature T_{a_t}) is lower than a third threshold value T_{a_set} is satisfied during an operation in the second mode (FIO), controller 130 changes the operation mode from the second mode (FIO) to the first mode (FCO).

[0054] Fig. 10 is a diagram showing one example of an operation of each component before and after entry into the second mode (FIO) in the first embodiment. During a period from time t_0 to t_1 , the normal operation (FCO) in heating is performed. A rotation speed of indoor air blower 113 is set to a rotation speed N_1 determined by setting made by a user.

[0055] When transition from the normal operation (FCO) to an operation at low load (FIO) is made at time t_1 , rotation speed N of indoor air blower 113 is intermittently switched between 0 and N_2 , wind direction plate (louver) 112 is changed from arbitrary angle θ set during a normal operation to prescribed angle θ_2 (= 60 to 85°), and an operation frequency of compressor 119 is changed from frequency F_1 corresponding to the lower limit value in the normal operation to frequency F_2 which is approximately half of the former.

[0056] Thus, under the control for an intermittent operation of indoor air blower 113 with an operation frequency of compressor 119 being fixed, a thermal boundary layer specific to air formed around a floor is destroyed, soaring of warm air is prevented, and oscillation of a temperature around feet is lessened.

[0057] Air-conditioning apparatus 101 according to the first embodiment will be summarized again with reference to Fig. 1 and the like. Air-conditioning apparatus 101 includes refrigerant circuit 102, pipe temperature sensor 111, indoor air blower 113, air-conditioning load sensor device 125, and controller 130. In refrigerant circuit 102, during heating, refrigerant circulates in the order of compressor 119, indoor heat exchanger 115 serving as a condenser, expansion valve 117, and outdoor heat exchanger 116 serving as an evaporator. Pipe temperature sensor 111 is configured to sense condensing temperature CT representing a refrigerant temperature in indoor heat exchanger 115. Indoor air blower 113 is configured to adjust an amount of heat radiation from indoor heat exchanger 115. Air-conditioning load sensor device 125 is configured to sense air-conditioning load in an air-conditioned space.

[0058] As represented by the flowchart in Fig. 4 and the waveform diagram in Fig. 10, controller 130 has the first mode (FCO) and the second mode (FIO) different from the first mode as the operation modes, and it is configured to control a volume of air sent from indoor air blower 113. In the second mode, controller 130 is configured to have indoor air blower 113 operate to change a volume of air between the first volume of air (zero) and the second volume of air (N2) higher than the first volume of air with variation in condensing temperature CT. As shown in Fig. 5, in the first mode, controller 130 is configured to change the first mode (FCO) to the second mode (FIO) when air-conditioning load Q sensed by air-conditioning load sensor device 125 becomes lower than first threshold value Q2.

[0059] Air-conditioning apparatus 101 according to the first embodiment achieves effects (1) to (3) below.

(1) By turning off the fan to increase a condensing temperature, a temperature of blown air can be increased even in an operation at a low frequency of the compressor. Warm air can be supplied toward feet when the fan is turned on again.

(2) By setting the wind direction plate to a downward direction, warm air can be directed toward feet. Warm air moves upward from below after it is sent toward feet owing to a temperature difference between blown warm air and air in a room. Therefore, an indoor temperature can be uniform even in an operation at a low frequency of the compressor.

(3) Even though the operation frequency of the compressor is low, a temperature in a room can uniformly be maintained. Therefore, such an operation that turn-on and turn-off of the compressor is repeated is suppressed and an energy saving effect can be expected.

[Second Embodiment]

[0060] A second embodiment of the present invention will be described below. An air-conditioning apparatus according to the second embodiment includes a controller which controls a plurality of indoor units 103 to set an indoor temperature in air-conditioned space R to a target temperature. Since the second embodiment is similar to the first embodiment in control of load sensing means, temperature sensing means, air blow control means, and wind direction control means of each indoor unit 103, illustration and description thereof will not be provided.

[0061] Fig. 11 is a diagram showing one example of a control system in the second embodiment. Indoor units 103A, 103B, and 103C are connected to a central controller 230 through communication devices 203, 204, and 205, respectively. Central controller 230 can control indoor units 103A, 103B, and 103C. Connection of indoor units 103A, 103B, and 103C to communication devices 203, 204, and 205 and connection of communication devices 203, 204, and 205 to central controller 230 may be

wired or wireless, and a control command or equipment information should only be transmitted among them.

[0062] Fig. 12 is a diagram showing one example of an operation of each component before and after entry into the second mode (FIO) in the second embodiment. Control of load sensing means, temperature sensing means, air blow control means, and wind direction control means of indoor units 103A, 103B, and 103C is similar to control in the first embodiment as shown in Fig. 12. The second embodiment, however, is characterized by a slight difference in timing for indoor units 103A, 103B, and 103C to enter the second mode (FIO) among them.

[0063] Fig. 13 is a diagram showing a difference in timing of entry into the second mode (FIO). As shown in Fig. 13, timing for indoor unit 103B to enter the second mode (FIO) is delayed by a time lag $FIO\Delta T$ as compared with the timing for indoor unit 103A to enter the second mode (FIO). By adjusting the time lag, a rotation speed of the fan, and setting of temperatures T1 and T2, while the fan of indoor unit 103A is turned off, warm air is blown from another indoor unit 103B or 103C.

[0064] In the second embodiment, as shown in Fig. 11 in a simplified manner, indoor heat exchanger 115 includes a first condenser 115A and a second condenser 115B connected in parallel to each other in the refrigerant circuit. Indoor air blower 113 includes a first air blower 113A and a second air blower 113B provided in correspondence with first condenser 115A and second condenser 115B, respectively. As shown in Fig. 13, central controller 230 controls first air blower 113A and second air blower 113B such that a period during which first air blower 113A sends air at the first volume of air (a fan rotation speed N2A) and a period during which second air blower 113B sends air at the second volume of air (a fan rotation speed N2B) do not overlap with each other in the second mode (FIO). Though not shown, a condenser and an air blower are provided also similarly in indoor unit 103C.

[0065] Under such control, air is sent alternately from the air blowers of the indoor units. Therefore, warm air is always supplied toward feet and oscillation of a temperature around the floor surface can be suppressed.

[0066] It should be understood that the embodiments disclosed herein are illustrative and non-restrictive in every respect. The scope of the present invention is defined by the terms of the claims rather than the description of the embodiments above and is intended to include any modifications within the scope of the appended claims.

50 REFERENCE SIGNS LIST

[0067] 101 air-conditioning apparatus; 103, 103A, 103B, 103C indoor unit; 104 outdoor unit; 110 infrared sensor; 111 pipe temperature sensor; 113 indoor air blower; 114 outdoor air blower; 115 indoor heat exchanger; 116 outdoor heat exchanger; 117 expansion valve; 118 four-way valve; 119 compressor; 120 refrigerant pipe; 121 indoor temperature sensor; 130 controller; 230

central controller; 203 communication device

Claims

1. An air-conditioning apparatus (101) comprising:

a refrigerant circuit (102) through which refrigerant circulates in an order of a compressor (119), a condenser (115), an expansion mechanism (117), and an evaporator (116);
 a condensing temperature sensor (111) configured to sense a condensing temperature which represents a refrigerant temperature in the condenser (115);
 an air blower (113) configured to regulate a volume of air sent to the condenser (115);
 an air-conditioning load sensor device (125) configured to sense air-conditioning load; and
 a controller (130) configured to control a volume of air sent by the air blower (113), the controller (130) having a first mode used during normal operation and a second mode different from the first mode as operation modes,
 in the second mode, the controller (130) being configured to have the air blower (113) operate to vary a volume of air between a first volume of air and a second volume of air larger than the first volume of air with variation in condensing temperature, and
 in the first mode, the controller (130) being configured to change the operation mode from the first mode to the second mode when the air-conditioning load sensed by the air-conditioning load sensor device (125) becomes lower than a threshold value,
 in the second mode, the controller (130) being configured to change the operation mode from the second mode to the first mode when the air-conditioning load becomes higher than the threshold value, wherein
 in the second mode, the controller (130) is configured to change a volume of air sent by the air blower (113) from the first volume of air to the second volume of air when the condensing temperature becomes higher than a first temperature,
 and change a volume of air sent by the air blower (113) from the second volume of air to the first volume of air when the condensing temperature becomes lower than a second temperature lower than the first temperature.

2. The air-conditioning apparatus according to claim 1, wherein

the air-conditioning load sensor device (125) comprises

a surface temperature sensor (110) is configured to sense a surface temperature of an object located in an air-conditioned space, and

an indoor temperature sensor (121) is configured to sense an indoor temperature, and

the controller (130) is configured to change the operation mode from the second mode to the first mode when at least one of a first condition and a second condition is satisfied during operations in the second mode, the first condition being a condition that the indoor temperature is lower than a first threshold value, and the second condition being a condition that the surface temperature is lower than a second threshold value.

3. The air-conditioning apparatus according to claim 1, wherein

the air-conditioning load sensor device senses a rotation speed of the compressor (119), and the controller (130) is configured to change the operation mode from the first mode to the second mode when the rotation speed of the compressor (119) becomes lower than a first threshold value.

4. The air-conditioning apparatus according to claim 1, the air-conditioning apparatus comprising a wind direction changing portion (112) configured to change a direction of air sent by the air blower, wherein the controller (130) is configured to control the wind direction changing portion (112) to set the direction of air to a prescribed wind direction when the operation mode is the second mode.

5. The air-conditioning apparatus according to claim 4, wherein

an angle indicating the prescribed wind direction is equal to or greater than 45° with an angle indicating a direction vertical to a floor surface being defined as 90° and an angle indicating a direction horizontal to the floor surface being defined as 0°.

6. The air-conditioning apparatus according to claim 1, the air-conditioning apparatus further comprising:

an additional condenser (115B) connected in parallel to the condenser (115A) in the refrigerant circuit; and
 an additional air blower (113B) provided in correspondence with the additional condenser (115B), wherein
 the controller (130) is configured to control the air blower (113A) and the additional air blower (113B) to avoid overlapping of a period during

which the air blower (113A) sends the second volume of air with a period during which the additional air blower (113B) sends the second volume of air in the second mode.

7. The air-conditioning apparatus according to any one of claims 1 to 6, wherein
the first volume of air refers to a volume of air corresponding to a state that the air blower (113, 113A) is turned off.

Patentansprüche

1. Klimatisierungsvorrichtung (101) aufweisend:

einen Kältekreislauf (102) durch den Kältemittel nacheinander durch einen Kompressor (119), einen Kondensator (115), einen Expansionsmechanismus (117) und einen Verdampfer (116) fließt;

einen Kondensationstemperatursensor (111), der dazu ausgebildet ist, eine Kondensationstemperatur zu erfassen, die eine Temperatur des Kältemittels in dem Kondensator (115) angibt;

ein Luftgebläse (113), das dazu ausgebildet ist, das dem Kondensator (115) zugeführte Luftvolumen zu steuern;

eine Sensorvorrichtung (125) für eine Klimatisierungslast, die dazu ausgebildet ist, eine Klimatisierungslast zu erfassen; und

eine Steuerung (130), die dazu ausgebildet ist, ein vom Luftgebläse (113) abgegebenes Luftvolumen zu steuern, wobei die Steuerung (130) einen ersten Modus aufweist, der während eines normalen Betriebs verwendet wird und einen zweiten Modus, der sich vom ersten Modus als Betriebsmodi unterscheidet,

wobei die Steuerung (130) dazu ausgebildet ist, im zweiten Modus das Luftgebläse (113) zur Veränderung eines Luftvolumens zwischen einem ersten Luftvolumen und einem zweiten Luftvolumen, das größer als das erste Luftvolumen ist, mit einer Veränderung der Kondensationstemperatur zu betreiben, und

wobei die Steuerung (130) dazu ausgebildet ist, im ersten Modus den Betriebsmodus vom ersten Modus zum zweiten Modus zu wechseln, wenn die von der Sensorvorrichtung (125) für eine Klimatisierungslast erfasste Klimatisierungslast unter einen Schwellenwert fällt,

wobei die Steuerung (130) dazu ausgebildet ist, im zweiten Modus den Betriebsmodus vom zweiten Modus zum ersten Modus zu wechseln, wenn die Klimatisierungslast einen Schwellenwert überschreitet, wobei

die Steuerung (130) dazu ausgebildet ist, im

zweiten Modus ein vom Luftgebläse (113) abgegebenes Luftvolumen von dem ersten Luftvolumen zu dem zweiten Luftvolumen zu ändern, wenn die Kondensationstemperatur eine erste Temperatur überschreitet

und ein vom Luftgebläse (113) abgegebenes Luftvolumen von dem zweiten Luftvolumen zu dem ersten Luftvolumen zu ändern, wenn die Kondensationstemperatur unter eine zweite Temperatur fällt, die niedriger als die erste Temperatur ist.

2. Klimatisierungsvorrichtung nach Anspruch 1, wobei die Sensorvorrichtung (125) für eine Klimatisierungslast aufweist:

einen Oberflächentemperatursensor (110), der dazu ausgebildet ist, eine Oberflächentemperatur von einem Objekt zu erfassen, das in einem klimatisierten Bereich angeordnet ist, und einen Raumtemperatursensor (121), der dazu ausgebildet ist, eine Raumtemperatur zu erfassen und

die Steuerung (130), die dazu ausgebildet ist, den Betriebsmodus vom zweiten Modus zum ersten Modus zu wechseln, wenn während Betriebs im zweiten Modus zumindest eine von einer ersten Bedingung und einer zweiten Bedingung erfüllt ist, wobei die erste Bedingung eine Bedingung ist, dass die Raumtemperatur niedriger als ein erster Schwellenwert ist und die zweite Bedingung eine Bedingung ist, dass die Oberflächentemperatur niedriger als ein zweiter Schwellenwert ist.

3. Klimatisierungsvorrichtung nach Anspruch 1, wobei

die Sensorvorrichtung für eine Klimatisierungslast eine Rotationsgeschwindigkeit des Kompressors (119) erfasst, und

die Steuerung (130) dazu ausgebildet ist, den Betriebsmodus vom ersten Modus zum zweiten Modus zu wechseln, wenn die Rotationsgeschwindigkeit von dem Kompressor (119) einen ersten Schwellenwert unterschreitet.

4. Klimatisierungsvorrichtung nach Anspruch 1, wobei

die Klimatisierungsvorrichtung einen Windrichtungsänderungsbereich (112) aufweist, der dazu ausgebildet ist, einen Richtung der vom Luftgebläse abgegebenen Luft zu ändern, wobei die Steuerung (130) dazu ausgebildet ist, den Windrichtungsänderungsbereich (112) zu steuern, um die Richtung der Luft auf eine vorgegebene Windrichtung einzustellen, wenn der Betriebsmodus der zweite Modus ist.

5. Klimatisierungsvorrichtung nach Anspruch 4, wobei ein Winkel, der die vorgegebene Windrichtung angibt, gleich oder größer als 45° ist, ein Winkel, der eine Richtung senkrecht zu einer Bodenfläche angibt, als 90 % definiert ist und ein Winkel, der eine Richtung horizontal zur Bodenfläche angibt, als 0 % definiert ist. 5
6. Klimatisierungsvorrichtung nach Anspruch 1, wobei die Klimatisierungsvorrichtung ferner aufweist: 10
- einen zusätzlichen Kondensator (115B), der im Kältekreislauf parallel zum Kondensator (115A) geschaltet ist; und
- ein zusätzliches Luftgebläse (113B), das entsprechend dem zusätzlichen Kondensator (115B) bereitgestellt wird, wobei 15
- die Steuerung (130) dazu ausgebildet ist, das Luftgebläse (113A) und das zusätzliche Luftgebläse (113B) zu steuern, um ein Überschneiden von einer Periode, in der das Luftgebläse (113A) das zweite Luftvolumen abgibt, mit einer Periode, in der das zusätzliche Luftgebläse (113B) das zweite Luftvolumen im zweiten Modus abgibt, zu vermeiden. 20 25
7. Klimatisierungsvorrichtung nach einem der Ansprüche 1 bis 6, wobei das erste Luftvolumen sich auf ein Luftvolumen bezieht, das einem Zustand entspricht, in dem das Luftgebläse (113, 113A) ausgeschaltet ist. 30

Revendications

1. Appareil de climatisation (101) comprenant :

un circuit de fluide frigorigène (102) dans lequel circule un fluide frigorigène dans un ordre d'un compresseur (119), d'un condenseur (115), d'un mécanisme de dilatation (117) et d'un évaporateur (116) ; 40

un capteur de température de condensation (111) configuré pour détecter une température de condensation qui représente une température de fluide frigorigène dans le condenseur (115) ; 45

une soufflante d'air (113) configurée pour réguler un volume d'air envoyé au condenseur (115) ; 50

un dispositif de détection de charge de climatisation (125) configuré pour détecter une charge de climatisation ; et

un dispositif de commande (130) configuré pour commander un volume d'air envoyé par la soufflante d'air (113), le dispositif de commande (130) présentant un premier mode utilisé pendant un fonctionnement normal et un second 55

mode différent du premier mode en tant que modes de fonctionnement,

dans le second mode, le dispositif de commande (130) étant configuré pour que la soufflante d'air (113) fonctionne afin de faire varier un volume d'air entre un premier volume d'air et un second volume d'air plus grand que le premier volume d'air avec variation de la température de condensation, et

dans le premier mode, le dispositif de commande (130) étant configuré pour changer le mode de fonctionnement du premier mode au second mode lorsque la charge de climatisation détectée par le dispositif de détection de charge de climatisation (125) devient inférieure à une valeur seuil,

dans le second mode, le dispositif de commande (130) étant configuré pour changer le mode de fonctionnement du second mode au premier mode lorsque la charge de climatisation devient supérieure à la valeur seuil, dans lequel

dans le second mode, le dispositif de commande (130) est configuré pour changer un volume d'air envoyé par la soufflante d'air (113) du premier volume d'air au second volume d'air lorsque la température de condensation devient supérieure à une première température,

et changer un volume d'air envoyé par la soufflante d'air (113) du second volume d'air au premier volume d'air lorsque la température de condensation devient inférieure à une seconde température inférieure à la première température.

2. Appareil de climatisation selon la revendication 1, dans lequel 35

le dispositif de détection de charge de climatisation (125) comprend

un capteur de température de surface (110) configuré pour détecter une température de surface d'un objet situé dans un espace climatisé, et

un capteur de température intérieure (121) configuré pour détecter une température intérieure, et

le dispositif de commande (130) est configuré pour changer le mode de fonctionnement du second mode au premier mode lorsqu'au moins une parmi une première condition et une seconde condition est satisfaite durant des fonctionnements dans le second mode, la première condition étant une condition selon laquelle la température intérieure est inférieure à une première valeur seuil, et la seconde condition étant une condition selon laquelle la température de surface est inférieure à la seconde valeur seuil.

3. Appareil de climatisation selon la revendication 1, dans lequel
- le dispositif de détection de charge de climatisation (125) détecte une vitesse de rotation du compresseur (119), et 5
- le dispositif de commande (130) est configuré pour changer le mode de fonctionnement du premier mode au second mode lorsque la vitesse de rotation du compresseur (119) devient inférieure à une première valeur seuil. 10
4. Appareil de climatisation selon la revendication 1, l'appareil de climatisation comprenant une partie de changement de direction de vent (112) configurée pour changer une direction d'air envoyé par la soufflante d'air, dans lequel 15
- le dispositif de commande (130) est configuré pour commander la partie de changement de direction de vent (112) pour régler la direction d'air sur une direction de vent prescrite lorsque le mode de fonctionnement est le second mode. 20
5. Appareil de climatisation selon la revendication 4, dans lequel 25
- un angle indiquant la direction de vent prescrite est supérieur ou égal à 45° , un angle indiquant une direction verticale à une surface de sol étant défini à 90° et un angle indiquant une direction horizontale à la surface de sol étant défini à 0° . 30
6. Appareil de climatisation selon la revendication 1, l'appareil de climatisation comprenant en outre :
- un condenseur supplémentaire (115B) relié en parallèle au condenseur (115A) dans le circuit de fluide frigorigène ; et 35
- une soufflante d'air supplémentaire (113B) située en correspondance avec le condenseur supplémentaire (115B), dans lequel 40
- le dispositif de commande (130) est configuré pour commander la soufflante d'air (113A) et la soufflante d'air supplémentaire (113B) pour éviter un chevauchement d'une période durant laquelle la soufflante d'air (113A) envoie le second volume d'air avec une période durant laquelle la soufflante d'air supplémentaire (113B) envoie le second volume d'air dans le second mode. 45
7. Appareil de climatisation selon l'une quelconque des revendications 1 à 6, dans lequel 50
- le premier volume d'air se rapporte à un volume d'air correspondant à un état selon lequel la soufflante d'air (113, 113A) est éteinte. 55

FIG. 1

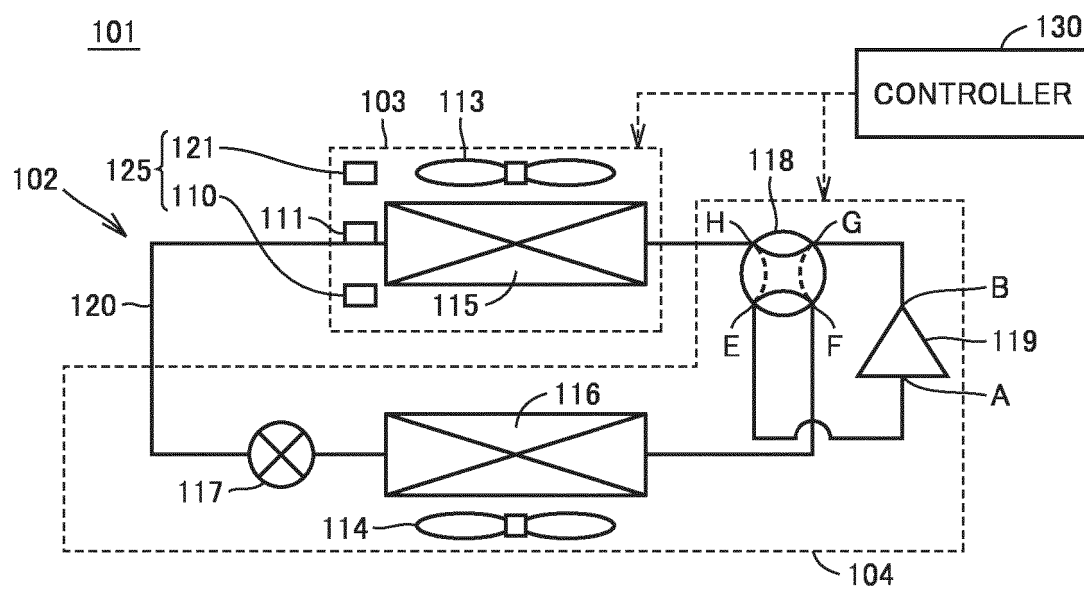


FIG.2

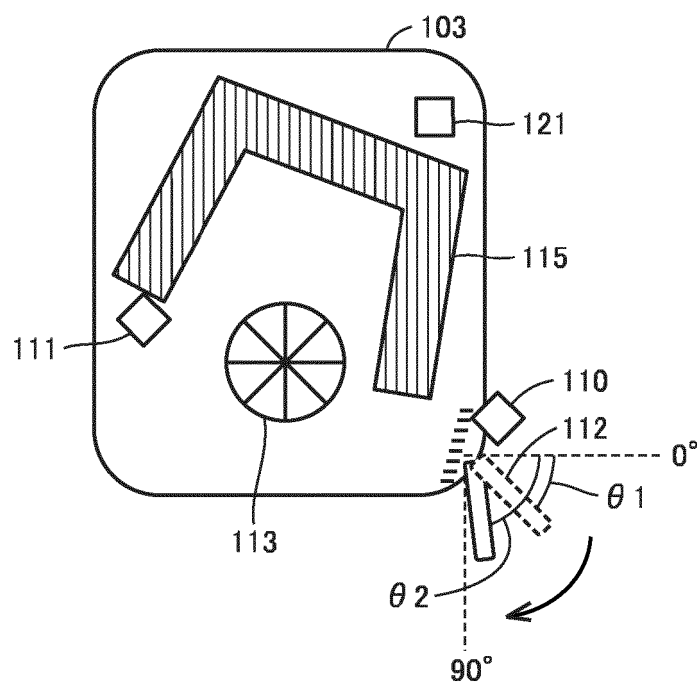


FIG.3

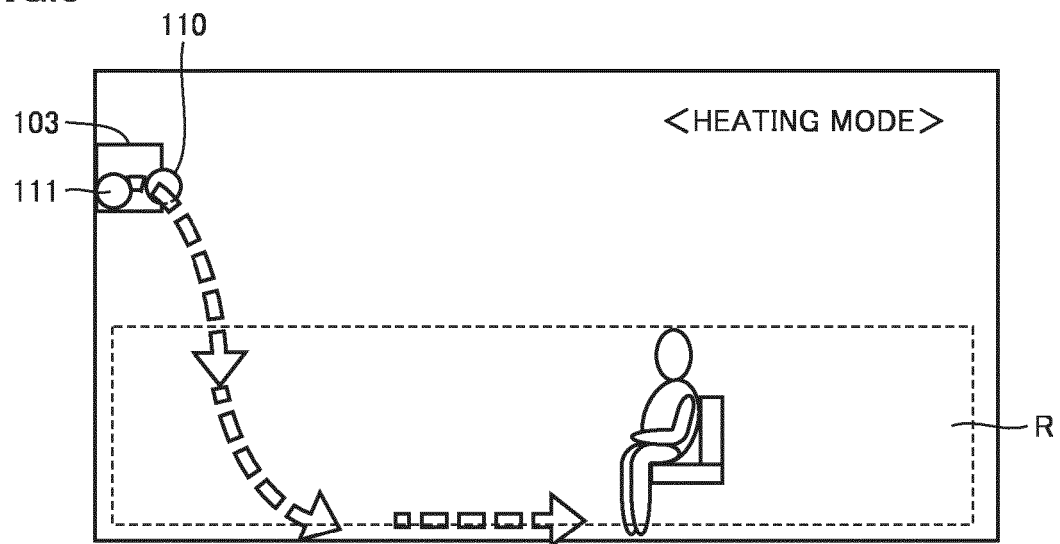


FIG.4

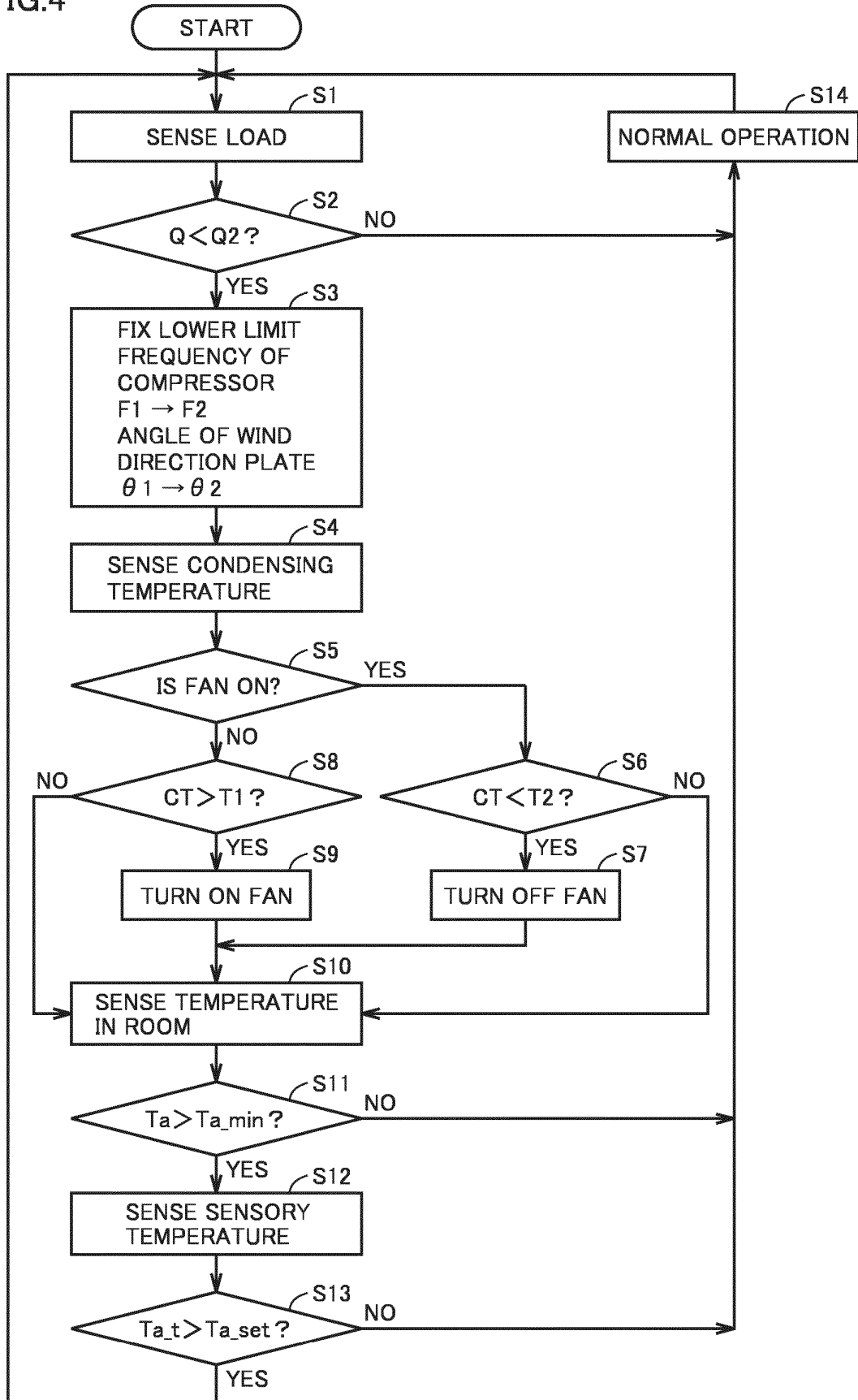


FIG.5

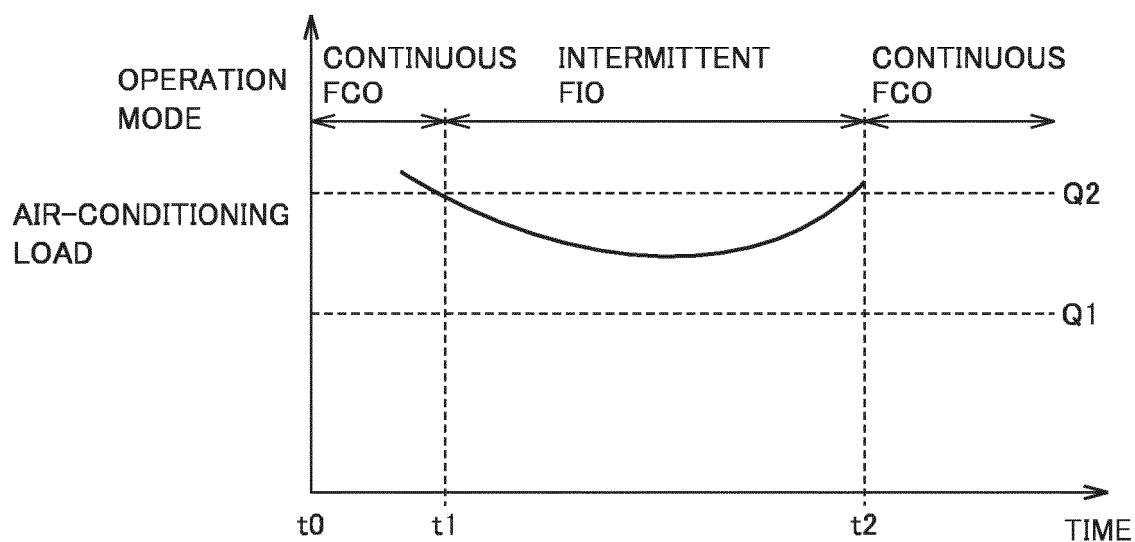


FIG.6

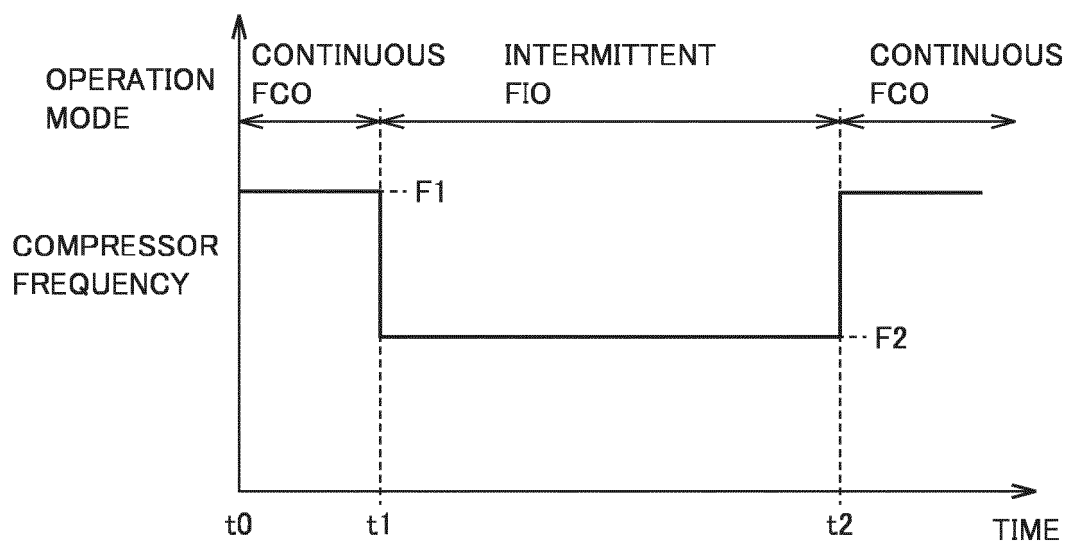


FIG.7

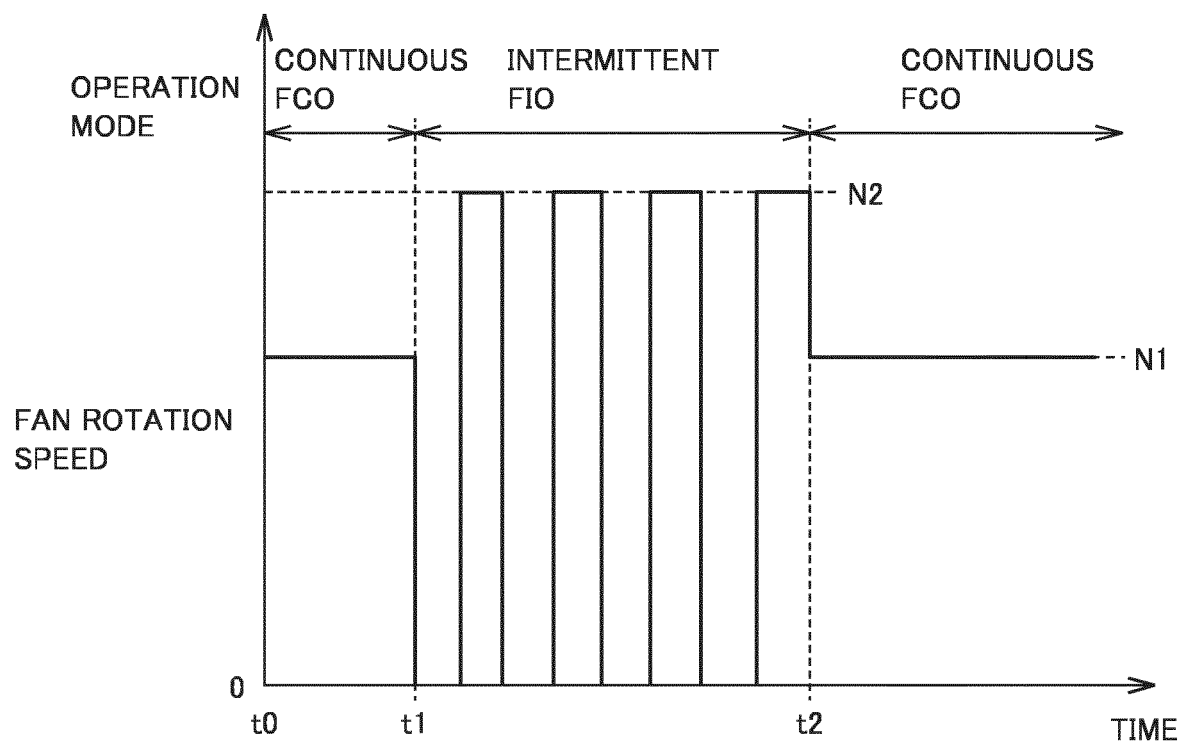


FIG.8

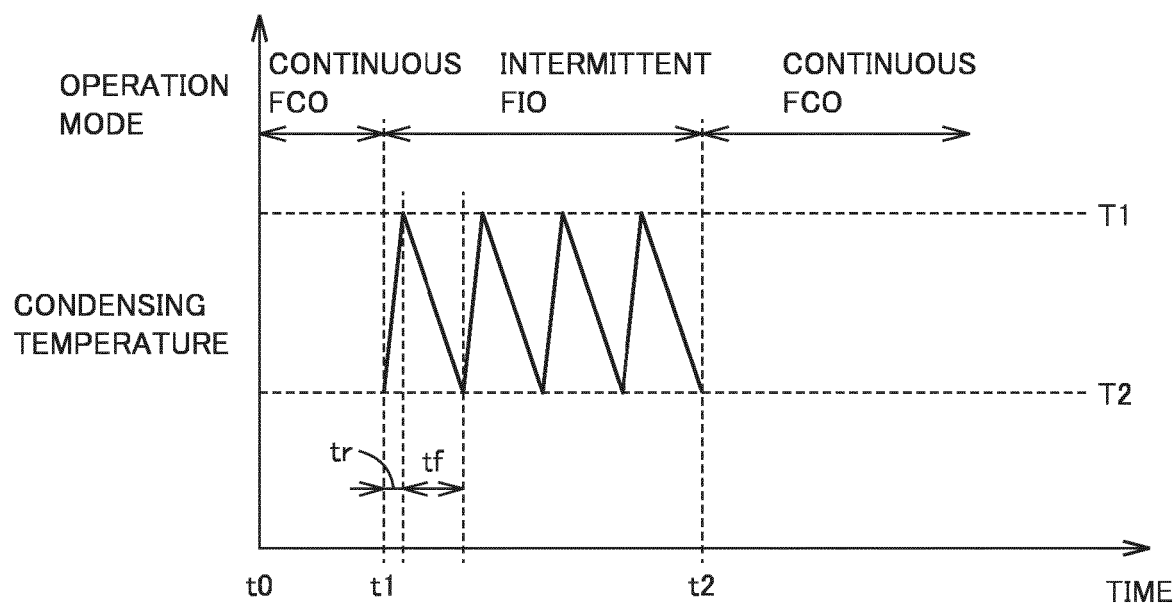


FIG.9

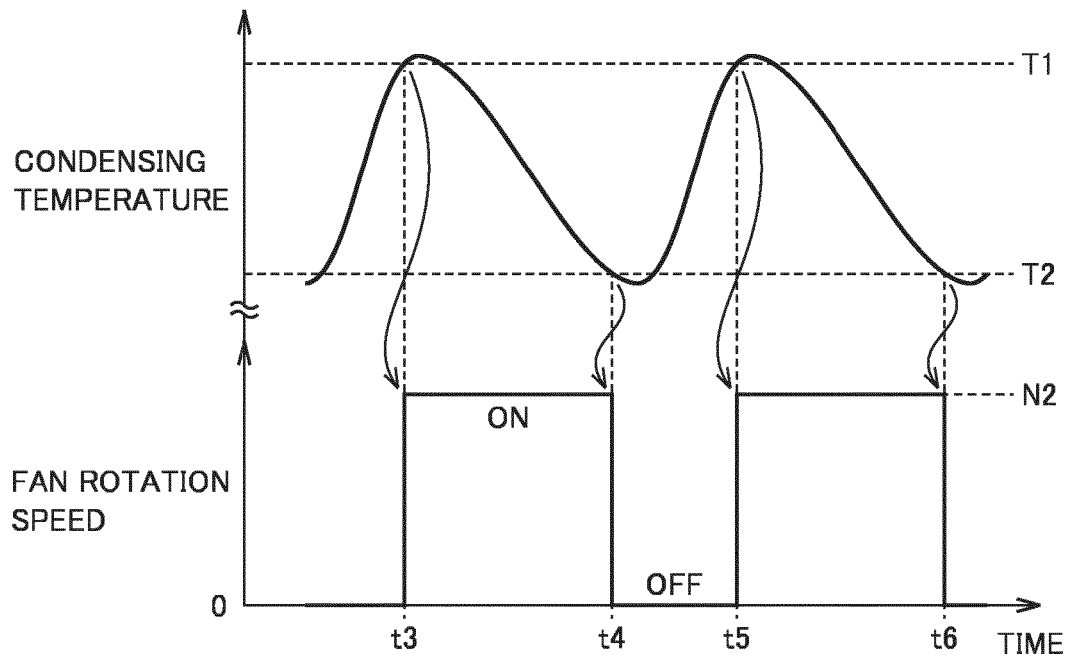


FIG.10

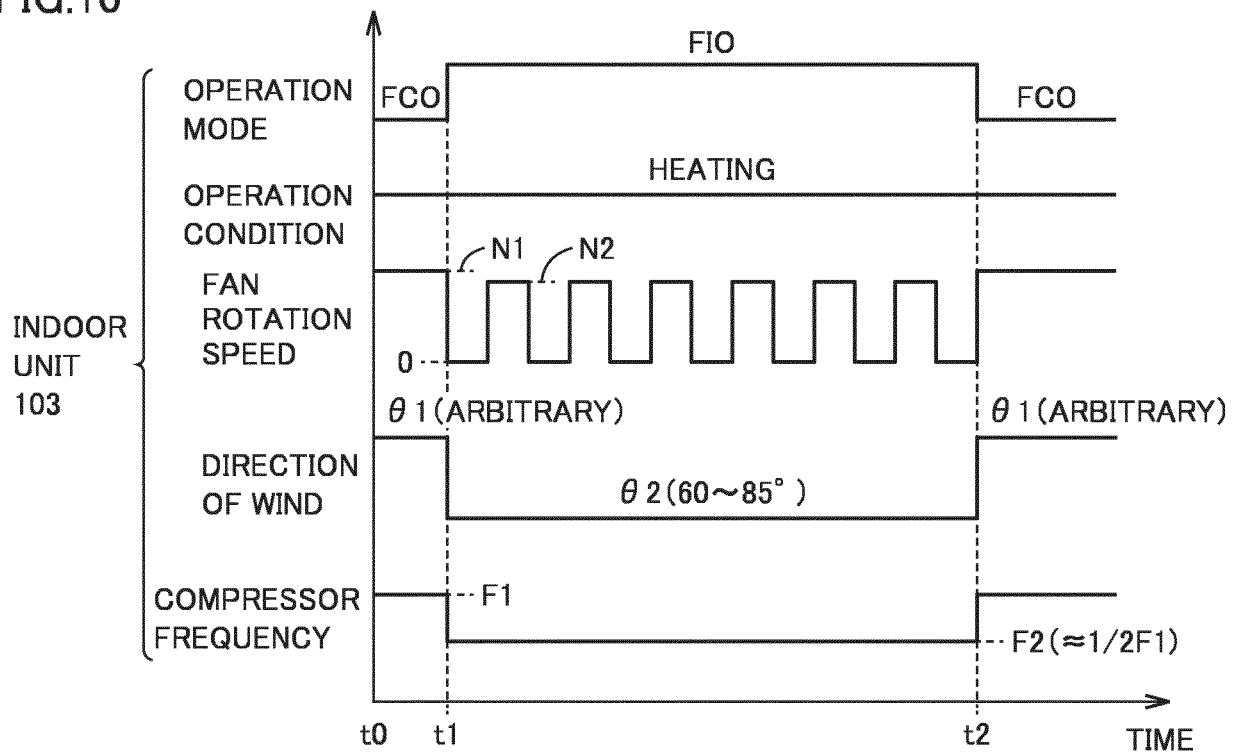


FIG.11

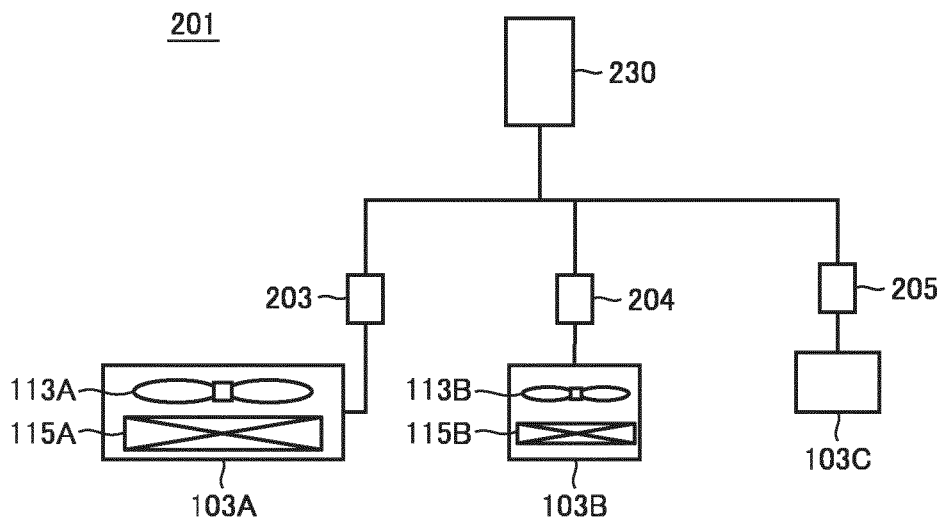


FIG.12

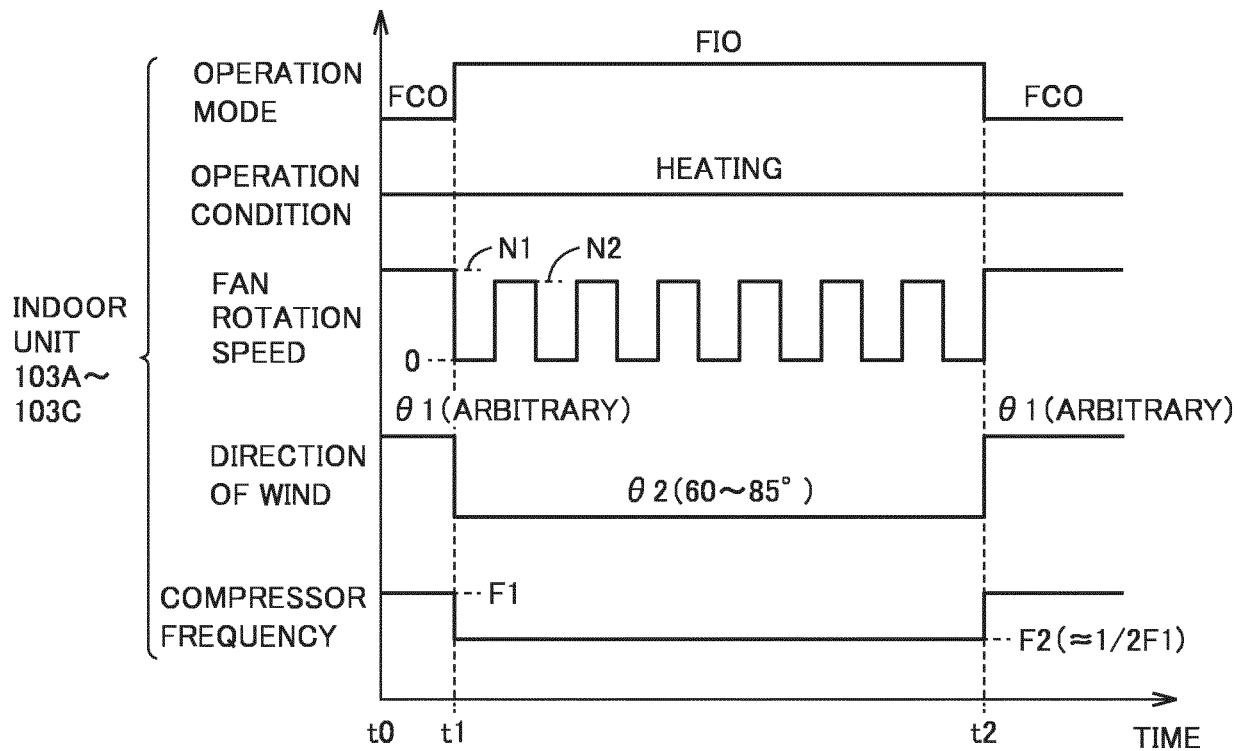
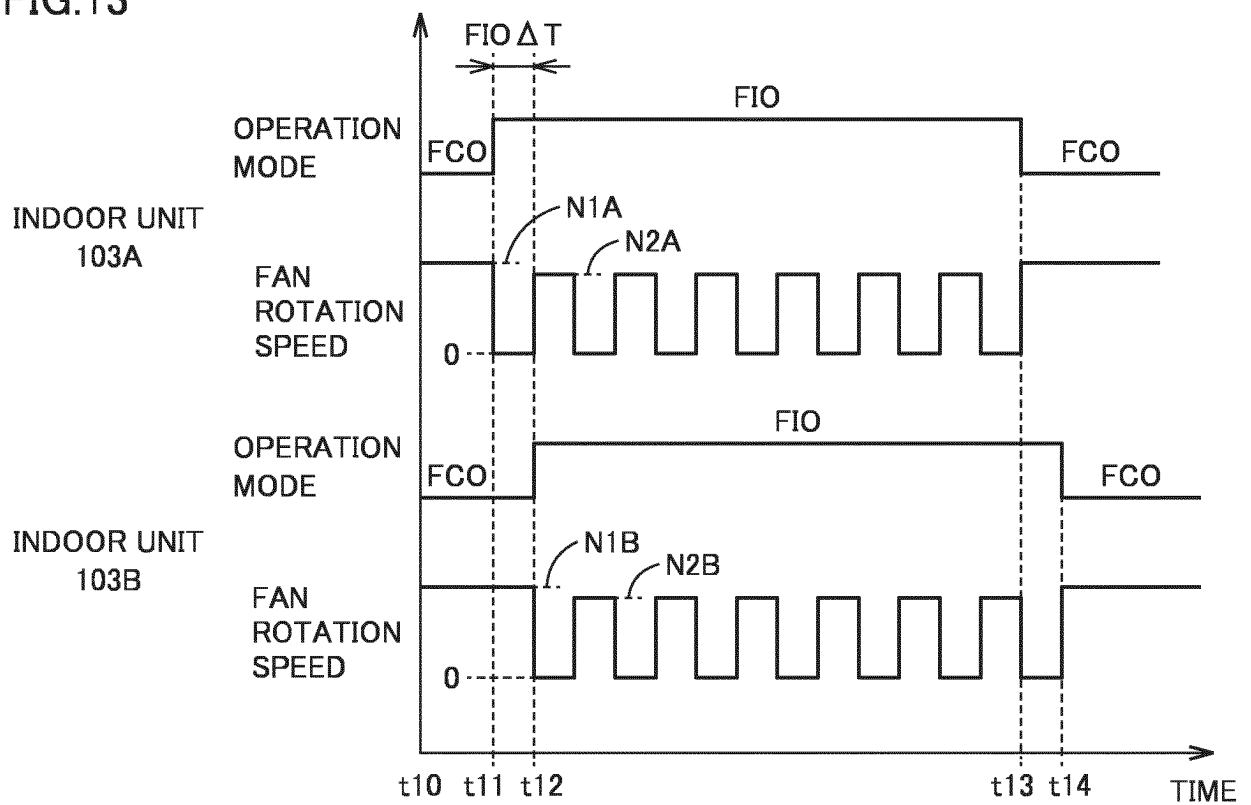


FIG.13



REFERENCES CITED IN THE DESCRIPTION

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