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(71) Applicant: **Mitsubishi Heavy Industries Thermal
Systems, Ltd.**
Tokyo 100-8332 (JP)

(72) Inventor: **ISHIZUKA, Hirofumi**
Tokyo 100-8332 (JP)

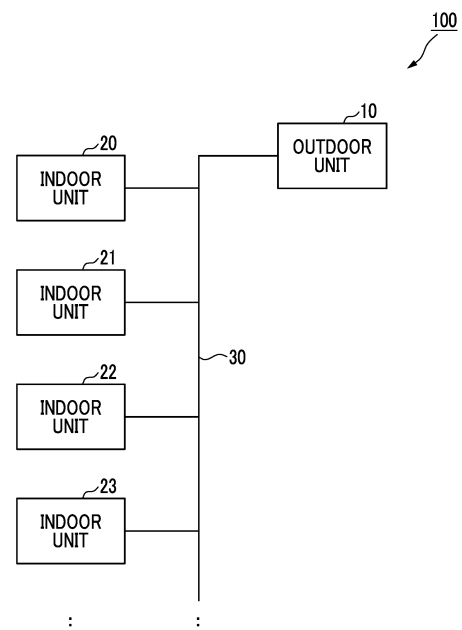
(74) Representative: **Cabinet Beau de Loménie**
158, rue de l'Université
75340 Paris Cedex 07 (FR)

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(54) **AIR CONDITIONER AND CONTROL METHOD**

(57) Provided is an air conditioner that is capable of detecting an indoor temperature without operating a fan during thermostat OFF of a heating operation. This air conditioner includes: an indoor unit that includes a fan, an indoor heat exchanger, a first opening that takes in air, a second opening that discharges air, and a temperature sensor; and an outdoor unit. The first opening is provided downward from the center in the height direction of the indoor heat exchanger. The second opening is provided upward from the indoor heat exchanger. In order to satisfy a conditional expression including the various parameters of an air temperature of the first opening during heating operation, an air temperature of the second opening, a height difference between the center in the height direction of the indoor heat exchanger and the height direction of the second opening, and an area of the second opening, the aforementioned parameters are set so that a flow of air being taken in through the first opening and discharged from the second opening is generated even if the fan is stopped when the heating operation enters a thermostat OFF state in which the heat exchange by the indoor heat exchanger is unnecessary.

FIG. 1



Description

Technical Field

5 **[0001]** The present invention relates to an air conditioner and a control method. The present disclosure claims priority based on Japanese Patent Application No. 2022-127123 filed in Japan on August 9, 2022, the contents of which are incorporated herein by reference.

Background Art

10 **[0002]** As shown in Fig. 1, a multi-type air conditioner 100 that includes a plurality of indoor units 20, 21, 22, and 23 with respect to one outdoor unit 10 is provided. In the multi-type air conditioner 100, the refrigerant sent out by the outdoor unit 10 is shared by the indoor units 20 to 23, and therefore, in a case where the refrigerant is excessively accumulated in an indoor heat exchanger of the indoor unit 20, for example, the amount of the refrigerant that is supplied to the indoor units 21
 15 to 23 is reduced, and the air conditioning capacity of the indoor units 21 to 23 is reduced. For example, in a case where thermostat OFF (the thermostat OFF means that an indoor temperature reaches a setting temperature and an operation state is made in which heat exchange between the refrigerant flowing through the indoor heat exchanger of the indoor unit 20 and the indoor air is unnecessary) is made during the heating operation of the indoor unit 20, the gas refrigerant supplied to the indoor heat exchanger is condensed and liquefied, and the refrigerant is accumulated in the indoor heat exchanger
 20 of the indoor unit 20. This is because, in the multi-type air conditioner 100, even in a case where the thermostat OFF is made, the refrigerant is supplied to the indoor heat exchanger and is condensed due to the operation of a fan, or the like. As a measure for preventing the refrigerant from being condensed in the indoor heat exchanger, a method of causing the refrigerant to continuously flow by opening an expansion valve is considered. However, in order to detect an accurate indoor temperature even at the time of the thermostat OFF, it is necessary to operate the fan, and thus the heating operation is actually performed even at the time of the thermostat OFF. As a related technique, PTL 1 discloses a method of
 25 installing a temperature sensor such that an indoor temperature can be accurately measured even in a case where a fan is not operated at the time of the thermostat OFF.

Citation List

Patent Literature

30 **[0003]** [PTL 1] Japanese Unexamined Patent Application Publication No. 2009-97742

Summary of Invention

Technical Problem

40 **[0004]** There is a demand for an air conditioner capable of measuring an indoor temperature without operating a fan even at the time of the thermostat OFF of the heating operation.

[0005] The present disclosure provides an air conditioner and a control method capable of solving the problem described above.

Solution to Problem

45 **[0006]** According to an aspect of the present disclosure, there is provided an air conditioner including: an indoor unit that includes a fan, an indoor heat exchanger, a first opening portion through which air is sucked, a second opening portion through which air is discharged, and a temperature sensor; and an outdoor unit, in which the first opening portion is provided on a lower side with respect to a center in a height direction of the indoor heat exchanger, the second opening
 50 portion is provided above the indoor heat exchanger, and based on a predetermined conditional expression that includes an air temperature at the first opening portion during heating operation, an air temperature at the second opening portion, a height difference in the height direction between the center in the height direction of the indoor heat exchanger and the second opening portion, and an area of the second opening portion, the air temperature at the first opening portion, the air temperature at the second opening portion, the height difference in the height direction between the center in the height
 55 direction of the indoor heat exchanger and the second opening portion, an area of the first opening portion, and the area of the second opening portion are set such that a flow of air in which the air is sucked in from the first opening portion and the air is discharged from the second opening portion is generated even when the fan is stopped in a case where thermostat OFF in which heat exchange in the indoor heat exchanger is unnecessary is made during the heating operation.

[0007] According to an aspect of the present disclosure, there is provided a control method including: stopping the fan when the heating operation of the indoor unit is turned to the thermostat OFF in the air conditioner described above.

Advantageous Effects of Invention

[0008] According to the air conditioner and the control method, it is possible to measure the indoor temperature without operating the fan at the time of the thermostat OFF of the heating operation.

Brief Description of Drawings

[0009]

Fig. 1 is a schematic diagram of a multi-type air conditioner according to an embodiment.

Fig. 2 is a schematic diagram showing an example of a refrigerant circuit of the multi-type air conditioner according to the embodiment.

Fig. 3 is a schematic diagram showing an example of an indoor unit according to the embodiment.

Description of Embodiments

<Embodiment>

[0010] Hereinafter, an air conditioner and a control method according to an embodiment of the present disclosure will be described with reference to Figs. 1 to 3.

(Configuration)

[0011] Fig. 1 is a schematic diagram showing an example of a multi-type air conditioner according to the embodiment. The multi-type air conditioner is an air conditioner in which a plurality of indoor units are connected to one outdoor unit. An air conditioner 100 in Fig. 1 is a multi-type air conditioning system that includes an outdoor unit 10 and a plurality of indoor units 20, 21, 22, and 23. The outdoor unit 10 and each of the indoor units 20 to 23 are connected to each other by a refrigerant pipe 30. The number of the outdoor units 10, and the number of the indoor unit 20 and the like are not limited to the number shown in Fig. 1. For example, the number of the indoor unit 20 and the like may be two or three, or five or more. The number of outdoor units 10 may be two or more.

[0012] Fig. 2 shows a schematic diagram of a refrigerant circuit of the multi-type air conditioner 100 in a case where the outdoor unit 10 is one and the indoor unit 20 and the like are two (20, 21). As shown in Fig. 2, the outdoor unit 10 includes a compressor 11, a four-way valve 12, an outdoor heat exchanger 13, and a control device 14. The discharge side of the compressor 11 and the four-way valve 12 are connected by a pipe 34, the four-way valve 12 and the outdoor heat exchanger 13 are connected by a pipe 32, and the four-way valve 12 and the suction side of the compressor 11 are connected by a pipe 33. The four-way valve 12 and a joint 3A are connected by a pipe 35. The outdoor heat exchanger 13 and a joint 3B are connected by a pipe 31. The control device 14 performs control of the compressor 11 or the like.

[0013] The indoor unit 20 includes an indoor heat exchanger 201, an expansion valve 202, a fan 203, a temperature sensor 204, a temperature sensor 205, and a control device 206. A pipe 36 connects the joint 3A and the indoor heat exchanger 201. A pipe 37 connects the indoor heat exchanger 201 and the joint 3B, and the expansion valve 202 is provided in the pipe 37. The fan 203 is provided in the vicinity of a suction port of the indoor unit 20, sucks in the indoor air, and sends the indoor air to the indoor heat exchanger 201. The temperature sensor 204 is provided in the vicinity of the suction port of the indoor unit 20 and measures an indoor temperature (the temperature of the sucked air). The temperature sensor 205 is provided in the vicinity of the center of the indoor heat exchanger 201, and measures a refrigerant temperature of the indoor heat exchanger 201. The temperature measured by the temperature sensor 205 is the same temperature as the air temperature after air conditioning, which is blown into the room from the indoor unit 20. The control device 206 controls the fan 203 and the like. Whether to turn to the thermostat OFF or the thermostat ON when the indoor unit 20 is in the heating operation is determined based on a temperature difference between the setting temperature for heating of the indoor unit 20 and the temperature measured by the temperature sensor 204. For example, the control device 206 determines to turn the heating operation to the thermostat OFF when the temperature measured by the temperature sensor 204 rises by a predetermined value or more above the setting temperature, and determines to turn the heating operation to the thermostat ON when the temperature measured by the temperature sensor 204 falls by a predetermined value or more below the setting temperature for heating.

[0014] The configuration of the indoor unit 21 is the same as that of the indoor unit 20. The indoor unit 21 includes an indoor heat exchanger 211, an expansion valve 212, a fan 213, a temperature sensor 214, a temperature sensor 215, and a

control device 216. A pipe 38 connects the joint 3A and the indoor heat exchanger 211. A pipe 39 connects the indoor heat exchanger 211 and the joint 3B, and the expansion valve 212 is provided in the pipe 39. The control device 216 controls the fan 213 and the like.

[0015] In a case where the heating operation is performed by the multi-type air conditioner 100, the four-way valve 12 is set for the heating operation, and the high-temperature and high-pressure gas refrigerant discharged from the compressor 11 is supplied to the indoor heat exchanger 201 of the indoor unit 20 through the pipe 34, the four-way valve 12, and the pipes 35 and 36, and is supplied to the indoor heat exchanger 211 of the indoor unit 21 through the pipes 34, 35, and 38. The refrigerant supplied to the indoor heat exchanger 201 is condensed by being heat-exchanged with the air sent by the fan 203, is depressurized by the expansion valve 202, and is supplied to the outdoor heat exchanger 13 through the pipes 37 and 31. Similarly, in the indoor unit 21, the refrigerant supplied to the indoor heat exchanger 211 is condensed by being heat-exchanged with the air sent by the fan 213, is depressurized by the expansion valve 212, and is supplied to the outdoor heat exchanger 13 through the pipes 39 and 31. The refrigerant supplied to the outdoor heat exchanger 13 is vaporized by heat exchange with the outside air, and the vaporized refrigerant is sucked into the compressor 11 through the pipe 32, the four-way valve 12, and the pipe 33.

[0016] As described with reference to Fig. 2, in the multi-type air conditioner 100, the refrigerant supplied from the outdoor unit 10 is shared by the indoor units 20 and 21. In the multi-type air conditioner 100, even in a case where the heating operation of the indoor unit 20 is turned to the thermostat OFF, the refrigerant is supplied to the indoor heat exchanger 201 (the supply amount is reduced by the control of the expansion valve 202). Therefore, in a case where the refrigerant is excessively accumulated in the indoor heat exchanger 201, the amount of refrigerant that is supplied to the indoor unit 21 is decreased. In order to prevent the refrigerant from being accumulated in the indoor heat exchanger 201, various controls of the expansion valve 202 or the fan 203 are performed. However, the fan 203 is often operated even at the time of the thermostat OFF such that the temperature sensor 204 can measure an accurate indoor temperature. In a case where the fan 203 is operated at the time of the thermostat OFF, the overheating of the room is caused, and the refrigerant condensation in the indoor heat exchanger 201 is promoted. Therefore, it is desirable to stop the fan 203 at the time of the thermostat OFF and to accurately measure the indoor temperature. Therefore, in the present embodiment, the indoor unit 20 and the outdoor unit 10 are configured to circulate the indoor air by natural convection, instead of operating the fan 203, by utilizing the tendency that warm air heated by the refrigerant supplied to the indoor heat exchanger 201 rises even at the time of the thermostat OFF to stir the indoor air, and to measure the indoor air temperature, which is made uniform as a result, by the temperature sensor 204.

[0017] Fig. 3 schematically shows the configuration of the indoor unit 20 according to the embodiment. The indoor unit 20 is a floor-standing indoor unit. A suction port 207 for indoor air is provided in a lower portion of the indoor unit 20, and a discharge outlet 208 for air after air conditioning is provided in an upper portion of the indoor unit 20. The fan 203 or the temperature sensor 204 is provided near the suction port 207. The suction port 207 is provided on a lower side with respect to the center of the indoor heat exchanger 201, and the discharge outlet 208 is provided above the indoor heat exchanger 201. By disposing the suction port 207, the indoor heat exchanger 201, and the discharge outlet 208 in this order from below, when the heating operation of the indoor unit 20 is turned to the thermostat OFF, the air inside the indoor unit 20 is heated by the indoor heat exchanger 201, rises, and is supplied into the room from the discharge outlet 208. The supplied air rises in the room. The indoor air flows into the indoor heat exchanger 201 at a low pressure from the suction port 207, and is supplied into the room from the discharge outlet 208 at the upper portion of the indoor unit 20 through the same process.

(Case of defining suction speed that causes natural convection)

[0018] In this case, in order to generate the natural convection, it is necessary to generate a flow stronger than the airflow already present in the room. Here, the following calculation expression (1) for calculating an air supply speed of a gas flowing into a chimney, based on a chimney effect, is adopted.

$$Q = C \cdot A \cdot \sqrt{2g \cdot h \cdot \frac{T_2 - T_1}{T_2}} \quad \dots (1)$$

[0019] Q is an air supply speed (m³/s), C is a predetermined flow rate coefficient (for example, a value in a range of 0.65 to 0.7), A is a chimney cross-sectional area (m²), g is a gravitational acceleration, h is a chimney height (m), T₁ is an outside air temperature (K), and T₂ is an average temperature in a chimney (K).

[0020] In a case where Expression (1) is applied to the indoor unit 20 of Fig. 3, the right side of the following expression (2) is obtained by regarding an air flow path from a center L in the height direction of the indoor heat exchanger 201 of the indoor unit 20 to the discharge outlet 208 as a chimney. The suction speed of the indoor air that is sucked into the indoor unit 20 can be calculated by the right side of Expression (2).

$$0.5 \text{ m/s} \leq A_o/A_i \times \sqrt{(C_2 \times 2g \times h \times (T_o - T_i)/T_o)} \quad \cdot \cdot \cdot (2)$$

[0021] A_o is an area (m^2) of the discharge outlet 208, A_i is an area (m^2) of the suction port 207, C_2 is a pressure loss coefficient by the indoor heat exchanger 201 (a reduction rate of a pressure loss due to a heat exchange pressure loss, for example, 0.5), g is a gravitational acceleration, h is a height difference (m) (h shown in Fig. 3) between the center in the height direction of the indoor heat exchanger 201 and the discharge outlet 208, T_o is a temperature (K) of discharged air, and T_i is a temperature (K) of suction air.

[0022] The value 0.5 m/s of the left side is based on the idea that, since the Building Standards Law stipulates that the indoor airflow must be 0.5 m/s or less, the natural convection will occur in a case where the airflow of 0.5 m/s or more is generated indoors. The value of the left side can be set to any value according to the environment in which the indoor unit 20 is installed. T_i is the temperature measured by the temperature sensor 204, and T_o is the same temperature as the temperature measured by the temperature sensor 205. The temperature measured by the temperature sensor 205 is the condensation temperature of the indoor heat exchanger 201, and the discharge pressure of the compressor 11 is determined based on the condensation temperature. For example, in a case where T_i is set as the setting temperature, T_o or the discharge pressure of the compressor 11 necessary for satisfying Expression (2) is determined. In the multi-type air conditioner 100, it is necessary to decide the operation of the compressor 11 in consideration of the setting temperature of the other indoor unit 21 or the like. However, it is possible to design h , A_o , A_i , T_o at the time of heating, the discharge pressure of the compressor 11, and the like in advance to satisfy Expression (2) even in consideration of the setting temperature of the other indoor unit 21 or the like. The control device 14 of the outdoor unit 10 is designed to operate the compressor 11 such that the condensation temperature of the indoor heat exchanger 201 is T_o satisfying Expression (2). Then, when the indoor unit 20 is in the thermostat OFF during the heating operation, the control device 206 of the indoor unit 20 stops the fan 203. Then, in the indoor unit 20, a flow of air in which at a speed that can be calculated by the right side of Expression (2), indoor air is sucked from the suction port 207 and warm air is discharged from the discharge outlet 208 is generated. Since the flow of air satisfies the condition of Expression (2), the flow of air is not affected by the indoor airflow, and natural convection occurs indoors. In a case where the indoor air circulates by natural convection, the indoor air is mixed, so that the indoor temperature is made uniform, and the temperature measured by the temperature sensor 204 is an accurate temperature in the room. In this way, it is possible to detect an accurate indoor temperature without operating the fan 203.

(Case of defining heating capacity according to air volume by natural convection)

[0023] In a case where the fan 203 is operated at the time of the thermostat OFF of the heating operation as in the control in the related art, it is noted that the room to be air-conditioned by the indoor unit 20 is excessively heated. From the viewpoint of the heating capacity of the indoor unit 20 at the time of the thermostat OFF, a condition for making the heating capacity of the indoor unit 20 at the time of the thermostat OFF appropriate (for example, not excessively heated) may be set, and T_o and the like may be calculated. Specifically, the following expression (3) which is application of Expression (2) described above can be used.

$$\text{Rated capacity} \times 0.5 \geq A_o \times \sqrt{(C_2 \times 2g \times h \times (T_o - T_i)/T_o)} \times C_p \times (T_o - T_i) \quad \cdot \cdot \cdot (3)$$

[0024] C_p is the specific heat of air. A_o , C_2 , g , h , T_i , and T_o are the same as in Expression (2). Expression (3) defines that the heating capacity of the indoor unit 20 when the fan 203 is stopped at the time of the thermostat OFF is set to 50% or less of the rated capacity of the indoor unit 20. The value of the left side of Expression (3) can be set to any value. Since the heating capacity is obtained by multiplying the air volume by the temperature difference between the suction port 207 and the discharge outlet 208, the right side of Expression (3) can be obtained from the right side of Expression (2) that defines the suction speed. The indoor unit 20 having A_i , A_o , and h that satisfy Expression (3) and operated at the setting temperature T_i and the condensation temperature T_o is designed. In this way, the heating capacity at the time of the thermostat OFF can be set to 50% or less of the rated capacity. Since T_o is a value (for example, 40°C or higher) that is established as the heating operation, it is found that, in a case where T_i and T_o are designed to satisfy Expression (3), the suction speed at the suction port 207, which can be calculated by the right side of Expression (2), is a speed at which the natural convection occurs. Accordingly, by operating the compressor 11 such that the condensation temperature of the indoor heat exchanger 201 is T_o with respect to the indoor unit 20 designed based on (3), even in a case where the fan 203 is stopped at the time of the thermostat OFF of the heating operation of the indoor unit 20, the flow of air due to the natural

convection occurs, and an accurate indoor temperature can be measured by the temperature sensor 204. The heating capacity at the thermostat OFF can be suppressed to be a desired value or less.

[0025] As described above, since T_i can be regarded as the setting temperature at the time of the heating operation and T_o can be regarded as the condensation temperature of the indoor heat exchanger at the time of the heating operation, the values of T_i and T_o are determined in an approximate range. By using this, values of h , A_o , and A_i satisfying Expression (2) and Expression (3) are designed, and the indoor unit 20 in which the suction port 207, the indoor heat exchanger 201, and the discharge outlet 208 are disposed in this order from below, as illustrated in Fig. 3, is designed and manufactured. Then, the manufactured indoor unit 20 is installed, and when the thermostat OFF is made during the heating operation, the fan 203 is controlled to be stopped. Then, since the indoor temperature is made uniform by the natural convection, it is possible to measure an accurate indoor temperature by the temperature sensor 204 provided in the vicinity of the suction port 207.

[0026] As described above, according to the present embodiment, even when the fan 203 is stopped at the time of the thermostat OFF of the heating operation of the indoor unit 20 designed based on Expression (2) and/or Expression (3), it is possible to measure an accurate indoor temperature by the temperature sensor 204. By stopping the fan 203, it is possible to prevent the overheating of the room at the time of the thermostat OFF. By stopping the fan 203, it is possible to reduce the amount of refrigerant that is condensed in the indoor heat exchanger 201 and to suppress the accumulation of the refrigerant in the indoor heat exchanger 201. Therefore, it is possible to prevent occurrence of a decrease in heating capacity due to a shortage of a refrigerant in the other indoor units 21 and the like.

[0027] In the embodiment described above, the opening portions of the indoor unit 20, which are used for natural convection at the time of the thermostat OFF, are defined as the suction port 207 and the discharge outlet 208. However, opening portions other than the suction port 207 and the discharge outlet 208 may be provided. For example, an opening portion 1 for suction and an opening portion 2 for discharge may be provided, and the opening portion 1, the indoor heat exchanger 201, and the opening portion 2 may be disposed in this order from below. Then, at the time of the thermostat OFF of the heating operation, the indoor air may be sucked in by using any one or both of the suction port 207 and the opening portion 1, and the warm air may be discharged by using any one or both of the discharge outlet 208 and the opening portion 2.

[0028] In addition, it is possible to appropriately replace the constituent elements in the embodiment described above with well-known constituent elements within a scope that does not depart from the gist of the present invention. The scope of the present invention is not limited to the above-mentioned embodiment, and the present invention can include various changes without departing from the scope of the present invention. For example, T_i , T_o , h , A_i , and A_o may be designed such that both of Expression (2) and Expression (3) are satisfied.

<Additional Remark>

[0029] The air conditioner and the control method described in each embodiment are understood, for example, as follows.

[0030]

(1) The air conditioner 100 according to a first aspect includes: an indoor unit that includes a fan, an indoor heat exchanger, a first opening portion through which air is sucked, a second opening portion through which air is discharged, and a temperature sensor; and an outdoor unit, in which the first opening portion is provided on a lower side with respect to a center in a height direction of the indoor heat exchanger, the second opening portion is provided above the indoor heat exchanger, and in order to satisfy a predetermined conditional expression that includes an air temperature at the first opening portion and an air temperature at the second opening portion during heating operation, a height difference in the height direction between the center in the height direction of the indoor heat exchanger and the second opening portion, and an area of the second opening portion, the air temperature at the first opening portion, the air temperature at the second opening portion, the height difference in the height direction between the center in the height direction of the indoor heat exchanger and the second opening portion, an area of the first opening portion, and the area of the second opening portion are set such that a flow of air in which the air is sucked in from the first opening portion and the air is discharged from the second opening portion is generated even when the fan is stopped in a case where thermostat OFF in which heat exchange in the indoor heat exchanger is unnecessary is made during the heating operation.

By configuring the air conditioner in this way, even when the fan is stopped at the time of the thermostat OFF of the heating operation, the indoor temperature is made uniform by natural convection, so that an accurate indoor temperature can be measured.

(2) In the air conditioner 100 according to a second aspect, in the air conditioner 100 of the above (1), when the air temperature at the first opening portion is set to be T_i , the air temperature at the second opening portion is set to be T_o , the height difference in the height direction between the center in the height direction of the indoor heat exchanger and the second opening portion is set to be h , the area of the first opening portion is set to be A_i , the area of the second

opening portion is set to be A_o , and C_2 is a pressure loss coefficient of the indoor heat exchanger, the conditional expression is a following expression.

$$\text{Lower limit value of wind speed of suction air} \leq A_o/A_i \times \sqrt{(C_2 \times 2g \times h \times (T_o - T_i)/T_o)}$$

For example, by setting the wind speed of an airflow present indoors on the left side, it is possible to design an air conditioner that generates natural convection that does not lose to an existing airflow.

(3) In the air conditioner 100 according to a third aspect, in the air conditioner of the above (1) or (2), when the air temperature at the first opening portion is set to be T_i , the air temperature at the second opening portion is set to be T_o , the height difference in the height direction between the center in the height direction of the indoor heat exchanger and the second opening portion is set to be h , the area of the second opening portion is set to be A_o , C_2 is a pressure loss coefficient of the indoor heat exchanger, and C_p is a specific heat of air, the conditional expression is a following expression.

$$\text{Upper limit value of heating capacity} \geq A_o \times \sqrt{(C_2 \times 2g \times h \times (T_o - T_i)/T_o)} \times C_p \times (T_o - T_i)$$

In this way, it is possible to design an air conditioner in which heating capacity at the time of thermostat OFF is suppressed.

(4) In the air conditioner 100 according to a fourth aspect, in the air conditioner of any one of the above (1) to (3), a plurality of the indoor units and the outdoor unit are provided, the plurality of indoor units and the outdoor unit are connected by a refrigerant pipe, and a refrigerant flows through the indoor heat exchanger even when the heating operation of the indoor unit having the indoor heat exchanger is in the thermostat OFF.

The indoor unit satisfying the conditional expression of the present embodiment is suitable for an indoor unit of a multi-type air conditioner.

(5) A control method according to a fifth aspect includes: stopping the fan when the heating operation of the indoor unit is turned to the thermostat OFF in the air conditioner of any one of the above (1) to (4).

[0031] In this way, it is possible to prevent the overheating of the room by the indoor unit that is in the thermostat OFF, the refrigerant accumulation in the indoor heat exchanger of the indoor unit, and the insufficient heating capacity in the other indoor unit.

Industrial Applicability

[0032] According to the air conditioner and the control method, it is possible to measure the indoor temperature without operating the fan at the time of the thermostat OFF of the heating operation.

Reference Signs List

[0033]

- 10: outdoor unit
- 11: compressor
- 12: four-way valve
- 13: outdoor heat exchanger
- 14: control device
- 20: indoor unit
- 201: indoor heat exchanger
- 202: expansion valve
- 203: fan
- 204: temperature sensor
- 205: temperature sensor
- 206: control device
- 21: indoor unit
- 211: indoor heat exchanger
- 212: expansion valve
- 213: fan

214: temperature sensor
 215: temperature sensor
 216: control device
 22: indoor unit
 23: indoor unit
 30 to 39: pipe
 3A, 3B: joint

Claims

1. An air conditioner comprising:

an indoor unit that includes a fan, an indoor heat exchanger, a first opening portion through which air is sucked, a second opening portion through which air is discharged, and a temperature sensor; and an outdoor unit, wherein the first opening portion is provided on a lower side with respect to a center in a height direction of the indoor heat exchanger, the second opening portion is provided above the indoor heat exchanger, and in order to satisfy a predetermined conditional expression that includes an air temperature at the first opening portion and an air temperature at the second opening portion during heating operation, a height difference in the height direction between the center in the height direction of the indoor heat exchanger and the second opening portion, and an area of the second opening portion, the air temperature at the first opening portion, the air temperature at the second opening portion, the height difference in the height direction between the center in the height direction of the indoor heat exchanger and the second opening portion, an area of the first opening portion, and the area of the second opening portion are set such that a flow of air in which the air is sucked in from the first opening portion and the air is discharged from the second opening portion is generated even when the fan is stopped in a case where thermostat OFF in which heat exchange in the indoor heat exchanger is unnecessary is made during the heating operation.

2. The air conditioner according to Claim 1,

wherein when the air temperature at the first opening portion is set to be T_i , the air temperature at the second opening portion is set to be T_o , the height difference in the height direction between the center in the height direction of the indoor heat exchanger and the second opening portion is set to be h , the area of the first opening portion is set to be A_i , the area of the second opening portion is set to be A_o , g is a gravitational acceleration, and C_2 is a pressure loss coefficient of the indoor heat exchanger, the conditional expression is a following expression.

$$\text{Lower limit value of wind speed of suction air} \leq A_o/A_i \times \sqrt{(C_2 \times 2g \times h \times (T_o - T_i)/T_o)}$$

3. The air conditioner according to Claim 1 or 2,

wherein when the air temperature at the first opening portion is set to be T_i , the air temperature at the second opening portion is set to be T_o , the height difference in the height direction between the center in the height direction of the indoor heat exchanger and the second opening portion is set to be h , the area of the second opening portion is set to be A_o , C_2 is a pressure loss coefficient of the indoor heat exchanger, g is a gravitational acceleration, and C_p is a specific heat of air, the conditional expression is a following expression.

$$\text{Upper limit value of heating capacity} \geq A_o \times \sqrt{(C_2 \times 2g \times h \times (T_o - T_i)/T_o)} \times C_p \times (T_o - T_i)$$

4. The air conditioner according to Claim 1 or 2,

wherein a plurality of the indoor units and the outdoor unit are provided, the plurality of indoor units and the outdoor unit are connected by a refrigerant pipe, and a refrigerant flows through the indoor heat exchanger even when the heating operation of the indoor unit having the indoor heat exchanger is in the thermostat OFF.

5. A control method comprising:

stopping the fan when the heating operation of the indoor unit is turned to the thermostat OFF in the air conditioner

according to Claim 1 or 2.

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FIG. 1

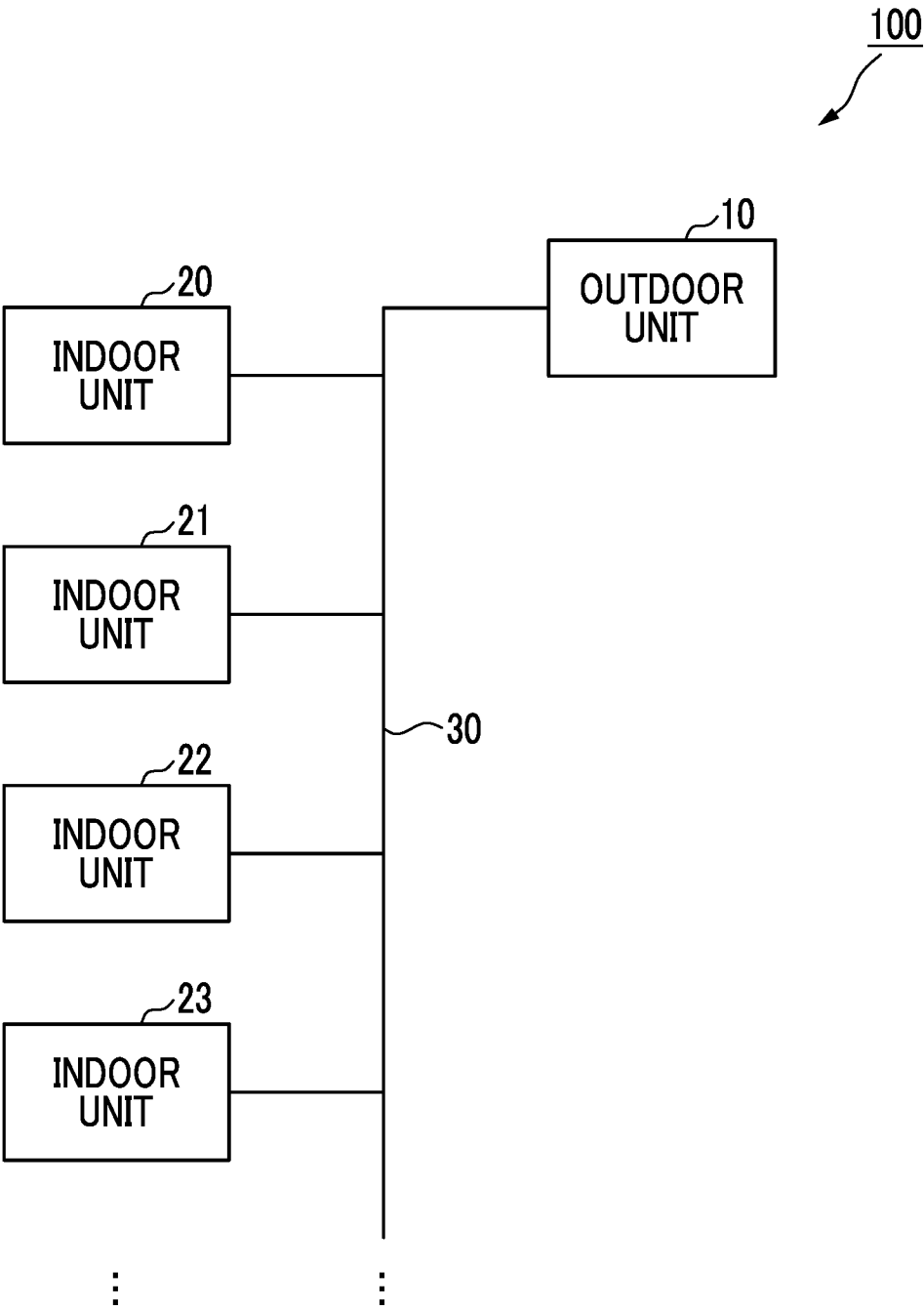


FIG. 2

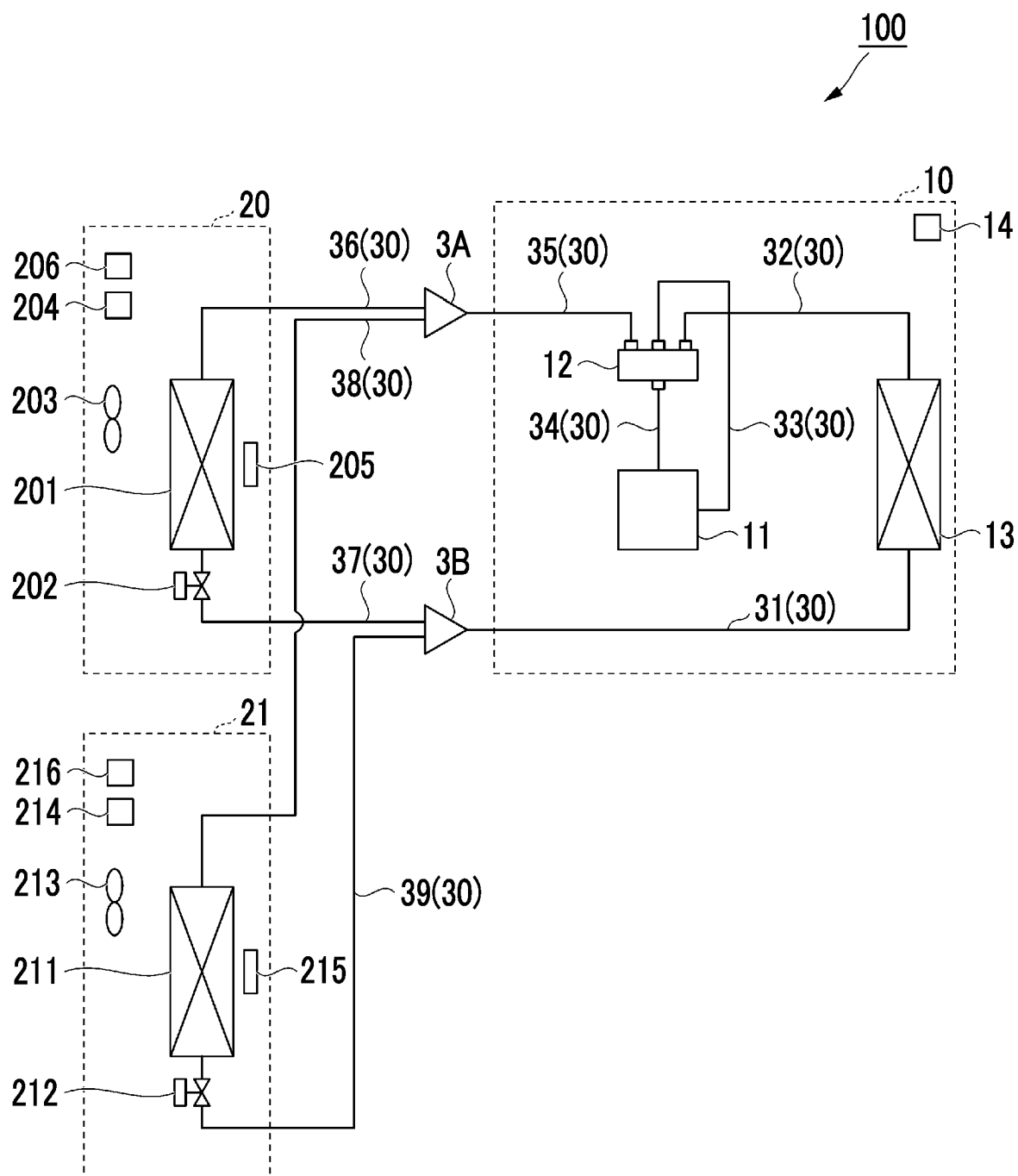
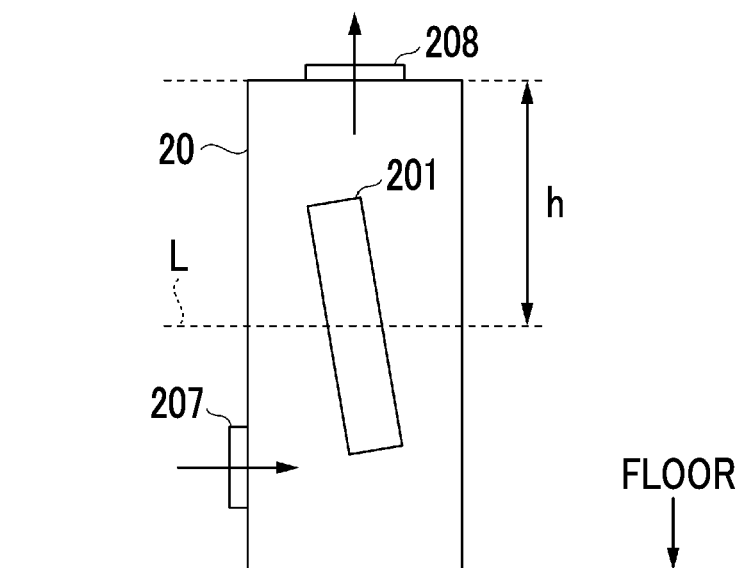


FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2023/026034

A. CLASSIFICATION OF SUBJECT MATTER

F24F 11/74(2018.01)i; **F24F 11/89**(2018.01)i; **F24F 1/0011**(2019.01)i
 FI: F24F1/0011; F24F11/74; F24F11/89

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F24F11/74; F24F11/89; F24F1/0011

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2023
 Registered utility model specifications of Japan 1996-2023
 Published registered utility model applications of Japan 1994-2023

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 11-101495 A (MITSUBISHI HEAVY IND., LTD.) 13 April 1999 (1999-04-13) paragraphs [0010]-[0030], fig. 1-3	1-5
A	JP 2017-110856 A (FUJITSU GENERAL LTD.) 22 June 2017 (2017-06-22) paragraphs [0013]-[0061], fig. 1-3	1-5
A	JP 2013-217549 A (MITSUBISHI HEAVY IND., LTD.) 24 October 2013 (2013-10-24) paragraphs [0017]-[0038], fig. 1, 2	1-5
A	WO 2021/176637 A1 (HITACHI-JOHNSON CONTROLS AIR CONDITIONING, INC.) 10 September 2021 (2021-09-10) paragraphs [0010]-[0085], fig. 1-8	1-5

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

13 September 2023

Date of mailing of the international search report

26 September 2023

Name and mailing address of the ISA/JP

**Japan Patent Office (ISA/JP)
 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915
 Japan**

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/JP2023/026034

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Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP	11-101495	A	13 April 1999	(Family: none)	
JP	2017-110856	A	22 June 2017	(Family: none)	
JP	2013-217549	A	24 October 2013	EP 2835596 A1	
				paragraphs [0020]-[0047], fig. 1, 2	
				WO 2013/150886 A1	
WO	2021/176637	A1	10 September 2021	EP 4116635 A1	
				paragraphs [0010]-[0085], fig. 1-8	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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- JP 2022127123 A [0001]
- JP 2009097742 A [0003]