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(71) Applicant: **DAIKIN INDUSTRIES, LTD.**

Osaka-shi, Osaka 530-0001 (JP)

(72) Inventors:

- **TAKAHASHI, Takashi**
Osaka-shi, Osaka 530-8323 (JP)
- **ODO, Tsunahiro**
Osaka-shi, Osaka 530-8323 (JP)
- **TSURUZONO, Shota**
Osaka-shi, Osaka 530-8323 (JP)

- **MATSUI, Nobuki**
Osaka-shi, Osaka 530-8323 (JP)
- **HANADA, Takuya**
Osaka-shi, Osaka 530-8323 (JP)
- **FUJITA, Naotoshi**
Osaka-shi, Osaka 530-8323 (JP)
- **YAMANOI, Yoshiki**
Osaka-shi, Osaka 530-8323 (JP)
- **IYOSHI, Yuta**
Osaka-shi, Osaka 530-8323 (JP)
- **SAEKI, Kumiko**
Osaka-shi, Osaka 530-8323 (JP)
- **MIYAZAKI, Takeru**
Osaka-shi, Osaka 530-8323 (JP)
- **MAEDA, Toshiyuki**
Osaka-shi, Osaka 530-8323 (JP)
- **OKAMOTO, Tetsuya**
Osaka-shi, Osaka 530-8323 (JP)

(74) Representative: **Hoffmann Eitle**

Patent- und Rechtsanwälte PartmbB
Arabellastraße 30
81925 München (DE)

(54) **VENTILATOR, AIR-CONDITIONING SYSTEM, VENTILATION METHOD, AND VENTILATION SYSTEM**

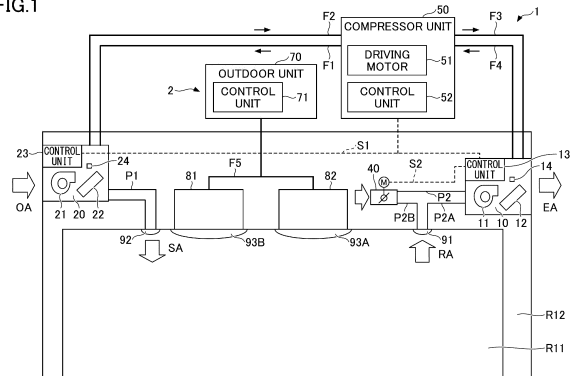
(57) A ventilation apparatus includes a compressor; a first heat exchanger; a first air flow path configured to supply air taken in from outdoors to an indoor space after passing through the first heat exchanger; a second heat exchanger; a second air flow path configured to exhaust air taken in from the indoor space to the outdoors after passing through the second heat exchanger; a refrigerant circuit through which a refrigerant flows, the refrigerant circuit being connected to the compressor, the first heat

exchanger, and the second heat exchanger by a refrigerant pipe; and a control unit. The control unit is configured to detect whether a predetermined reference indicating a possibility of frosting in the second heat exchanger is satisfied while the second heat exchanger is functioning as an evaporator, and to control a temperature of the refrigerant flowing through the second heat exchanger such that the second heat exchanger will have a temperature at which frosting does not occur in the second

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heat exchanger, when the control unit detects that the predetermined reference is satisfied.

FIG. 1



Description

Technical Field

[0001] The present disclosure relates to a ventilation apparatus, an air conditioning system, a ventilation method, and a ventilation system.

Background Art

[0002] Conventionally, there has been known a ventilation and air conditioning apparatus which, while ventilating the indoors by an exhaust fan and an air supply fan, blows the outdoor air which has been heat exchanged with a refrigerant by a first heat exchanger into the indoors while discharging the indoor air which has been heat exchanged with a refrigerant by a second heat exchanger to the outdoors (see Patent Document 1 and Patent Document 2).

Citation List

Patent Document

[0003]

[Patent Document 1] Japanese Patent No. 5076745
[Patent Document 2] Japanese Unexamined Patent Application Publication No. H3-20573

Summary of Invention

Technical Problem

[0004] In the ventilation and air conditioning apparatus described in Patent Document 1, a technology for preventing frosting to the second heat exchanger by preheating air before being supplied to the second heat exchanger by a preheating heater is proposed. However, there are various methods for preventing frosting.

[0005] The purpose of the present disclosure is to prevent frosting and to continue ventilation operation.

Solution to Problem

[0006] The present disclosure provides a ventilation apparatus including

a compressor;
a first heat exchanger configured to function as a condenser or an evaporator;
a first air flow path configured to supply air taken in from outdoors to an indoor space after passing through the first heat exchanger;
a second heat exchanger configured to function as a condenser or an evaporator;
a second air flow path configured to exhaust air taken in from the indoor space to the outdoors after passing

through the second heat exchanger;
a refrigerant circuit through which a refrigerant flows, the refrigerant circuit being connected to the compressor, the first heat exchanger, and the second heat exchanger by a refrigerant pipe; and
a control unit configured to detect whether a predetermined reference indicating a possibility of frosting in the second heat exchanger is satisfied while the second heat exchanger is functioning as an evaporator, and to control a temperature of the refrigerant flowing through the second heat exchanger such that the second heat exchanger will have a temperature at which frosting does not occur in the second heat exchanger, when the control unit detects that the predetermined reference is satisfied.

[0007] According to the ventilation apparatus, when a predetermined reference is satisfied, frosting is prevented by controlling the temperature of a refrigerant, and a ventilation operation by supplying air to an indoor space and exhausting air to the outdoors can be continued.

[0008] In the above ventilation apparatus, the control unit may detect whether the predetermined reference indicating a possibility of frosting in the second heat exchanger is satisfied while the second heat exchanger is functioning as an evaporator, and outputs a signal for controlling an air conditioner provided in the indoor space to control the temperature of the refrigerant flowing through the second heat exchanger, when the control unit detects that the predetermined reference is satisfied.

[0009] According to the ventilation apparatus, by operating the air conditioner according to the signal, the temperature of the indoor space is adjusted, and by controlling the temperature of the refrigerant, frosting can be prevented to achieve efficient frost prevention.

[0010] In the above ventilation apparatus, the control unit may output a signal for increasing a temperature currently set for the air conditioner, with respect to the air conditioner provided in the indoor space, when the control unit detects that the predetermined reference is satisfied.

[0011] According to the ventilation unit, the air conditioner can raise the air temperature in the indoor space by the signal, thereby raising the temperature of the refrigerant to prevent frosting, thereby achieving efficient frosting prevention.

[0012] In the above ventilation apparatus,

the refrigerant circuit may include a bypass pipe configured to pass the refrigerant to the second heat exchanger without involving the first heat exchanger while the second heat exchanger is functioning as an evaporator, wherein
the control unit may implement control to cause the refrigerant that has been compressed at the compressor to flow to the second heat exchanger via the bypass pipe, when the predetermined reference is satisfied.

[0013] According to the ventilation apparatus, by passing the refrigerant through the bypass pipe to the second heat exchanger, frosting can be prevented by raising the temperature of the refrigerant, thereby achieving efficient frosting prevention.

[0014] The above ventilation apparatus may further include

a third air flow path configured to take in air from a space that is different from a space from which the second air flow path takes in air in the indoor space, and to pass the taken in air to the second heat exchanger; and

a first guide mechanism configured to switch between whether or not to guide air to the second heat exchanger through the third air flow path, wherein the control unit may control the first guide mechanism to guide air to the second heat exchanger through the third air flow path when the predetermined reference is satisfied.

[0015] According to the ventilation apparatus, air is guided through the third air flow path to the second heat exchanger, and, therefore, frosting can be prevented by raising the temperature of the refrigerant flowing through the second heat exchanger to achieve efficient frosting prevention.

[0016] The above ventilation apparatus may further include

a second ventilation unit configured to adjust an air volume flowing to the second heat exchanger upon flowing through the second air flow path, wherein the control unit may control the second ventilation unit to increase the air volume flowing to the second heat exchanger compared to before the predetermined reference is satisfied, when the predetermined reference is satisfied.

[0017] According to the ventilation apparatus, by increasing the air volume flowing through the second heat exchanger, the temperature of the refrigerant flowing through the second heat exchanger is raised to prevent frosting, thereby efficiently preventing frosting.

[0018] The above ventilation apparatus may further include

a plurality of the second heat exchangers; and the second ventilation unit associated with each of the plurality of the second heat exchangers, wherein the control unit may control the second ventilation unit associated with any one of the plurality of the second heat exchangers, to increase the air volume flowing to the corresponding second heat exchanger compared to before the predetermined reference is satisfied, when the predetermined reference is satisfied, while the plurality of the second heat exchangers are functioning as an evaporator.

[0019] According to the ventilation apparatus, by increasing the air volume flowing to the second heat exchangers by the second ventilation unit, the temperature of the refrigerant flowing through the second heat exchangers is increased to prevent frosting, thereby efficiently preventing frosting.

[0020] In the above ventilation apparatus, the control unit may control the second ventilation unit associated with any another one of the plurality of the second heat exchangers, to reduce the air volume flowing to the corresponding second heat exchanger compared to before the predetermined reference is satisfied, when controlling the second ventilation unit associated with the one of the plurality of the second heat exchangers to increase the air volume.

[0021] According to the ventilation apparatus, the comfort of the living room space can be maintained by adjusting the total air volume to be exhausted.

[0022] The above ventilation apparatus may further include

a first ventilation unit configured to adjust an air volume flowing to the first heat exchanger upon flowing through the first air flow path, wherein the control unit may control the first ventilation unit to increase the air volume flowing to the first heat exchanger compared to before the predetermined reference is satisfied, based on the air volume increased with respect to the second ventilation unit, when the second ventilation unit associated with the one of the plurality of the second heat exchangers is controlled to increase the air volume.

[0023] According to the ventilation apparatus, when the air volume in the second air supply unit is increased, the air volume supplied and the air volume exhausted can be adjusted by increasing the air volume in the first air supply unit to maintain the comfort of the living room space.

[0024] The above ventilation apparatus may further include

a first ventilation unit configured to adjust an air volume flowing to the first heat exchanger upon flowing through the first air flow path; and a second ventilation unit configured to adjust an air volume flowing to the second heat exchanger upon flowing through the second air flow path, wherein the control unit may control the first ventilation unit to increase the air volume flowing to the first heat exchanger and controls the second ventilation unit to increase the air volume flowing to the second heat exchanger compared to before the predetermined reference is satisfied, upon determining that the predetermined reference is satisfied when a signal indicating to perform a defrosting operation is received from an air conditioner provided in the indoor space, while the second heat exchanger is functioning as

an evaporator.

[0025] According to the ventilation apparatus, when the air conditioner performs a defrosting operation, by increasing the air volume in the first ventilation unit and the second ventilation unit respectively, the reduction in heating performance can be prevented and the comfort of the living room space can be maintained.

[0026] The above ventilation apparatus may further include

a bypass flow path configured to guide air that has undergone heat exchange by the first heat exchanger to the second heat exchanger; and
a second guide mechanism configured to switch between whether or not to guide air to the second heat exchanger through the bypass flow path, wherein the control unit may control the second guide mechanism to guide air to the second heat exchanger through the bypass flow path when the predetermined reference is satisfied.

[0027] According to the ventilation apparatus, by guiding air to the second heat exchanger through the bypass flow path, the temperature of the refrigerant flowing through the second heat exchanger is increased to prevent frosting, thereby efficiently preventing frosting.

[0028] The above ventilation apparatus may further include

a second ventilation unit configured to adjust an air volume flowing to the second heat exchanger upon flowing through the second air flow path, wherein the control unit may implement control to stop the compressor and to control the second ventilation unit to cause air that has passed through the second air flow path to flow to the second heat exchanger, when the predetermined reference is satisfied.

[0029] According to the ventilation apparatus, when the compressor is stopped and air flows through the second heat exchanger, the temperature of the refrigerant flowing through the second heat exchanger is increased to prevent frosting, thereby efficiently preventing frosting.

[0030] The above ventilation apparatus may further include

a plurality of the second heat exchangers; and
the second ventilation unit associated with each of the plurality of the second heat exchangers, wherein the refrigerant circuit may include a first valve part configured to adjust an opening of a flow path flowing to the second heat exchanger for each of the second heat exchangers, and
the control unit may implement control to close a plurality of the first valve parts associated with the second heat exchanger satisfying the predetermined reference in a predetermined order, and controls the

second ventilation unit associated with the second heat exchanger satisfying the predetermined reference to cause air that has passed through the second air flow path to flow to the second heat exchanger, when information relating to a temperature detected from the plurality of the second heat exchangers has satisfied the predetermined reference.

[0031] According to the ventilation apparatus, by closing the valve parts in a predetermined order, it is possible to maintain the comfort of the living room space by preventing a refrigerant from being simultaneously stopped in the plurality of second heat exchangers.

[0032] The above ventilation apparatus may further include

a first ventilation unit configured to adjust an air volume flowing to the first heat exchanger upon flowing through the first air flow path; and
a second ventilation unit configured to adjust an air volume flowing to the second heat exchanger upon flowing through the second air flow path, wherein the control unit may control the first ventilation unit and the second ventilation unit such that an air volume exhausted to the outdoors by the second air flow path is greater than an air volume supplied to the indoor space by the first air flow path, when the predetermined reference is satisfied.

[0033] According to the ventilation apparatus, the air flowing to the second heat exchanger increases, and, therefore, the temperature of the refrigerant flowing through the second heat exchanger is raised to prevent frosting, thereby achieving efficient frosting prevention.

[0034] In the above ventilation apparatus, the control unit may control the first heat exchanger such that a temperature of air that has passed through the first heat exchanger becomes lower than a temperature set in an air conditioner provided in the indoor space, when the predetermined reference is satisfied.

[0035] According to the ventilation apparatus, the temperature of the refrigerant flowing through the second heat exchanger rises, so that efficient control of frosting can be implemented.

[0036] In the above ventilation apparatus,

a plurality of combinations of the compressor, the first heat exchanger, the second heat exchanger, the refrigerant circuit, and the second ventilation unit associated with the second heat exchanger may be provided, and
the control unit may implement control to stop the compressor associated with the second heat exchanger satisfying the predetermined reference in a predetermined order, and control the second ventilation unit associated with the second heat exchanger satisfying the predetermined reference such that air that has passed through the second air flow path

flows to the second heat exchanger, when information relating to a temperature detected from a plurality of the second heat exchanger satisfies the predetermined reference.

[0037] According to the ventilation apparatus, it is possible to maintain the comfort of the living room space by preventing a refrigerant from being simultaneously stopped in the plurality of second heat exchangers.

[0038] The above ventilation apparatus may further include

a first casing configured to house the first heat exchanger and at least a part of the first air flow path; and
a second casing configured to house the second heat exchanger and at least a part of the second air flow path, wherein
the first casing and the second casing may be separable.

[0039] According to the ventilation apparatus, the first casing and the second casing can be separated, so that the arrangement layout can be facilitated, thereby reducing the burden of installation.

[0040] In the above ventilation apparatus, the control unit may implement control to reduce a rotational speed of the compressor compared to before the predetermined reference is satisfied, when the predetermined reference is satisfied.

[0041] According to the ventilation apparatus, by lowering the rotational speed of the compressor, the temperature of the refrigerant flowing through the second heat exchanger rises, and therefore, an efficient control of frosting can be implemented.

[0042] The above ventilation apparatus may further include

the refrigerant circuit including a second valve part configured to adjust an opening of a flow path, the second valve part being provided between the first heat exchanger and the second heat exchangers, wherein
the control unit may implement control to increase an opening of the second valve part compared to before the predetermined reference is satisfied, when the predetermined reference is satisfied.

[0043] The above ventilation apparatus may further include

a third valve part provided downstream from the second heat exchanger in a flow of the refrigerant in the refrigerant circuit when the second heat exchanger functions as an evaporator, wherein
the control unit may implement control to throttle the third valve part compared to before the predetermined reference is satisfied, when the predetermined

reference is satisfied, when the second heat exchanger functions as an evaporator.

[0044] The above ventilation apparatus may further include

a third heat exchanger configured to function as a condenser or an evaporator; and
a third air flow path configured to exhaust, to the outdoors, air obtained by performing heat exchange between air of the outdoors and the refrigerant flowing through the third heat exchanger, wherein
the refrigerant circuit may be connected to the third heat exchanger by the refrigerant pipe in addition to the compressor, the first heat exchanger, and the second heat exchanger.

[0045] The present disclosure provides an air conditioning system including
a ventilation apparatus including:

a compressor configured to operate when a heat recovery ventilation operation is performed;
a first heat exchanger configured to function as a condenser or an evaporator;
a first air flow path configured to supply air taken in from outdoors to an indoor space after passing through the first heat exchanger;
a second heat exchanger configured to function as a condenser or an evaporator;
a second air flow path configured to exhaust air taken in from the indoor space to the outdoors after passing through the second heat exchanger; and
a refrigerant circuit through which a refrigerant flows, the refrigerant circuit being connected to the compressor, the first heat exchanger, and the second heat exchanger by a refrigerant pipe,

an air conditioner including:

a third heat exchanger configured to function as a condenser or an evaporator; and
an air conditioning indoor unit configured to exhaust, to the indoor space, air obtained by performing heat exchange between air of the indoor space and the refrigerant flowing through the third heat exchanger, and

a control unit configured to detect whether a predetermined reference indicating a possibility of frosting in the second heat exchanger is satisfied, and when the predetermined reference is determined to be satisfied, the control unit controls a temperature of the refrigerant flowing through the second heat exchanger such that the second heat exchanger will have a temperature at which frosting does not occur in the second heat exchanger, or controls an operation to defrost the second heat exchanger after frosting has occurred in the second heat

exchanger, based on power consumption of the ventilation apparatus the air conditioner required for controlling the temperature of the refrigerant flowing through the second heat exchanger such that the second heat exchanger will have a temperature at which frosting does not occur in the second heat exchanger and power consumption of the ventilation apparatus the air conditioner required for defrosting the second heat exchanger after frosting has occurred in the second heat exchanger.

[0046] According to the air conditioning system, by controlling the temperature of a refrigerant when a predetermined reference is satisfied, an efficient control of frosting can be implemented.

[0047] The present disclosure provides a ventilation method performed to control a ventilation apparatus including

a compressor;

a first heat exchanger configured to function as a condenser or an evaporator;

a first air flow path configured to supply air taken in from outdoors to an indoor space after passing through the first heat exchanger;

a second heat exchanger configured to function as a condenser or an evaporator;

a second air flow path configured to exhaust air taken in from the indoor space to the outdoors after passing through the second heat exchanger; and

a refrigerant circuit through which a refrigerant flows, the refrigerant circuit being connected to the compressor, the first heat exchanger, and the second heat exchanger by a refrigerant pipe, the ventilation method including

detecting whether a predetermined reference indicating a possibility of frosting in the second heat exchanger is satisfied while the second heat exchanger is functioning as an evaporator, and controlling a temperature of the refrigerant flowing through the second heat exchanger such that the second heat exchanger will have a temperature at which frosting does not occur in the second heat exchanger, when the predetermined reference is detected to be satisfied.

[0048] According to the ventilation method, efficient control of frosting can be implemented by controlling the temperature of a refrigerant when a predetermined reference is satisfied.

[0049] The present disclosure presents a ventilation system including

a refrigerant circuit through which a refrigerant flows, the refrigerant circuit being connected to a compressor, a first heat exchanger, and a second heat exchanger by a refrigerant pipe;

an air supply fan configured to supply air of outdoors to indoors through the first heat exchanger;

an exhaust fan configured to exhaust air of the in-

doors to the outdoors through the second heat exchanger; and

a control unit, wherein

when the second heat exchanger functions as an evaporator, the control unit starts the compressor, and when the control unit determines that a low pressure of the refrigerant circuit or an evaporation temperature of the second heat exchanger or a temperature of the indoors or a temperature of the outdoors has dropped below a first threshold with respect to the low pressure of the refrigerant circuit or the evaporation temperature of the second heat exchanger or the temperature of the indoors or the temperature of the outdoors, the control unit performs first control to raise the low pressure of the refrigerant circuit.

[0050] According to the ventilation system, when the second heat exchanger functions as an evaporator in the ventilation system provided with a refrigerant circuit capable of recovering heat from exhaust air, the compressor can be reliably continuously operated.

[0051] In the above ventilation system, the refrigerant circuit includes:

a bypass pipe configured to connect a discharge pipe of the compressor and the second heat exchanger or a liquid pipe connected to the second heat exchanger; and

a valve provided in the bypass pipe, wherein the control unit preferably opens the valve in the first control.

[0052] In this case, a high temperature and high pressure gas refrigerant can be supplied to the second heat exchanger in the first control. Thus, frosting in the second heat exchanger can be prevented.

[0053] In the above ventilation system, when the valve is opened and the control unit determines that a low pressure of the refrigerant circuit or a saturation temperature of the second heat exchanger or an intake air temperature of the exhaust fan exceeds a second threshold with respect to the low pressure of the refrigerant circuit or the saturation temperature of the second heat exchanger or the intake air temperature of the second heat exchanger, the control unit preferably opens the valve.

[0054] In this case, the first control can be ended when conditions for the second heat exchanger to function as an evaporator are satisfied during the execution of the first control.

[0055] In the above ventilation system, the control unit preferably causes the second heat exchanger to take in air having a temperature higher than a second threshold with respect to an intake air temperature, in the first control.

[0056] In this case, air at a temperature higher than the second threshold can flow into the second heat exchanger during the execution of the first control. Thus, frosting in the second heat exchanger can be prevented.

[0057] In the above ventilation system, the control unit preferably adjusts a blowout direction of the air supply fan so as to guide air blown out from the air supply fan toward an intake side of the exhaust fan, in the first control.

[0058] In this case, the air having a temperature higher than the second threshold can flow into the second heat exchanger during the execution of the first control.

[0059] The above ventilation system further includes

an air conditioner configured to air condition the indoors, wherein

the control unit preferably drives the exhaust fan when air temperature of the indoors becomes higher than the second threshold due to the air conditioner, in the first control.

[0060] In this case, air having a higher temperature than the second threshold can flow into the second heat exchanger during the execution of the first control.

Brief Description of Drawings

[0061]

[FIG. 1] FIG. 1 is a diagram illustrating a configuration example of a ventilation apparatus and an air conditioner according to the first embodiment.

[FIG. 2] FIG. 2 is a flowchart illustrating the control of frost prevention performed by the exhaust unit of the ventilation apparatus according to the first embodiment.

[FIG. 3] FIG. 3 is a diagram illustrating a configuration example of the ventilation apparatus and the air conditioner according to the modified example 3 of the first embodiment.

[FIG. 4] FIG. 4 is a diagram illustrating a configuration example of the ventilation apparatus and the air conditioner according to the second embodiment.

[FIG. 5] FIG. 5 is a diagram illustrating a refrigerant circuit according to the modified example 1 of the second embodiment.

[FIG. 6] FIG. 6 is a diagram illustrating a configuration example of a ventilation apparatus, an air conditioner, and an upper-level control device according to the third embodiment.

[FIG. 7] FIG. 7 is a sequence diagram illustrating a flow of processing performed between the upper-level control device, the ventilation apparatus, and the air conditioner when defrosting operation of the air conditioner according to the third embodiment is started.

[FIG. 8] FIG. 8 is a sequence diagram illustrating a flow of processing performed between the upper-level control device, the compressor unit, and the exhaust unit group when there is a possibility of defrosting in each exhaust unit in the exhaust unit group according to the fourth embodiment.

[FIG. 9] FIG. 9 is a diagram illustrating an arrangement of the device group including the upper-level control device according to the seventh embodiment.

[FIG. 10] FIG. 10 is a diagram illustrating an arrangement of a device group including an upper-level control device according to an eighth embodiment.

[FIG. 11] FIG. 11 illustrates a refrigerant circuit according to the eleventh embodiment.

[FIG. 12] FIG. 12 illustrates a refrigerant circuit according to a modified example of the eleventh embodiment.

[FIG. 13] FIG. 13 is a flowchart illustrating a processing procedure of the upper-level control device according to the twelfth embodiment.

[FIG. 14] FIG. 14 illustrates a schematic configuration of a ventilation system according to an embodiment.

[FIG. 15] FIG. 15 is a control block diagram of a ventilation system according to an embodiment of the present invention.

[FIG. 16] FIG. 16 is a flow diagram illustrating the operation of a ventilation system according to an embodiment.

[FIG. 17] FIG. 17 is a schematic configuration diagram of a ventilation system according to a thirteenth embodiment.

[FIG. 18] FIG. 18 is a schematic configuration diagram of a ventilation system according to a fourteenth embodiment.

[FIG. 19] FIG. 19 is a schematic configuration diagram illustrating a state of installation of a ventilation system according to fourteenth and fifteenth embodiments in a building.

[FIG. 20] FIG. 20 is a schematic configuration diagram of a ventilation system according to a fifteenth embodiment.

[FIG. 21] FIG. 21 is a schematic configuration diagram of a ventilation system according to a sixteenth embodiment.

[FIG. 22] FIG. 22 is a schematic configuration diagram of a ventilation system according to a seventeenth embodiment.

[FIG. 23] FIG. 23 is a schematic configuration diagram of a ventilation system according to an eighteenth embodiment.

Description of Embodiments

[0062] Hereinafter, a ventilation apparatus, an air conditioning system, a ventilation method, and a ventilation system according to the present embodiment will be described with reference to the drawings. Note that the following embodiments are essentially preferred examples and the embodiments are not intended to limit the scope of the present disclosure, the application, or the use thereof.

(First embodiment)

[0063] FIG. 1 is a diagram illustrating a configuration example of a ventilation apparatus and an air conditioner according to the first embodiment. In the example illustrated in FIG. 1, an air conditioning system includes a ventilation apparatus 1 and an air conditioner 2 for air conditioning an indoor space.

[0064] In the present embodiment, as an example of an indoor space, an example having a living room space R11 and a ceiling space R12 will be described. However, the indoor space is not limited to the living room space R11 and the ceiling space R12, and may be a space inside a building, for example, a space under the floor.

[0065] The living room space R11 is, for example, a living room inside an office or a house. The ceiling space R12 is an adjacent space above the living room space R11. The ceiling space R12 exists above the living room space R11, and, therefore, warm air tends to be collected in the ceiling space R12.

[0066] The air conditioner 2 includes an outdoor unit 70 and two air conditioning indoor units 81 and 82. In the present embodiment, the number of air conditioning indoor units is not limited to two units, but may be one unit or three units or more.

[0067] The air conditioner 2 performs a vapor compression type refrigeration cycle to cool and heat the living room space R11. The air conditioner 2 according to the present embodiment can both cool and heat the living room space R11. However, the present embodiment is not limited to an air conditioner capable of both cooling and heating, and may be a device capable of only cooling, for example.

[0068] The space between the outdoor unit 70 and the two air conditioning indoor units 81 and 82 is connected by a connection pipe F5. The connection pipe F5 includes a liquid refrigerant connection pipe and a gas refrigerant connection pipe (not illustrated). Accordingly, a refrigerant circuit in which a refrigerant circulates between the outdoor unit 70 and the two air conditioning indoor units 81 and 82 is formed. When refrigerant circulates in the refrigerant circuit, a vapor compression type refrigeration cycle is performed in the air conditioner 2.

[0069] The outdoor unit 70 is arranged outdoors. The outdoor unit 70 is provided with a heat exchanger, and the air in which the heat is exchanged with the refrigerant flowing through the heat exchanger is discharged outdoors.

[0070] The air conditioning indoor units 81 and 82 are provided with a heat exchanger, and the air conditioning indoor units 81 and 82 exchange the heat in the air with the refrigerant flowing through the heat exchanger, and blow the heat exchanged air into the living room space R11. In the present embodiment, the air conditioning indoor units 81 and 82 are ceiling-installed types installed on the ceiling of the living room space R11. In particular, the air conditioning indoor units 81 and 82 of the present embodiment are ceiling-embedded type air conditioning

indoor units, and air in which heat has been exchanged is blown out from ventilation ports 93A and 93B. Although an example in which the ventilation ports 93A and 93B are provided on the ceiling will be described in the present embodiment, the positions at which the ventilation ports 93A and 93B are provided are not particularly limited. The air conditioning indoor units 81 and 82 are not limited to the ceiling-embedded type, and may be a ceiling-suspended type. The air conditioning indoor units 81 and 82 may be other than the ceiling installed type, such as a wall mounted type or a floor mounted type.

[0071] The ventilation apparatus 1 includes the exhaust unit 10, the air supply unit 20, a compressor unit 50, refrigerant circuits F1, F2, F3, and F4, an air supply flow path P1, and a return air flow path P2.

[0072] The ventilation apparatus 1 supplies the air taken in from outdoors to the living room space R11 and exhausts the air taken in from the indoor space (including the living room space R11) to the outside. Thus, the ventilation apparatus 1 implements the replacement of the air in the living room space R11.

[0073] Furthermore, the ventilation apparatus 1 according to the present embodiment exchanges heat between the exhaust unit 10 and the air supply unit 20 to reduce the temperature difference between the temperature of the air taken in from the outside and the temperature of the living room space R11.

[0074] The air supply flow path P1 (an example of the first air flow path) is a flow path for supplying air taken in from the outside to the living room space R11 from the ventilation port 92 after passing through the air supply unit 20 having the first heat exchanger 22. Although the present embodiment will describe an example in which the ventilation port 92 is provided on the ceiling, the position at which the ventilation port 92 is provided is not particularly limited.

[0075] The return air flow path P2 (an example of the second air flow path) is a flow path for exhausting air (return air) taken in from the ventilation port 91 of the living room space R11 to the outside after passing through the exhaust unit 10 having the second heat exchanger 12. Although the present embodiment will describe an example in which the ventilation port 91 is provided on the ceiling, the position at which the ventilation port 91 is provided is not particularly limited.

[0076] In the return air flow path P2 according to the present embodiment, the air intake destination is branched into two in order to allow air intake from a plurality of rooms. Each of the air intake destinations is referred to as a first return air branch path P2A (an example of a second air flow path) and a second return air branch path P2B (an example of the third air flow path).

[0077] The first return air branch path P2A (an example of the second air flow path) is an air flow path provided for exhausting air taken in from the living room space R11 to the outside after passing through the exhaust unit 10 including the second heat exchanger 12. The first return air branch path P2A takes in air from the ventilation

port 91 provided on the ceiling of the living room space R11. Although the present embodiment will describe an example in which the position of the ventilation port 91 is provided on the ceiling, the ventilation port may be provided in another place such as under the floor or on a wall.

[0078] The second return air branch path (an example of the third air flow path) P2B is an air flow path provided for exhausting air taken in from the ceiling space R12 to the outside after passing through the exhaust unit 10 having the second heat exchanger 12. An example is described in which the space that is the air intake destination of the second return air branch path P2B is the ceiling space R12, which is a different space from that of the first return air branch path P2A. However, the space that is the air intake destination is not limited to the ceiling space R12, and may be an underfloor space. As described above, the air intake destination of the second return air branch path P2B may be a space different from the living room space R11.

[0079] An opening/closing damper 40 is provided at the tip of the second return air branch path. The opening/closing damper 40 is usually closed. Then, the opening/closing damper 40 (an example of a first guide mechanism) can adjust the air volume taken in from the ceiling space R12 by controlling from the control unit 13 provided in the exhaust unit 10 through the signal line S2.

[0080] The refrigerant circuits F1, F2, F3, and F4 are circuits in which the compressor unit 50, the first heat exchanger 22 of the air supply unit 20, and the second heat exchanger 12 of the exhaust unit 10 are connected by refrigerant pipe, and the refrigerant flows in these refrigerant circuits.

[0081] The control unit 52 of the compressor unit 50, the control unit 23 of the air supply unit 20, and the control unit 13 of the exhaust unit 10 are connected by a signal line S1 indicated by a dotted line in FIG. 1. Thus, information can be transmitted and received between the control unit 52 of the compressor unit 50, the control unit 23 of the air supply unit 20, and the control unit 13 of the exhaust unit 10. The processing by the control units 13, 23, and 52 described below may be implemented by a CPU (not illustrated) reading a program, or by a hardware connection. The same applies to the control unit and the upper-level control device described in the following embodiments.

[0082] The compressor unit 50 is provided with a driving motor 51 and a control unit 52, and controls circulation of the refrigerant in the refrigerant circuits F1, F2, F3, and F4 by compressing any one of the refrigerants in the refrigerant circuits F1, F2, F3, and F4. For example, when the second heat exchanger 12 in the exhaust unit 10 functions as an evaporator, the compressor unit 50 compresses the refrigerant in the refrigerant circuit F2 to circulate the refrigerant in the refrigerant circuits F1, F2, F3, and F4.

[0083] The driving motor 51 is a motor for rotating (driving) the compressor for compressing the refrigerant.

[0084] The control unit 52 controls the configuration in the compressor unit 50. For example, the control unit 52 outputs an instruction for rotating (driving) the compressor to the driving motor 51.

5 **[0085]** The air supply unit 20 includes a fan 21, a first heat exchanger 22, a control unit 23, and a temperature detecting unit 24, and takes in the outside air (OA), and supplies air (SA) to the living room space R11.

10 **[0086]** The fan 21 functions to supply air (SA) to the living room space R11 from the outside air (OA) that is taken in.

[0087] The first heat exchanger 22 functions as a condenser or an evaporator.

15 **[0088]** The temperature detecting unit 24 detects the outdoor temperature, the surface temperature of the first heat exchanger 22 and the temperature of the refrigerant flowing through the first heat exchanger 22.

20 **[0089]** The control unit 23 controls the configuration inside the air supply unit 20. The control unit 23 performs various kinds of control according to the detection result by a temperature detecting unit 14. For example, the control unit 23 adjusts the function of the first heat exchanger 22 as a condenser or an evaporator according to the detection result by the temperature detecting unit 24.

25 **[0090]** The exhaust unit 10 is provided with a fan 11, a second heat exchanger 12, a control unit 13, and a temperature detecting unit 14, takes in return air (RA) of the living room space R11, and exhausts (EA) the taken in air to the outside.

30 **[0091]** The fan 11 functions to exhaust (EA) the return air (RA) taken in from the living room space R11 to the outside.

[0092] The second heat exchanger 12 functions as a condenser or an evaporator.

35 **[0093]** The temperature detecting unit 14 detects the indoor air temperature, the surface temperature of the second heat exchanger 12, and the temperature of the refrigerant flowing through the second heat exchanger 12. Further, the indoor air temperature to be detected includes, for example, the temperature of air in the living room space R11 and the temperature of air in the ceiling space R12 through the sensor unit (not illustrated).

40 **[0094]** The control unit 13 controls the configuration of the inside of the exhaust unit 10. The control unit 13 performs various kinds of control according to the detection result by the temperature detecting unit 14. For example, the control unit 13 adjusts the function of the second heat exchanger 12 as a condenser or an evaporator according to the detection result of the temperature detecting unit 14.

45 **[0095]** Furthermore, the control unit 13 according to the present embodiment can adjust the air volume taken in from the ceiling space R12 by controlling the opening/closing damper 40 based on the detection result by the temperature detecting unit 14.

[0096] A process performed by the ventilation apparatus 1 when the air temperature is low will be described. When the air temperature is low, the ventilation apparatus

tus 1 warms the outside air (OA) taken in from the outside in the air supply unit 20, then supplies the air (SA) to the living room space R11, and cools the return air (RA) taken in from the living room space R11 in the exhaust unit 10, then exhausts the air (EA) to the outside. That is, the first heat exchanger 22 in the air supply unit 20 functions as a condenser, and the second heat exchanger 12 in the exhaust unit 10 functions as an evaporator. As the second heat exchanger 12 functions as an evaporator, the temperature of the refrigerant flowing through the second heat exchanger 12 becomes low, and therefore there is a possibility that the second heat exchanger 12 freezes (frosts). Therefore, in the present embodiment, control is performed to avoid freezing (frosting) of the second heat exchanger 12, or to prevent frost from growing if frost are formed. In the embodiment to be described later, at least one or more of the control to avoid frost and the control to prevent frost from growing if frost is formed are referred to as the control to prevent frost.

[0097] Specifically, while the second heat exchanger 12 is functioning as an evaporator, the control unit 13 of the exhaust unit 10 determines whether the second heat exchanger 12 satisfies a predetermined reference indicating the possibility of frosting (freezing) from the detection result by the temperature detecting unit 14. The predetermined reference indicating the possibility that the second heat exchanger 12 will frost (freeze) may be, for example, a reference for determining whether the outdoor air temperature detected by the temperature detecting unit 14 is 0 degrees or less. Further, the present embodiment does not limit the predetermined reference to whether the outdoor air temperature is 0 degrees or less, but may be a reference for determining whether the outdoor air temperature is the minimum operating temperature of the second heat exchanger 12.

[0098] The predetermined reference may not be a reference based on the air temperature of the outside air. For example, whether the surface temperature of the second heat exchanger 12 is less than or equal to the predetermined temperature (e.g., 0 degrees) may be used as the determination reference. As another example, whether the temperature of the refrigerant flowing through the second heat exchanger 12 is less than or equal to the predetermined temperature (e.g., 0 degrees) may be used as the determination reference. In the following description, an example of the predetermined reference is also provided, but any reference may be used as long as the reference indicates the possibility of frosting (freezing) of the second heat exchanger 12. For example, as described in the embodiment to be described later, the reference may be used to determine whether the low pressure of the refrigerant circuits F1, F2, F3, and F4 has fallen below the predetermined pressure threshold.

[0099] In the present embodiment, an example of acquiring the temperature of the outside air, the surface temperature of the second heat exchanger, and the like and determining whether the acquired temperature sat-

isfies the predetermined reference will be described. However, the present embodiment indicates an example of the information to be acquired, and the information to be acquired may be information that enables determining whether the predetermined reference is satisfied. For example, other than the temperature of the outside air, the surface temperature of the second heat exchanger 12, the temperature of the refrigerant, the pressure of the refrigerant, and the like may be acquired. Further, it may be determined whether the predetermined reference is satisfied by combining these pieces of information. An example of the information to be acquired is also illustrated in the following embodiments and modified examples, and any kind of information may be used as long as the information can be used to determine whether the predetermined reference is satisfied.

[0100] When the control unit 13 of the exhaust unit 10 according to the present embodiment determines that the predetermined reference is satisfied, the control unit controls the opening/closing damper 40 so that the air present in the ceiling space R12 is guided to the second heat exchanger 12 through the second return air branch path P2B as a control to prevent frosting in the second heat exchanger 12. That is, warm air is gathered in the ceiling space R12 because the ceiling space R12 exists above the living room space R11. Therefore, when there is a possibility of frosting in the second heat exchanger 12, the opening/closing damper 40 is controlled to be opened. By this control, the air mixed with the warm air existing in the ceiling space R12 and the air existing in the living room space R11 is guided to the second heat exchanger 12.

[0101] As an example of the control for raising the temperature of the refrigerant flowing through the second heat exchanger 12, the control unit 13 according to the present embodiment controls the warm air in the ceiling space R12 to flow to the second heat exchanger 12. Thus, frosting in the second heat exchanger 12 can be prevented.

[0102] FIG. 2 is a flowchart illustrating the control of preventing frosting performed by the exhaust unit 10 of the ventilation apparatus 1 according to the present embodiment.

[0103] The control unit 13 of the exhaust unit 10 acquires the temperature of the outside air from the temperature detecting unit 14 (S1201).

[0104] Based on the acquired temperature of the outside air, the control unit 13 of the exhaust unit 10 determines whether a predetermined reference indicating the possibility of freezing of the second heat exchanger 12 is satisfied (S1202).

[0105] When the control unit 13 of the exhaust unit 10 determines that the predetermined reference is not satisfied (S1202: NO), the control unit 13 ends the process without performing any particular processing.

[0106] On the other hand, when the control unit 13 of the exhaust unit 10 determines that the predetermined reference is satisfied (S1202: YES), the control unit 13

acquires, from the temperature detecting unit 14, the temperature of the air in the ceiling space R12 and the temperature of the air taken in from the living room space R11 (S1203).

[0107] The control unit 13 of the exhaust unit 10 determines whether the temperature of the air in the ceiling space R12 is higher than the temperature of the air in the living room space R11 (S1204). When the control unit 13 determines that the temperature of the air in the ceiling space R12 is lower than the temperature of the air in the living room space R11 (S1204: NO), the control unit ends the process without performing control on the opening/closing damper 40. When the control on the opening/closing damper 40 is not performed, the control to prevent frosting described in the following embodiments and modified examples may be performed.

[0108] On the other hand, when the control unit 13 determines that the temperature of the air in the ceiling space R12 is higher than the temperature of the air in the living room space R11 (S1204: YES), the control unit performs control to open the opening/closing damper 40 (S1205).

[0109] In the present embodiment, when there is a possibility of frosting in the second heat exchanger 12 according to the processing procedure described above, the air in the ceiling space R12 where the air is warmer than the living room space R11 is guided to the second heat exchanger 12.

[0110] That is, the temperature of the air flowing into the second heat exchanger 12 rises, and, therefore, the temperature of the refrigerant flowing through the second heat exchanger 12 can rise. Thus, the possibility of frosting in the second heat exchanger 12 can be reduced.

(Modified example 1 of the first embodiment)

[0111] In the first embodiment described above, as an example of the control for raising the temperature of the air flowing through the second heat exchanger 12, a method for reducing the possibility of frosting in the second heat exchanger 12 by guiding the air in the ceiling space R12 to the second heat exchanger 12 has been described. However, the control method for raising the temperature of the air flowing through the second heat exchanger 12 is not limited to the method for guiding the air in the ceiling space R12 to the second heat exchanger 12, and other methods may be used. Therefore, in the modified example 1 of the first embodiment, the air conditioner 2 is controlled to raise the temperature (room temperature) of the air in the living room space R11.

[0112] In the present modified example, the control unit 13 of the exhaust unit 10 and the control unit 71 of the outdoor unit 70 are connected by a signal line. Thus, the control unit 71 of the outdoor unit 70 can output a control signal to the control unit 13 of the exhaust unit 10.

[0113] Note that the present modified example describes an example in which information can be transmitted and received between the control unit 13 of the

exhaust unit 10 and the control unit 71 of the outdoor unit 70 by means of a signal line. However, the mode in which information can be transmitted and received is not limited to an example in which information can be transmitted and received by means of a signal line; control signals may be transmitted and received via an upper-level control device (not illustrated), or control signals may be transmitted and received via a cloud or a server connected via a public network.

[0114] The control unit 13 of the exhaust unit 10 according to the present modified example detects whether a predetermined reference indicating the possibility of freezing of the second heat exchanger 12 is satisfied while the second heat exchanger 12 functions as an evaporator.

[0115] When the control unit 13 determines that the predetermined reference is satisfied, in order to raise the temperature of the refrigerant flowing through the second heat exchanger 12, the control unit 71 of the outdoor unit 70 of the air conditioner 2 outputs a control signal for raising the temperature currently set in the living room space R11. In the present modified example, the temperature of the air flowing through the second heat exchanger 12 rises by raising the air temperature in the living room space R11, and, therefore, the temperature of the refrigerant flowing through the second heat exchanger 12 can be raised.

[0116] Thus, as an example of the control for raising the temperature of the refrigerant flowing through the second heat exchanger 12, the control unit 13 according to the present modified example outputs to the control unit 71 a control signal for raising the temperature currently set in the living room space R11. Accordingly, the room temperature of the living room space R11 is raised, and, therefore, warm air flows into the second heat exchanger 12, and the temperature of the refrigerant flowing through the second heat exchanger 12 is raised to prevent frosting in the second heat exchanger 12.

[0117] In the present modified example, an example of outputting a control signal for raising the temperature currently set in the living room space R11 to the control unit 71 of the outdoor unit 70 of the air conditioner 2 has been described. However, the present modified example does not limit the control signal output to the control unit 71 of the outdoor unit 70 of the air conditioner 2 to a control signal for raising the temperature currently set in the living room space R11, but the control signal may be a control signal for raising the temperature of the refrigerant flowing through the second heat exchanger 12. For example, the control unit 13 may output a control signal for increasing the air volume in order to circulate the air in the living room space R11.

(Modified example 2 of the first embodiment)

[0118] The first embodiment and modified example described above are not limited to using the method described above. Therefore, in the modified example 2 of

the first embodiment, a method for controlling the fan 11 in order to prevent frosting will be described.

[0119] The control unit 13 of the exhaust unit 10 according to the modified example determines whether a predetermined reference indicating the possibility of frosting in the second heat exchanger 12 is satisfied while the second heat exchanger 12 functions as an evaporator.

[0120] The control unit 13 controls the fan 11 (an example of a second ventilation unit) to increase the air volume flowing to the second heat exchanger 12 in comparison with before the predetermined reference is satisfied in order to raise the temperature of the refrigerant flowing through the second heat exchanger 12 when it is determined that the predetermined reference is satisfied.

[0121] Thus, as an example of the control to raise the temperature of the refrigerant flowing through the second heat exchanger 12, the control unit 13 according to the present modified example outputs a control signal to the fan 11 (an example of a second ventilation unit) to increase the air volume flowing to the second heat exchanger 12 in comparison with before the predetermined reference is satisfied. Accordingly, the amount of warm air flowing to the second heat exchanger 12 increases, and, therefore, the temperature of the refrigerant can be raised to prevent frosting in the second heat exchanger 12.

[0122] When the fan 11 is controlled to increase the air volume flowing to the second heat exchanger 12, there is a possibility of negative pressure in the living room space R11. Therefore, the control unit 13 may output a control signal to increase the air volume of the fan 21, to the control unit 23 of the air supply unit 20.

(Modified example 3 of the first embodiment)

[0123] The first embodiment and the modified example described above are not limited to using the method described above. Therefore, in the modified example 3 of the first embodiment, a method for providing a bypass flow path for direct air flow between the air supply unit and the exhaust unit will be described.

[0124] FIG. 3 is a diagram illustrating a configuration example of a ventilation apparatus and an air conditioner according to the modified example 3 of the first embodiment. In the example illustrated in FIG. 3, a ventilation apparatus 1A and an air conditioner 2 are provided for air conditioning an indoor space. In the present modified example, the same reference numerals are assigned to the same configuration as in the first embodiment, and descriptions thereof will be omitted.

[0125] As illustrated in FIG. 3, a bypass flow path P102 is provided between the air supply unit 20 and the exhaust unit 110. The bypass flow path P102 includes a first bypass partial flow path P102A further towards the air supply unit 20 than the air supply flow path P101, a third bypass partial flow path P102C further towards the ex-

haust unit 110 than the return flow path P103, and a second bypass partial flow path P102B connecting the first bypass partial flow path P102A and the third bypass partial flow path P102C.

[0126] An opening/closing damper 140 is provided on the second bypass partial flow path P102B. The opening/closing damper 140 is usually closed. The opening/closing damper 140 (an example of the second guide mechanism) can guide air warmed by the air supply unit 20 directly to the exhaust unit 110 by control from the control unit 113 provided in the exhaust unit 110 through the signal line S3.

[0127] After taking in outside air (OA), the air supply unit 20 usually supplies air (SA) to the living room space R11 through the first bypass partial flow path P102A and the air supply flow path P101.

[0128] The exhaust unit 110 includes the fan 11, the second heat exchanger 12, a control unit 113, and the temperature detecting unit 14, and takes in return air (RA) of the living room space R11 through the return flow path P103 and the third bypass partial flow path P102C, and exhausts (EA) the air to the outside.

[0129] The control unit 113 of the exhaust unit 110 according to the present modified example detects whether a predetermined reference indicating the possibility of frosting in the second heat exchanger 12 is satisfied, while the second heat exchanger 12 functions as an evaporator.

[0130] When the control unit 13 determines that the predetermined reference is satisfied, the control unit 13 performs control to open the opening/closing damper 140 in order to raise the temperature of the refrigerant flowing through the second heat exchanger 12.

[0131] Thus, as an example of the control for raising the temperature of the refrigerant flowing through the second heat exchanger 12, the control unit 113 according to the present modified example performs control to open the opening/closing damper 140 so as to guide air through the bypass flow path P102 to the second heat exchanger 12. Accordingly, the air warmed in the exhaust unit 110 can flow directly to the second heat exchanger 12, thereby preventing frosting in the second heat exchanger 12.

(Second embodiment)

[0132] In the above-described embodiment and modified example, an example of raising the temperature of the refrigerant flowing through the second heat exchanger 12 by adjusting the air flowing through the second heat exchanger 12 has been described. However, another method may be used for raising the temperature of the refrigerant flowing through the second heat exchanger 12. Therefore, in the present embodiment, a method for raising the temperature of the refrigerant by controlling the refrigerant flowing through the second heat exchanger 12 will be described.

[0133] FIG. 4 is a diagram illustrating a configuration

example of a ventilation apparatus and an air conditioner according to the second embodiment. In the example illustrated in FIG. 4, a ventilation apparatus 1B and an air conditioner 2 are provided for air conditioning an indoor space. Among the configurations according to the present embodiment, the same reference numerals are assigned to the configurations similar to those of the first embodiment, and descriptions thereof will be omitted.

[0134] The control unit 52 of the compressor unit 50, the control unit 23 of the first air supply unit 220A, the control unit 23 of the second air supply unit 220B, and the control unit 213 of the exhaust unit 210 are connected by a signal line S201 indicated by a dotted line. Thus, information can be transmitted and received between the control unit 52 of the compressor unit 50, the control unit 23 of the first air supply unit 220A, the control unit 23 of the second air supply unit 220B, and the control unit 213 of the exhaust unit 210.

[0135] The ventilation apparatus 1B includes an exhaust unit 210, a first air supply unit 220A, a second air supply unit 220B, a compressor unit 50, refrigerant circuits F1, F2, F3, and F4, a first air supply flow path P201, a second air supply flow path P202, and a return air flow path P203.

[0136] The first air supply flow path P201 (an example of the first air flow path) supplies air taken in from the outdoors to the living room space R11 from the ventilation port 92A after passing through the first air supply unit 220A having the first heat exchanger 22.

[0137] The second air supply flow path P202 (an example of the first air flow path) supplies air taken in from the outside to the living room space R11 from the ventilation port 92B after passing through the second air supply unit 220B having the first heat exchanger 22.

[0138] The return air flow path P203 (an example of the second air flow path) exhausts air taken in from the indoor space to the outside after passing through the exhaust unit 210 having the second heat exchanger 12.

[0139] The first air supply unit 220A and the second air supply unit 220B are provided with a fan 21, a first heat exchanger 22, a control unit 23, and a temperature detecting unit 24, and take in outside air (OA) and supply air (SA) to the living room space R11.

[0140] The exhaust unit 210 is provided with the fan 11, the second heat exchanger 12, a control unit 213, and the temperature detecting unit 14, and takes in return air (RA) of the living room space R11 and exhausts air (EA) to the outside.

[0141] The control unit 213 of the exhaust unit 210 controls the configuration of the inside of the exhaust unit 210. For example, the control unit 213 outputs a control signal to the control unit 52 of the compressor unit 50 according to the detection result of the temperature detecting unit 14.

[0142] The processing performed by the ventilation apparatus 1B when the air temperature is low will be described below. Similar to the above-described embodiment, the first heat exchanger 22 of the first air supply

unit 220A and the second air supply unit 220B functions as a condenser, and the second heat exchanger 12 in the exhaust unit 210 functions as an evaporator. As the second heat exchanger 12 functions as an evaporator, the temperature of the refrigerant flowing through the second heat exchanger 12 becomes low, and, therefore, the second heat exchanger 12 may be frosted. Therefore, in the present embodiment, control is performed to prevent frosting in the second heat exchanger 12.

[0143] Specifically, while the second heat exchanger 12 functions as an evaporator, the control unit 213 of the exhaust unit 210 determines whether a predetermined reference indicating the possibility of frosting in the second heat exchanger 12 is satisfied based on the detection result by the temperature detecting unit 14. The predetermined reference indicating the possibility of frosting in the second heat exchanger 12 may be, for example, a reference for determining whether the temperature of the refrigerant detected by the temperature detecting unit 14 is 0 degrees or less. The present embodiment does not limit the predetermined reference to a reference based on the temperature of the refrigerant, but may be a reference for determining whether the pressure of the refrigerant is less than or equal to the predetermined pressure.

[0144] The predetermined reference may not be based on the temperature or pressure of the refrigerant. For example, the reference may be based on the temperature of the outside air or the surface temperature of the second heat exchanger 12.

[0145] The control unit 213 of the exhaust unit 210 according to the present embodiment outputs a control signal for reducing the rotational speed of the compressor compared to before satisfying the predetermined reference, to the control unit 52 of the compressor unit 50 as a control for preventing frosting in the second heat exchanger 12 when the predetermined reference is determined to be satisfied.

[0146] When the control signal is received, the control unit 52 of the compressor unit 50 outputs a control signal for reducing the rotational speed of the compressor as compared to before the predetermined reference is satisfied, to the driving motor 51 for driving the compressor. Accordingly, the rotational speed of the compressor is reduced. Accordingly, the pressure of the refrigerant flowing through the refrigerant circuits F1, F2, F3, and F4 is reduced, and, therefore, the temperature (evaporation temperature) of the refrigerant flowing through the second heat exchanger 12 can be increased.

[0147] As an example of the control for raising the temperature of the refrigerant flowing through the second heat exchanger 12, the control unit 213 according to the present embodiment outputs a control signal for lowering the rotational speed of the compressor compared to before the predetermined reference is satisfied, to the control unit 52 of the compressor unit 50. Thus, frosting in the second heat exchanger 12 can be prevented.

(Modified example 1 of the second embodiment)

[0148] In the second embodiment, an example of raising the temperature (evaporation temperature) of the refrigerant flowing through the second heat exchanger 12 by lowering the rotational speed of the compressor has been described. However, the method of raising the temperature (evaporation temperature) of the refrigerant flowing through the second heat exchanger 12 is not limited to the method of lowering the rotational speed of the compressor. Therefore, in the modified example 1, an example of providing a bypass flow path (an example of a bypass pipe) in the refrigerant circuit will be described. In the modified example 1, as in the second embodiment, two air supply units and one exhaust unit are provided.

[0149] FIG. 5 is a diagram illustrating a refrigerant circuit according to the modified example 1 of the second embodiment. In the example illustrated in FIG. 5, the flow of refrigerant when the second heat exchanger 12 of the exhaust unit 310 functions as an evaporator is illustrated. Note that the same reference numerals are assigned to the configuration similar to the above-described embodiment, and the description thereof will be omitted.

[0150] In the example illustrated in FIG. 5, the air supply units 320A and 320B, the exhaust unit 310, and the compressor unit 350 are provided.

[0151] The air supply units 320A and 320B include the fan 21, the first heat exchanger 22, the control unit 23, the temperature detecting unit 24, a driving motor 25, and an electric valve 26.

[0152] The driving motor 25 controls the air volume of the fan 21 by the control unit 23.

[0153] The electric valve 26 functions as an expansion valve for decompressing the refrigerant, and switches whether the refrigerant is to be decompressed based on the control of the control unit 23. The electric valve 26 functions to reduce pressure when the first heat exchanger 22 functions as an evaporator and not to reduce pressure when the first heat exchanger 22 functions as a condenser.

[0154] The exhaust unit 310 includes the fan 11, the second heat exchanger 12, a control unit 313, the temperature detecting unit 14, a driving motor 15, and an electric valve 16.

[0155] While the second heat exchanger 12 functions as an evaporator, the control unit 313 determines whether a predetermined reference indicating the possibility of frosting in the second heat exchanger 12 is satisfied based on the detection result by the temperature detecting unit 14. The predetermined reference is the same as that in the second embodiment, and the description thereof is omitted.

[0156] When the control unit 313 of the exhaust unit 310 according to the present modified example determines that the predetermined reference is satisfied, the control unit 313 outputs, to the control unit 352 of the compressor unit 350, a control signal for causing the refrigerant to flow into the bypass flow path F6, as a control

for preventing frosting in the second heat exchanger 12.

[0157] The driving motor 15 controls the air volume of the fan 11 by the control unit 313.

[0158] The electric valve 16 functions as an expansion valve for decompressing the refrigerant, and switches whether the refrigerant is to be decompressed based on the control by the control unit 313. The electric valve 16 functions to reduce pressure when the second heat exchanger 12 functions as an evaporator and not to reduce pressure when the second heat exchanger 12 functions as a condenser.

[0159] The compressor unit 350 is provided with a driving motor 51, a control unit 352, a compressor 53, a four-way valve 54, an electric valve 55, and a bypass electric valve 56.

[0160] The compressor 53 compresses the refrigerant flowing through the refrigerant circuit.

[0161] The driving motor 51 is an actuator for driving the compressor 53. The driving motor 51 according to the present embodiment drives the compressor 53 at a rotational speed controlled by the control unit 352.

[0162] The control unit 352 controls the configuration inside the compressor unit 350. For example, the control unit 352 controls the following driving motor 51 and the four-way valve 54.

[0163] The four-way valve 54 functions as a valve for switching the outflow destination of the refrigerant compressed by the compressor 53 from the refrigerant circuit F1 and the refrigerant circuit F4. For example, when the second heat exchanger 12 functions as an evaporator, the four-way valve 54 is switched so that the refrigerant compressed by the compressor 53 flows into the refrigerant circuit F1 based on the control of the control unit 352.

[0164] The electric valve 55 functions as a valve for controlling the opening and closing of the refrigerant circuit according to the control from the control unit 352. When the second heat exchanger 12 functions as an evaporator, the electric valve 55 is in a closed state in which the refrigerant does not flow.

[0165] In the present modified example, when the second heat exchanger 12 functions as an evaporator, a bypass flow path F6 is provided to allow the refrigerant compressed by the compressor 53 to flow directly to the second heat exchanger 12 in order to raise the temperature of the refrigerant flowing through the second heat exchanger 12.

[0166] The bypass flow path F6 is provided as a flow path for the refrigerant to bypass between the point between the compressor 53 and the four-way valve 54, and the refrigerant circuit F3. That is, while the second heat exchanger 12 functions as an evaporator, the bypass flow path F6 functions as a pipe for passing the refrigerant to the second heat exchanger 12 without going through the first heat exchanger 22.

[0167] The bypass electric valve 56 functions as a valve for switching whether the refrigerant flows to the bypass flow path F6 according to the control from the

control unit 352.

[0168] Specifically, the control unit 313 of the exhaust unit 310 first outputs a control signal for passing the refrigerant to the bypass flow path F6, to the control unit 352 of the compressor unit 350, when it is determined that a predetermined reference indicating the possibility of frosting in the second heat exchanger 12 is satisfied.

[0169] When the control signal for passing the refrigerant to the bypass flow path F6 is received from the control unit 313 of the exhaust unit 310, the control unit 352 of the compressor unit 350 controls the bypass electric valve 56 to be opened.

[0170] When the bypass electric valve 56 is opened, the refrigerant compressed by the compressor 53 to become a gas of high temperature and high pressure flows into the refrigerant circuit F3 through the bypass flow path F6. Accordingly, the temperature of the refrigerant flowing through the refrigerant circuit F3 rises. Then, the refrigerant whose temperature has risen flows into the second heat exchanger 12.

[0171] That is, in the present modified example, when the predetermined reference is satisfied, the refrigerant compressed by the compressor 53 flows through the bypass flow path F6 into the second heat exchanger 12. Thus, frosting in the second heat exchanger 12 can be prevented.

(Modified example 2 of the second embodiment)

[0172] Further, another method may be used as a method for raising the temperature of the refrigerant flowing into the second heat exchanger 12. Therefore, in the modified example 2 of the second embodiment, an example of controlling the electric valve 16 inside the exhaust unit 310 will be described. The configuration of the modified example 2 of the second embodiment is the refrigerant circuit illustrated in FIG. 5, excluding the bypass flow path F6.

[0173] When the second heat exchanger 12 functions as an evaporator, the electric valve 16 functions as a valve part for decompressing the refrigerant of the high-pressure liquid flowing out from the first heat exchanger 22 in order to facilitate the evaporation of the refrigerant according to the control of the control unit 313. As the opening of the electric valve 16 decreases, the pressure is reduced, and the temperature of the refrigerant decreases. That is, as the opening of the electric valve 16 increases, the temperature of the refrigerant increases.

[0174] Therefore, while the second heat exchanger 12 is functioning as an evaporator, the control unit 313 of the exhaust unit 310 determines whether a predetermined reference indicating the possibility of frosting in the second heat exchanger 12 is satisfied based on the detection result by the temperature detecting unit 14. The predetermined reference is the same as that in the second embodiment, and the description thereof is omitted.

[0175] When the control unit 313 determines that the predetermined reference has been satisfied, the control

unit performs control to increase the opening degree of the electric valve 16 (an example of the second valve part) as compared with before the predetermined reference has been satisfied, as a control to prevent frosting in the second heat exchanger 12.

[0176] That is, in the present modified example, when the predetermined reference is satisfied, control is performed such that the opening degree of the electric valve 16 is increased, and the temperature of the refrigerant flowing to the second heat exchanger 12 is increased. Thus, frosting in the second heat exchanger 12 can be prevented.

(Third embodiment)

[0177] In the above-described embodiments and modified examples, an example of determining whether the control unit in the exhaust unit satisfies a predetermined reference and performing control based on the determination result has been described. However, the above-described embodiment and modified example are not limited to a method in which the control unit in the exhaust unit performs control. For example, the upper-level control device provided on an upper level of the air conditioner and the ventilation apparatus may perform the control.

[0178] FIG. 6 is a diagram illustrating a configuration example of a ventilation apparatus, an air conditioner, and an upper-level control device according to the third embodiment. Note that the same reference numerals are assigned to the configuration similar to the above-described embodiment, and the description thereof is omitted.

[0179] In the example illustrated in FIG. 6, an upper-level control device 400 is provided for performing the cooperation between the ventilation apparatus 1C and the air conditioner 2C.

[0180] The air conditioner 2C includes an outdoor unit 470 and two air conditioning indoor units 81 and 82. In the present embodiment, the number of air conditioning indoor units is not limited to two units, but may be one unit or three units or more.

[0181] The outdoor unit 470 includes a control unit 471 together with a heat exchanger (not illustrated).

[0182] The control unit 471 controls the entire air conditioner 2C. The control unit 471 also transmits and receives information to and from the upper-level control device 400. The control unit 471 performs various kinds of control according to the control signal from the upper-level control device 400.

[0183] The ventilation apparatus 1C includes a first exhaust unit 410A, a second exhaust unit 410B, a first air supply unit 420A, a second air supply unit 420B, a compressor unit 450, refrigerant circuits F401, F402, F403, and F404, a first air supply flow path P401, a second air supply flow path P402, a first return air flow path P403, and a second return air flow path P404.

[0184] The first air supply flow path P401 supplies air

taken in from outside to the living room space R11 from the ventilation port 92A after passing through the first air supply unit 420A having the first heat exchanger 22.

[0185] The second air supply flow path P402 supplies air taken in from outside to the living room space R11 from the ventilation port 92B after passing through the second air supply unit 420B having the first heat exchanger 22.

[0186] The first return air flow path P403 exhausts air (return air) taken in from the ventilation port 91A of the indoor space to the outside after passing through the first exhaust unit 410A having the second heat exchanger 12.

[0187] The second return air flow path P404 exhausts air (return air) taken in from the ventilation port 91B of the indoor space to the outside after passing through the second exhaust unit 410B having the second heat exchanger 12.

[0188] The refrigerant circuits F401, F402, F403, and F404 are circuits that connect the compressor unit 450, the first heat exchanger 22 of the first air supply unit 420A and the second air supply unit 420B, and the second heat exchanger 12 of the first exhaust unit 410 and the second exhaust unit 410B by a refrigerant pipe, and allow the refrigerant to flow inside.

[0189] The control unit 452 of the compressor unit 450, the control unit 423A of the first air supply unit 420A, the control unit 423B of the second air supply unit 420B, the control unit 413A of the first exhaust unit 410A, and the control unit 413B of the second exhaust unit 410B are connected by a signal line S401 indicated by a dotted line. Thus, information can be transmitted and received between the control unit 452, the control unit 423A, the control unit 423B, the control unit 413A, and the control unit 413B.

[0190] The control unit 452 of the compressor unit 450 transmits the status of the ventilation apparatus 1C received from the control unit 423A, the control unit 423B, the control unit 413A, and the control unit 413B to the upper-level control device 400. Accordingly, the upper-level control device 400 can implement control according to the status of the ventilation apparatus 1C.

[0191] The first air supply unit 420A is provided with the fan 21, the first heat exchanger 22, the control unit 423A, and the temperature detecting unit 24, takes in outside air (OA), and supplies air (SA) from the ventilation port 92A to the living room space R11.

[0192] The second air supply unit 420B is provided with the fan 21, the first heat exchanger 22, the control unit 423B, and the temperature detecting unit 24, takes in outside air (OA), and supplies air (SA) from the ventilation port 92B to the living room space R11.

[0193] The control unit 423A and the control unit 423B control the configuration in each air supply unit. Further, the control unit 423A and the control unit 423B transmit the detection result by the temperature detecting unit 24 or the like in each air supply unit to the control unit 452 of the compressor unit 450. The control unit 452 of the compressor unit 450 recognizes the current status from

the detection result and transmits the recognition result to the upper-level control device 400. Thus, the upper-level control device 400 can recognize the status of the first air supply unit 420A and the second air supply unit 420B.

[0194] The first exhaust unit 410A is provided with the fan 11 (an example of a second ventilation unit), the second heat exchanger 12, a control unit 413A, and the temperature detecting unit 14, and takes in return air (RA) from a ventilation port 91A of the living room space R11 and exhausts (EA) the air to the outside.

[0195] The second exhaust unit 410B is provided with the fan 11 (an example of a second ventilation unit), the second heat exchanger 12, a control unit 413B, and the temperature detecting unit 14, and takes in return air (RA) from a ventilation port 91B of the living room space R11 and exhausts (EA) the air to the outside.

[0196] The control unit 413A and the control unit 413B control the configuration in each exhaust unit. Further, the control unit 413A and the control unit 413B transmit the detection result by the temperature detecting unit 14 or the like in each exhaust unit to the control unit 452 of the compressor unit 450. The control unit 452 of the compressor unit 450 recognizes the current status from the detection result and transmits the recognition result to the upper-level control device 400. Thus, the upper-level control device 400 can recognize the status of the first exhaust unit 410A and the second exhaust unit 410B.

[0197] The upper-level control device 400 performs various kinds of control to coordinate the operation of the ventilation apparatus 1C with the operation of the air conditioner 2C.

[0198] The upper-level control device 400 receives the status of the air conditioner 2C from the control unit 471 of the outdoor unit 470 and receives the status of the ventilation apparatus 1C from the control unit 452 of the compressor unit 450. The upper-level control device 400 performs various kinds of control according to the status of the air conditioner 2C and the status of the ventilation apparatus 1C.

[0199] For example, when the upper-level control device 400 recognizes that the air conditioner 2C is performing a defrosting operation based on the information received from the control unit 471 of the outdoor unit 470, the upper-level control device 400 performs control to improve the heating performance of the ventilation apparatus 1C.

[0200] That is, when the air conditioner 2C performs a defrosting operation, the air conditioner 2C does not function as a heater, and, therefore, the temperature in the living room space R11 may decrease. On the other hand, when the air supply temperature of the first air supply unit 420A and the second air supply unit 420B is increased to compensate for the decrease in the function of the air conditioner 2C when the air conditioner 2C performs a defrosting operation, the temperature of the refrigerant flowing to the second heat exchanger 12 of the first exhaust unit 410A and the second exhaust unit 410B

connected by the refrigerant circuits F401, F402, F403, and F404 decreases. In this case, the possibility of frosting in the second heat exchanger 12 of the first exhaust unit 410A and the second exhaust unit 410B is increased.

[0201] Therefore, when the upper-level control device 400 recognizes that the air conditioner 2C is performing a defrosting operation, the upper-level control device 400 increases the air volume of the air supply and exhaust air of the ventilation apparatus 1C, thereby improving the heating performance and preventing a decrease in temperature in the living room space R11.

[0202] FIG. 7 is a sequence diagram illustrating the flow of processing performed between the upper-level control device 400, the ventilation apparatus 1C, and the air conditioner 2C when the defrosting operation of the air conditioner 2C according to the present embodiment is started.

[0203] First, when the defrosting operation is started, the control unit 471 in the outdoor unit 470 of the air conditioner 2C transmits a signal indicating that the defrosting operation is to be performed to the upper-level control device 400 (S1701).

[0204] Then, when the upper-level control device 400 recognizes that the defrosting operation has started in the air conditioner 2C based on the received signal, the upper-level control device 400 determines that the air volume of the ventilation apparatus 1C is to be controlled to rise in order to compensate for the decrease of function caused by the defrosting operation (S1702).

[0205] Then, the upper-level control device 400 transmits a control signal to instruct an increase in air volume of the exhaust unit group (the first exhaust unit 410A and the second exhaust unit 410B) to the control unit 452 of the compressor unit 450 (S1703).

[0206] Similarly, the control unit 452 of the compressor unit 450 transmits a control signal to instruct an increase in air volume to each of the control units 413A and 413B of the exhaust unit group (the first exhaust unit 410A and the second exhaust unit 410B) (S1704).

[0207] Based on the received control signal, the control units 413A and 413B of the exhaust unit group control the fan 11 (an example of the second ventilation unit) to increase the air volume flowing to the second heat exchanger 12 (increase in air volume) as compared with before the air conditioner 2C performs defrosting operation (S1705).

[0208] Furthermore, the upper-level control device 400 transmits a control signal to instruct the air volume increase of the air supply unit group (the first air supply unit 420A and the second air supply unit 420B), to the control unit 452 of the compressor unit 450 (S1706).

[0209] The control unit 452 of the compressor unit 450 transmits a control signal to instruct the air volume increase to the control units 423A and 423B of the air supply unit group (the first air supply unit 420A and the second air supply unit 420B) (S1707).

[0210] Based on the received control signal, the control units 423A and 423B of the air supply unit group control

the fan 21 (an example of the first ventilation unit) to increase the air volume flowing to the first heat exchanger 22 (air volume increase) compared with before the air conditioner 2C performs defrosting operation (S1708).

[0211] In the present embodiment, the heating performance of the ventilation apparatus 1C is increased by increasing the air supply/exhaust volume without increasing the air supply temperature of the ventilation apparatus 1C, thereby preventing a decrease in the room temperature of the living room space R11. Further, in the present embodiment, the possibility of frosting in the second heat exchanger 12 due to a decrease in the evaporation temperature can be reduced by preventing an increase in the air supply temperature of the ventilation apparatus 1C.

[0212] The upper-level control device 400 according to the present embodiment can reduce the possibility of frosting in the second heat exchanger 12, thereby increasing the heating performance and preventing a decrease in the room temperature, by increasing the air supply/exhaust volume of the ventilation apparatus 1C in order to compensate for the decrease in performance caused by the frosting operation of the air conditioner 2C.

[0213] The upper-level control device 400 according to the present embodiment can perform various kinds of control other than the above-mentioned cooperative control.

[0214] For example, the upper-level control device 400 may determine whether a predetermined reference indicating the possibility of frosting in the second heat exchanger 12 is satisfied, when the temperature of the outside air is received from the control unit 413A or the control unit 413B of the exhaust unit group through the control unit 452 of the compressor unit 450 and satisfies a predetermined reference indicating the possibility of frosting in the second heat exchanger 12. Then, when the upper-level control device 400 determines that the predetermined reference is satisfied, the upper-level control device 400 may perform control to prevent frosting in the second heat exchanger 12. As a control for preventing frosting in the second heat exchanger 12, for example, the upper-level control device 400 may transmit a control signal for increasing the current set temperature of the heater to the control unit 471 of the outdoor unit 470.

[0215] The configuration of the upper-level control device 400 illustrated in the present embodiment may also be included as a configuration of the ventilation apparatus. That is, the processing performed by the upper-level control device 400 may be a function of the ventilation apparatus. The same shall apply to the following embodiments.

(Fourth embodiment)

[0216] In the third embodiment, coordination control in the case where defrosting operation is performed on the air conditioner 2C by the upper-level control device 400 has been described. However, the upper-level control

device 400 performs various kinds of coordination control. Therefore, in the fourth embodiment, control in the case where there is a possibility of frosting in the second heat exchanger 12 of the plurality of exhaust units 410 will be described.

[0217] When the possibility of frosting occurs in the second heat exchangers 12 of the plurality of exhaust units 410, there arises a status in which it is difficult to perform control for simultaneously preventing frosting in the second heat exchangers 12 of the plurality of exhaust units 410. Therefore, the upper-level control device 400 makes an adjustment so as not to implement control for simultaneously preventing frosting in the second heat exchangers 12 of the plurality of exhaust units 410.

[0218] In the present embodiment, the control of preventing frosting in the ventilation apparatus 1C controls to increase the air volume flowing to the second heat exchangers 12. When the control to increase the air volume flowing to the second heat exchangers 12 is simultaneously performed by a plurality of exhaust units 410A and 410B, the pressure in the living room space R11 may become negative pressure.

[0219] Therefore, in the present embodiment, the defrosting control is performed by increasing the air volume in one of the plurality of exhaust units 410A and 410B, and the air volume is decreased in the other one of the plurality of exhaust units 410A and 410B. That is, in the present embodiment, the defrosting control operation is performed preferentially in one of the plurality of exhaust units 410A and 410B. Furthermore, the upper-level control device 400 prevents the negative pressure of the living room space R11 by adjusting to maintain the total air volume to be discharged.

[0220] FIG. 8 is a sequence diagram illustrating the flow of processing performed between the upper-level control device 400, the compressor unit 450, and the exhaust unit group when there is a possibility of frosting in each of the exhaust units in the exhaust unit group according to the present embodiment.

[0221] First, the control unit 413A of the first exhaust unit 410A acquires the temperature of the outside air from the temperature detecting unit 14 (S1801).

[0222] Then, the control unit 413A reports the detected temperature of the outside air to the control unit 452 of the compressor unit 450 (S1802).

[0223] The control unit 413B of the second exhaust unit 410B acquires the temperature of the outside air from the temperature detecting unit 14 (S1811).

[0224] The control unit 413B reports the detected temperature of the outside air to the control unit 452 of the compressor unit 450 (S1812).

[0225] The control unit 452 of the compressor unit 450 determines, based on the detected outside air temperatures received from the control unit 413A of the first exhaust unit 410A and the control unit 413B of the second exhaust unit 410B, whether the second heat exchanger 12 of the first exhaust unit 410A and the second exhaust unit 410B satisfies a predetermined reference indicating

the possibility of frosting (S1821). In the example illustrated in FIG. 8, it is determined that each of the second heat exchangers 12 of the first exhaust unit 410A and the second exhaust unit 410B satisfies the predetermined reference. The predetermined reference is the same as in the above-described embodiment, and, therefore, the description thereof will be omitted.

[0226] The control unit 452 of the compressor unit 450 reports, to the upper-level control device 400, the determination result indicating the possibility of frosting (S1822).

[0227] The upper-level control device 400 determines the order in which frost prevention is controlled for the first exhaust unit 410A and the second exhaust unit 410B based on the received determination result (S1831). Any method may be used to determine the order. For example, the frost prevention may be controlled so that the frost prevention is carried out first when there is a high probability of frosting, or the order may be determined according to the priority order previously assigned to the first exhaust unit 410A and the second exhaust unit 410B. The example illustrated in FIG. 8 is an example in which it has been determined to prevent frosting in the order of the first exhaust unit 410A and the second exhaust unit 410B.

[0228] The upper-level control device 400 transmits a signal indicating an instruction to increase the air volume of the first exhaust unit 410A to the control unit 452 of the compressor unit 450 (S1832).

[0229] The control unit 452 of the compressor unit 450 transmits a signal indicating an instruction to increase the air volume to the control unit 413A of the first exhaust unit 410A (S1823).

[0230] Accordingly, the control unit 413A of the first exhaust unit 410A controls the fan 11 to increase the air volume flowing to the second heat exchanger 12 (increase the air volume) compared with before the temperature detection at S1801 (S1803).

[0231] After increasing the air volume flowing to the second heat exchanger 12 by the control described above, the upper-level control unit 400 transmits a signal indicating an instruction to decrease the air volume of the second exhaust unit 410B to the control unit 452 of the compressor unit 450 after a predetermined time (a predetermined time for preventing frosting) has elapsed (S1833).

[0232] Then, the control unit 452 of the compressor unit 450 transmits a signal indicating an instruction of air volume reduction to the control unit 413B of the second exhaust unit 410B (S1824).

[0233] Accordingly, the control unit 413B of the second exhaust unit 410B controls the fan 11 to reduce the air volume flowing to the second heat exchanger 12 (air volume reduction) compared with before temperature detection at S1811 (S1813).

[0234] In the present embodiment, the air volume of the first exhaust unit 410A is increased and the air volume of the second exhaust unit 410B is decreased to maintain

the total air volume discharged. Thereafter, the upper-level control device 400 switches the exhaust unit for which frosting prevention is to be performed.

[0235] The upper-level control device 400 transmits a signal indicating an instruction for reducing the air volume of the first exhaust unit 410A to the control unit 452 of the compressor unit 450 (S1834).

[0236] The control unit 452 of the compressor unit 450 transmits a signal indicating an instruction for reducing the air volume to the control unit 413A of the first exhaust unit 410A (S1825).

[0237] Accordingly, the control unit 413A of the first exhaust unit 410A controls the fan 11 to reduce the air volume flowing to the second heat exchanger 12 (air volume reduction) as compared with before temperature detection was performed in S1801 (S1804).

[0238] The upper-level control device 400 transmits a signal indicating an instruction to increase the air volume of the second exhaust unit 410B to the control unit 452 of the compressor unit 450 (S1835).

[0239] The control unit 452 of the compressor unit 450 transmits a signal indicating an instruction to increase the air volume to the control unit 413B of the second exhaust unit 410B (S1826).

[0240] Accordingly, the control unit 413B of the second exhaust unit 410B controls the fan 11 to increase the air volume flowing to the second heat exchanger 12 (increase the air volume) compared with before the temperature detection at S1811 (S1814).

[0241] As described above, the control unit 452 of the compressor unit 450 and the upper-level control device 400 according to the present embodiment control the fan 11 associated with any one of the plurality of second heat exchangers 12 to increase the air volume flowing to the second heat exchanger 12 compared with before the predetermined reference is satisfied when it is determined that the predetermined reference has been satisfied while the plurality of second heat exchangers 12 are functioning as evaporators. Accordingly, the amount of (warm) air flowing into any one of the second heat exchangers 12 increases, and, therefore, frosting can be prevented.

[0242] Further, when the upper-level control unit 400 controls the fan 11 associated with one of the plurality of the second heat exchangers 12 to increase the air volume, the upper-level control unit 400 controls the fan 11 associated with the other one of the plurality of the second heat exchangers 12 to decrease the air volume flowing to the second heat exchanger 12 compared to before the predetermined reference is satisfied. Accordingly, the air volume discharged from the group of a plurality of exhaust unit can be maintained, thereby avoiding a situation where the pressure in the living room space R11 becomes negative pressure.

[0243] Further, in the present embodiment, by controlling frosting prevention for each of the plurality of exhaust units according to a predetermined order, it is possible to prevent frosting in the second heat exchanger 12 of

the plurality of exhaust units.

(Fifth embodiment)

[0244] In the fourth embodiment, an example of making an adjustment to maintain the air volume discharged from a group of a plurality of exhaust units when controlling frosting has been described. However, the method of avoiding negative pressure is not limited to a method of making an adjustment to maintain the air volume discharged from a group of a plurality of exhaust units. Accordingly, in the fifth embodiment, a case in which the air volume taken in from the outside by the air supply unit group is increased when the air volume exhausted from the exhaust unit group is increased will be described. The configuration of the present embodiment is similar to that of the fourth embodiment.

[0245] Similar to the fourth embodiment, the control unit 452 of the compressor unit 450 of the present embodiment determines whether the second heat exchanger 12 of the first exhaust unit 410A and the second exhaust unit 410B satisfies the predetermined reference indicating the possibility of frosting based on the received outside air temperature.

[0246] When the control unit 452 of the compressor unit 450 determines that any one of the first exhaust unit 410A and the second exhaust unit 410B satisfies the predetermined reference, the upper-level control device 400 instructs the exhaust unit to increase the air volume. The method of the instruction is the same as that of the fourth embodiment, and the description thereof is omitted.

[0247] When the upper-level control device 400 determines that each of the first exhaust unit 410A and the second exhaust unit 410B satisfies the predetermined reference, the upper-level control device 400 determines the order in which frost prevention is to be performed for the first exhaust unit 410A and the second exhaust unit 410B. The upper-level control device 400 then instructs each of the first exhaust unit 410A and the second exhaust unit 410B to increase the air volume according to the order.

[0248] The upper-level control device 400 according to the present embodiment instructs one or more of the first air supply unit 420A and the second air supply unit 420B to increase the air volume, instead of instructing the decrease of the air volume as described in the fourth embodiment. The upper-level control device 400 gives an instruction to increase the air volume to one or more of the control unit 423A of the first air supply unit 420A and the control unit 423B of the second air supply unit 420B to increase the air volume through the control unit 452 of the compressor unit 450.

[0249] The target for instructing the increase of the air volume may be any one of the first air supply unit 420A and the second air supply unit 420B, or may be each of the first air supply unit 420A and the second air supply unit 420B. However, the upper-level control device 400 makes an adjustment such that the air volume dis-

charged by the first exhaust unit 410A and the second exhaust unit 410B and the air volume taken in by the first air supply unit 420A and the second air supply unit 420B are the same.

[0250] Thus, the upper-level control device 400 according to the present embodiment controls the fan 21 included in the air supply unit group to increase the air volume flowing to the first heat exchanger 22 compared with before the predetermined reference is satisfied based on the increased air volume when the fan 11 associated with any one of the plurality of second heat exchangers 12 included in the exhaust unit group is controlled to increase the air volume flowing to the second heat exchanger 12. Accordingly, in the present embodiment, the air volume to be taken in and the air volume to be exhausted are substantially the same, and, therefore, it is possible to prevent the pressure in the living room space R11 from becoming negative pressure.

(Sixth embodiment)

[0251] The method for controlling frosting is not limited to the above-described embodiment, and other methods may be used. Therefore, in the sixth embodiment, an example will be described in which the operation of the compressor of the compressor unit is stopped, and the frosting control is performed by passing air through the second heat exchanger 12.

[0252] The configuration of the present embodiment may be any configuration, and a configuration may have the upper-level control device 400 as illustrated in FIG. 6 of the third embodiment. In the example illustrated in FIG. 6, two exhaust units and two air supply units are provided, but one exhaust unit and one air supply unit may be provided. As described above, the number of exhaust units and air supply units may be any number.

[0253] While the second heat exchanger 12 functions as an evaporator, the control unit 413A of the first exhaust unit 410A and the control unit 413B of the second exhaust unit 410B obtain the surface temperature of the second heat exchanger 12 from the temperature detecting unit 14. The control unit 413A and the control unit 413B of the second exhaust unit 410B transmit the detected surface temperature of the second heat exchanger 12 to the control unit 452 of the compressor unit 450.

[0254] Based on the surface temperature of the second heat exchanger 12, the control unit 452 of the compressor unit 450 determines whether a predetermined reference indicating the possibility of frosting in the second heat exchanger 12 is satisfied. The predetermined reference indicating the possibility of frosting in the second heat exchanger 12 may be, for example, a reference for determining whether the surface temperature of the second heat exchanger 12 is zero degrees or less. The predetermined reference may be any reference indicating the possibility of frosting in the second heat exchanger 12. For example, the predetermined reference may be a reference such as that of the above-described embodiment,

for example, a reference based on the temperature or pressure of the refrigerant.

[0255] When the predetermined reference is determined to be satisfied, the control unit 452 of the compressor unit 450 according to the present embodiment reports, to the upper-level control unit 400, a determination result indicating the possibility of frosting in the second heat exchanger 12.

[0256] Based on the determination result, the upper-level control unit 400 transmits a control signal instructing to stop the compressor to the control unit 452 of the compressor unit 450. Accordingly, the control unit 452 of the compressor unit 450 performs control to stop the compressor.

[0257] Based on the determination result, the upper-level control device 400 outputs a control signal so as to continue to control the fan 11 to pass the air to the second heat exchanger 12, through the control unit 452 of the compressor unit 450, to the control unit 413A of the first exhaust unit 410A and the control unit 413B of the second exhaust unit 410B. Further, the upper-level control device 400 may perform control of increasing the air volume of the fan 11 as in the fourth embodiment.

[0258] In the present embodiment, by stopping the compressor in the compressor unit 450 and passing air in the living room space R11 to the second heat exchanger 12, the temperature of the surface of the second heat exchanger 12 can be increased to prevent frosting in the second heat exchanger 12.

(Seventh embodiment)

[0259] In the sixth embodiment, an example in which the upper-level control device 400 controls one compressor unit 450 has been described. However, the number of compressor units controlled by the upper-level control device 400 is not limited to one. Therefore, in the seventh embodiment, an example in which the upper-level control device 400 controls three compressor units will be described.

[0260] FIG. 9 is a diagram illustrating an arrangement of a group of devices including the upper-level control device 500 according to the seventh embodiment. The example illustrated in FIG. 9 includes at least living room spaces R501, R502, R503, lavatory rooms R511, R512, and a pipe shaft R521.

[0261] The lavatory rooms R511, R512 are provided with ventilation ports 595A, 595B, respectively.

[0262] The air conditioner 2D includes three outdoor units 571, 572, and 573 and eight air conditioning indoor units 581, 582, 583, 584, 585, 586, 587, and 588. The three outdoor units 571 to 573 and the eight air conditioning indoor units 581 to 588 are connected by a connection pipe (not illustrated).

[0263] The three outdoor units 571 to 573 are connected to the upper-level control device 500 by a signal line. Thus, the three outdoor units 571 to 573 can perform air conditioning control according to the control of the upper-

level control device 500.

[0264] The first ventilation apparatus 1D_1 is a ventilation apparatus provided in the living room space R501 and includes a first compressor unit 550A, a first air supply unit 520A, and a first exhaust unit 510A.

[0265] The first air supply unit 520A supplies air (SA) from the ventilation port 592A. The first exhaust unit 510A returns air (RA) from the ventilation port 591A. The first compressor unit 550A, the first air supply unit 520A, and the first exhaust unit 510A are connected by a connection pipe F501. The connection pipe F501 includes a plurality of refrigerant connection pipes. Thereby, the refrigerant can be circulated between the first compressor unit 550A, the first air supply unit 520A, and the first exhaust unit 510A.

[0266] The first compressor unit 550A, the first air supply unit 520A, and the first exhaust unit 510 A are connected by a signal line (not illustrated). This enables transmission and reception of information between the units. The configuration inside the first compressor unit 550A, the first air supply unit 520A, and the first exhaust unit 510A is the same as that of the compressor unit 450A, the first air supply unit 420A, and the first exhaust unit 410A illustrated in FIG. 6, and the description thereof will be omitted.

[0267] The second ventilation apparatus 1D_2 is a ventilation apparatus provided in the living room space R502 and includes a second compressor unit 550B, a second air supply unit 520B, and a second exhaust unit 510B.

[0268] The second air supply unit 520B supplies air (SA) from the ventilation port 592B. The second exhaust unit 510B returns air (RA) from the ventilation port 591B. The second compressor unit 550B, the second air supply unit 520B, and the second exhaust unit 510B are connected by a connection pipe F502. The connection pipe F502 includes a plurality of refrigerant connection pipes. Thus, the refrigerant can be circulated between the second compressor unit 550B, the second air supply unit 520B, and the second exhaust unit 510B.

[0269] The second compressor unit 550B, the second air supply unit 520B, and the second exhaust unit 510B are connected by a signal line (not illustrated). This enables transmission and reception of information between the units. The configuration inside the second compressor unit 550B, the second air supply unit 520B, and the second exhaust unit 510B is the same as that of the compressor unit 450A, the first air supply unit 420A, and the first exhaust unit 410A illustrated in FIG. 6, and descriptions thereof will be omitted.

[0270] The third ventilation apparatus 1D_3 is a ventilation apparatus provided in the living room space R503 and includes a third compressor unit 550C, a third air supply unit 520C, and a third exhaust unit 510C.

[0271] The third air supply unit 520C supplies air (SA) from the ventilation port 592C. The third exhaust unit 510C returns air (RA) from the ventilation port 591C. The third compressor unit 550C, the third air supply unit 520C,

and the third exhaust unit 510C are connected by a connection pipe F503. The connection pipe F503 includes a plurality of refrigerant connection pipes. Thus, the refrigerant can be circulated between the third compressor unit 550C, the third air supply unit 520C, and the third exhaust unit 510C.

[0272] The third compressor unit 550C, the third air supply unit 520C, and the third exhaust unit 510C are connected by a signal line (not illustrated). This enables transmission and reception of information between the units. The configuration inside the third compressor unit 550C, the third air supply unit 520C, and the third exhaust unit 510C is the same as that of the compressor unit 450A, the first air supply unit 420A, and the first exhaust unit 410A illustrated in FIG. 6, and the description thereof will be omitted.

[0273] As described above, the present embodiment includes a plurality of combinations of a compressor unit, an air supply unit, an exhaust unit, and a connection pipe. The first compressor unit 550A, the second compressor unit 550B, and the third compressor unit 550C are arranged on the pipe shaft R521.

[0274] The upper-level control device 500 is connected to the first compressor unit 550A, the second compressor unit 550B, and the third compressor unit 550C by a signal line. Accordingly, the upper-level control device 500 can recognize the state of each apparatus of the first ventilation apparatus 1D_1 to the third ventilation apparatus 1D_3 and control each apparatus.

[0275] According to the above configuration, while the second heat exchanger 12 of each of the first exhaust units 510A to the third exhaust unit 510C functions as an evaporator, the control unit (not illustrated) of the first compressor unit 550A to the third compressor unit 550C receives the surface temperature of the second heat exchanger 12 from each of the first exhaust units 510A to the third exhaust unit 510C.

[0276] Then, while the second heat exchanger 12 functions as an evaporator, the control unit of the first compressor unit 550A to the third compressor unit 550C of the present embodiment determines whether a predetermined reference indicating the possibility of frosting in the second heat exchanger 12 is satisfied based on the surface temperature of the second heat exchanger 12. The predetermined reference is the same as in the above-described embodiment, and, therefore, the description thereof will be omitted.

[0277] The control units of the first compressor unit 550A to the third compressor unit 550C report, to the upper-level control device 400, the determination result indicating whether the predetermined reference is satisfied.

[0278] When the upper-level control device 500 determines from the determination result that there are a plurality of compressor units (for example, the first compressor unit 550A to the third compressor unit 550C) connected to the second heat exchanger 12 satisfying a predetermined reference by a connection pipe, the upper-

level control device 500 outputs a control signal for stopping the compressor to the plurality of compressor units (for example, the first compressor unit 550A to the third compressor unit 550C) in a predetermined order as a control for preventing frosting in the second heat exchanger 12. Thus, a plurality of compressor units are prevented from simultaneously stopping the compressor. The predetermined order may be any order, such as an ascending order according to surface temperature, or may be based on a preset priority order of compressor units.

[0279] Further, the upper-level control device 500 maintains control of the fan 11 corresponding to the second heat exchanger 12 that satisfies the predetermined reference to pass air from the living room spaces R501 to R503 to the second heat exchanger 12. Accordingly, the temperature of the refrigerant flowing through the second heat exchanger 12 can be increased.

[0280] In the present embodiment, by carrying out the control described above, the frosting in the second heat exchanger 12 can be prevented by stopping the refrigerant flowing to the second heat exchanger 12 and maintaining the air flowing to the second heat exchanger 12.

(Eighth embodiment)

[0281] In the seventh embodiment, an example in which the upper-level control device 500 stops a plurality of compressor units in a predetermined order has been described. On the other hand, in the eighth embodiment, an example in which a plurality of air supply units and a plurality of exhaust units are connected to one compressor will be described.

[0282] FIG. 10 is a diagram illustrating an arrangement of a group of devices including an upper-level control device 600 according to the eighth embodiment. Among the configurations illustrated in FIG. 10, configurations similar to those of the above-described embodiments are assigned the same reference numerals, and descriptions thereof will be omitted.

[0283] As illustrated in FIG. 10, the compressor unit 650 is connected to the first air supply unit 520A and the first exhaust unit 510A through the connection pipe F601, connected to the second air supply unit 520B and the second exhaust unit 510B through the connection pipe F602, and connected to the third air supply unit 520C and the third exhaust unit 510C through the connection pipe F603. Accordingly, the refrigerant circulates through the units connected by the connection pipes F601, F602, and F603.

[0284] The compressor unit 650, the first air supply unit 520A to the third air supply unit 520C, and the first exhaust unit 510A to the third exhaust unit 510C are connected by a signal line (not illustrated), and, therefore, information can be transmitted and received between the units. The upper-level control device 500 and the compressor unit 650 are also connected by a signal line, and, therefore, information can be transmitted and received

therebetween.

[0285] The first air supply unit 520A, the second air supply unit 520B, and the third air supply unit 520C are provided with the electric valve 26 (an example of the first valve part) as illustrated in FIG. 5. Similarly, the first exhaust unit 510A, the second exhaust unit 510B, and the third exhaust unit 510C are provided with the electric valve 16 (an example of the first valve part) as illustrated in FIG. 5.

[0286] When the second heat exchanger 12 of the first exhaust unit 510A, the second exhaust unit 510B, and the third exhaust unit 510C functions as an evaporator, the electric valve 16 functions as a valve to adjust the opening of the flow path to the second heat exchanger 12 (to adjust the pressure of the refrigerant).

(Example of a valve part)

[0287] Thus, with respect to each of the first exhaust unit 510A, the second exhaust unit 510B, and the third exhaust unit 510C, the upper-level control device 600 can individually stop and control the inflow of refrigerant by controlling the electric valve 16 to be in a closed state.

[0288] While the second heat exchanger 12 functions as an evaporator, the control unit (not illustrated) of the compressor unit 650 according to the present embodiment determines whether a predetermined reference indicating the possibility of frosting in the second heat exchanger 12 is satisfied based on the surface temperature of the second heat exchanger 12. Note that the predetermined reference is the same as that of the above-described embodiment, and a description thereof is omitted. The control unit 652 (not illustrated) of the compressor unit 650 reports, to the upper-level control device 600, the determination result.

[0289] In the present embodiment, when the upper-level control device 600 recognizes, based on the determination result, that there are a plurality of second heat exchangers 12 that satisfy the predetermined reference, the upper-level control device 600 outputs, in a predetermined order, a control signal for closing the electric valve 16 to a plurality of exhaust units (for example, the first exhaust unit 510A to the third exhaust unit 510C) including the second heat exchanger 12 that satisfy the predetermined reference, as a control for preventing frosting in the second heat exchanger 12. Thus, the inflow of the refrigerant into the plurality of second heat exchangers 12 is prevented from being stopped simultaneously. The predetermined order may be any order, such as an ascending order according to surface temperature, or may be based on a preset priority order of compressor units.

[0290] The upper-level control device 500 also maintains control of the fan 11 corresponding to the second heat exchanger 12 that satisfies the predetermined reference, to pass air from the living room spaces R501 to R503 to the second heat exchanger 12.

[0291] In the present embodiment, by performing the

control described above, the refrigerant flowing to the second heat exchanger 12 is stopped and the air flowing to the second heat exchanger 12 is maintained, so that frosting can be prevented.

(Ninth embodiment)

[0292] A method other than the above-described embodiment may be used to prevent frosting in the second heat exchanger 12. Therefore, in the ninth embodiment, an example of performing adjustment between the air supply amount and the exhaust amount will be described.

[0293] The configuration of the ninth embodiment may be any configuration of the above-described embodiment, for example, the configuration illustrated in FIG. 6. Therefore, in the present embodiment, a case with the configuration illustrated in FIG. 6 will be described.

[0294] While the second heat exchanger 12 functions as an evaporator, the control unit 452 of the compressor unit 450 according to the present embodiment determines whether a predetermined reference indicating the possibility of frosting in the second heat exchanger 12 is satisfied based on the surface temperature of the second heat exchanger 12. Note that the predetermined reference is the same as that of the above-described embodiment, and a description thereof is omitted.

[0295] In the present embodiment, the control unit 452 of the compressor unit 450 reports, to the upper-level control device 400, the determination result. When the upper-level control device 400 recognizes that there are a plurality of second heat exchangers 12 that meet the predetermined reference, the upper-level control device 400 outputs a control signal for controlling the fans 11 and 21 such that the total air volume supplied by the fan 11 (an example of the second ventilation unit) of the exhaust unit group (for example, the first exhaust unit 410A and the second exhaust unit 410B) is greater than the total air volume exhausted by the fan 21 (an example of the first ventilation unit) of the air supply unit group (for example, the first supply air unit 420A and the second supply air unit 420B), as a control for preventing frosting in the second heat exchanger 12.

[0296] In the present embodiment, frosting prevention can be implemented by preventing the condensing ability of the air supply unit group and raising the evaporation temperature of the second heat exchanger 12 of the exhaust unit group, by making the air volume of the exhausted air larger than the air volume of the supplied air.

(Tenth embodiment)

[0297] A method other than the above-described embodiment may be used to prevent frosting in the second heat exchanger 12. Therefore, in the tenth embodiment, an example of adjusting the temperature of air after passing through the first heat exchanger 22 will be described.

[0298] The configuration of the tenth embodiment may be any configuration of the above-described embodi-

ment, and may be, for example, the configuration illustrated in FIG. 6. Therefore, in the present embodiment, a case with the configuration illustrated in FIG. 6 will be described.

[0299] The control unit 452 of the compressor unit 450 according to the present embodiment determines whether a predetermined reference indicating the possibility of frosting in the second heat exchanger 12 is satisfied based on the surface temperature of the second heat exchanger 12 while the second heat exchanger 12 functions as an evaporator. The predetermined reference is the same as that of the above embodiment, and, therefore, the description thereof is omitted.. The control unit 452 of the compressor unit 450 reports, to the upper-level control device 400, the determination result.

[0300] In the present embodiment, when the upper-level control device 400 recognizes that there are a plurality of second heat exchangers 12 that satisfy a predetermined reference, the upper-level control device 400 outputs a control signal that causes the temperature of the air after passing through the first heat exchanger 22 to become lower than the temperature set to the air conditioner 2C provided in the living room space R11, to the first heat exchanger of the air supply unit group (for example, the first supply air unit 420A and the second supply air unit 420B), as the control for preventing frosting in the second heat exchangers 12. The temperature set in the air conditioner 2C is acquired from the control unit 471 of the outdoor unit 470.

[0301] In the present embodiment, the temperature of the air after passing through the first heat exchanger 22 of the air supply unit group (air supply temperature) becomes lower than the indoor set temperature. Accordingly, the compressor of the compressor unit 450 is operated at a low rotational speed, and, therefore, the decrease in the evaporation temperature of the second heat exchanger 12 can be prevented.

(Eleventh embodiment)

[0302] A method other than the above-described embodiment may be used to prevent frosting in the second heat exchanger 12. Therefore, in the eleventh embodiment, an example of adjusting the pressure of the refrigerant by an electric valve (an example of the third valve part) provided downstream of the exhaust unit will be described.

[0303] The configuration of the eleventh embodiment may be any configuration of the above-described embodiment, for example, the configuration illustrated in FIG. 6. Therefore, in the present embodiment, a case with the configuration illustrated in FIG. 6 will be described.

[0304] FIG. 11 is a diagram illustrating a refrigerant circuit according to the eleventh embodiment. In the example illustrated in FIG. 11, a flow of refrigerant when the second heat exchanger 12 of the exhaust units 410A and 410B functions as an evaporator is illustrated. The

same reference numerals are assigned to the configuration similar to that of the above-described embodiment, and the description thereof is omitted.

[0305] In the example illustrated in FIG. 11, when the second heat exchanger 12 of the exhaust units 410A and 410B functions as an evaporator, electric valves 601 and 602 are provided downstream from the second heat exchanger 12 of each of the exhaust units 410A and 410B.

[0306] The control unit 452 of the compressor unit 450 according to the present embodiment determines whether a predetermined reference indicating the possibility of frosting in the second heat exchanger 12 is satisfied based on the surface temperature of the second heat exchanger 12 while the second heat exchanger 12 functions as an evaporator. Note that the predetermined reference is the same as in the above-described embodiment, and the description thereof is omitted. The control unit 452 of the compressor unit 450 reports, to the upper-level control device 400, the determination result.

[0307] In the present embodiment, when the upper-level control device 400 recognizes the existence of the second heat exchanger 12 that satisfies the predetermined reference, the upper-level control device 400 outputs a control signal to throttle the electric valve (the electric valve 601 or the electric valve 602) compared with before the predetermined reference is satisfied, to the control unit (the control unit 413A or the control unit 413B) of the exhaust unit (for example, the first exhaust unit 410A or the second exhaust unit 410B) that includes the second heat exchanger 12.

[0308] By reducing the opening degree of the expansion valve (the expansion valve 161 or the expansion valve 162), the pressure of refrigerant flowing through the second heat exchanger 12 that exists upstream from the expansion valve (the expansion valve 161 or the expansion valve 162) can be increased. Accordingly, the evaporation temperature of refrigerant flowing through the second heat exchanger 12 can be increased. Therefore, frosting in the second heat exchanger 12 can be prevented.

[0309] Although the bypass flow path F6 is illustrated in FIG. 11, in the present embodiment, the bypass flow path F6 may or may not be combined with the control using the bypass flow path F6 illustrated in the above embodiment.

(Modified example of eleventh embodiment)

[0310] In the eleventh embodiment, an example of preventing frosting using a method of throttling the electric valves 601 and 602 downstream from the second heat exchanger 12 has been described. In the eleventh embodiment, in addition to a method of adjusting the electric valves 601 and 602 downstream from the second heat exchanger 12, a case in which an exhaust unit 730 of an outdoor unit is further provided in a refrigerant circuit to control the exhaust unit 730 will be described.

[0311] FIG. 12 is a diagram illustrating a refrigerant

circuit according to a modified example of the eleventh embodiment. In the example illustrated in FIG. 12, an exhaust unit 730 is further provided in the refrigerant circuit illustrated in FIG. 11. Except for the exhaust unit 730, the configuration is similar to that of the eleventh embodiment, and descriptions thereof will be omitted.

[0312] The exhaust unit 730 includes the fan 11, a third heat exchanger 732, a control unit 733, the temperature detecting unit 14, a driving motor 15, and an electric valve 16.

[0313] The exhaust unit 730 functions as an outdoor unit. That is, the exhaust unit 730 is provided on a flow path (an example of the fourth air flow path) for exhausting, to the outdoors, the air in which heat exchange has been performed between the outdoor air and a refrigerant flowing through the third heat exchanger 732.

[0314] While the second heat exchanger 12 functions as an evaporator, the control unit 452 of the compressor unit 450 according to the present embodiment determines whether a predetermined reference indicating the possibility of frosting in the second heat exchanger 12 is satisfied based on the surface temperature of the second heat exchanger 12. Note that the predetermined reference is the same as that of the above-described embodiment, and a description thereof is omitted. The control unit 452 of the compressor unit 450 reports, to the upper-level control device 400, the determination result.

[0315] In the present embodiment, when the upper-level control device 400 recognizes that there is the second heat exchanger 12 that satisfies a predetermined reference, the upper-level control device 400 performs the same control as in the eleventh embodiment, and performs control such that the third heat exchanger 732 of the exhaust unit 730 performs heat exchange at a lower evaporation temperature than the second heat exchanger 12.

[0316] As illustrated in FIG. 12, the flow of refrigerant through the third heat exchanger 732 of the exhaust unit 730 is connected to the flow of refrigerant through the second heat exchanger 12 of the exhaust units 410A and 410B. Therefore, the evaporation temperature of the second heat exchanger 12 can be increased by lowering the evaporation temperature of the third heat exchanger 732. Thus, frosting in the second heat exchanger 12 can be prevented.

[0317] In the above embodiment and modified example, although the method of sharing the processing between the control unit 452 of the compressor unit 450 and the upper-level control device 500 has been described, the method is not limited to the method of sharing the processing between the control unit 452 of the compressor unit 450 and the upper-level control device 500, and the determination and control of other devices may be performed by either of the control unit 452 of the compressor unit 450 or the upper-level control device 500. Furthermore, the method is not limited to processing by the control unit 452 of the compressor unit 450 and the upper-level control device 500, but it is possible to per-

form processing of the above-described embodiment on a server for centralized management or in the cloud.

(Twelfth embodiment)

[0318] A method other than the above-described embodiment may be used to prevent frosting in the second heat exchanger 12. Therefore, in the twelfth embodiment, an example of switching the control in consideration of power consumption will be described.

[0319] The configuration of the twelfth embodiment may be any configuration of the above-described embodiment, for example, the configuration illustrated in FIG. 6. Therefore, in the present embodiment, a case with the configuration illustrated in FIG. 6 will be described. The upper-level control device 400 performs the following control during the heat recovery ventilation operation.

[0320] While the second heat exchanger 12 functions as an evaporator, the control unit 452 of the compressor unit 450 of the present embodiment determines whether a predetermined reference indicating the possibility of frosting in the second heat exchanger 12 is satisfied based on the surface temperature of the second heat exchanger 12. The control unit 452 of the compressor unit 450 reports, to the upper-level control device 400, the determination result.

[0321] The predetermined reference may be based on the temperature of the refrigerant or the pressure of the refrigerant flowing through the second heat exchanger 12, or the predetermined reference may be the same as in the above-described embodiment.

[0322] In the present embodiment, when the upper-level control unit 400 recognizes the existence of a plurality of second heat exchangers 12 that satisfy the predetermined reference, the upper-level control unit 400 determines whether to control frosting or to allow frosting and perform defrosting operation after frosting. According to the determination result of the upper-level control device 400, the exhaust unit group (for example, the first exhaust unit 410A and the second exhaust unit 410B) controls the frosting prevention or allows the frosting and performs defrosting operation after the frosting.

[0323] FIG. 13 is a flowchart illustrating the processing procedure of the upper-level control device 400 according to the present embodiment.

[0324] First, the control unit 452 of the compressor unit 450 according to the present embodiment receives the detection result of the second heat exchanger 12 from each exhaust unit in the exhaust unit group (S2101). The detection result is the temperature or the pressure of the refrigerant flowing through the second heat exchanger 12.

[0325] The control unit 452 of the compressor unit 450 determines whether the predetermined reference is satisfied based on the detection result (S2102). For example, as the predetermined reference indicating the possibility of frosting in the second heat exchanger 12, the

reference is whether the detected (evaporation) temperature of the refrigerant is lower than a predetermined temperature t , or whether the detected (evaporation) pressure of the refrigerant is lower than a predetermined pressure p . If it is determined that the predetermined reference is not satisfied (NO in S2102), the process is performed again from S2101. Note that the predetermined temperature t and pressure p are values determined according to the embodiment as the reference of whether there is a possibility of frosting, and explanations thereof are omitted. It is considered that the determination is made every predetermined time (for example, x minutes).

[0326] When the control unit 452 of the compressor unit 450 determines that the predetermined reference is satisfied (YES in S2102), the control unit 452 reports, to the upper-level control device 400, the determination result.

[0327] The upper-level control device 400 controls the temperature of the refrigerant flowing through the second heat exchanger 12 to prevent frosting, and calculates the power consumption $E1$ for maintaining the current temperature of the living room space $R11$ and the like (S2103).

[0328] Further, the upper-level control device 400 performs a defrosting operation, and calculates the power consumption $E2$ for maintaining the current temperature of the living room space $R11$ and the like (S2104).

[0329] For example, in the present embodiment, the upper-level control device 500 stores in advance the power consumption calculation model set in advance for calculating the power consumption $E1$ and the power consumption $E2$. The upper-level control device 500 inputs input information (for example, room/outside air temperature, air volume of fans 11 and 21, pressure of refrigerant, rotational speed of the compressor, etc.: an example of the status of the living room space) into the power consumption calculation model to calculate power consumption. The power consumption calculation method is not limited to the method of using the calculation model, and other methods may be used.

[0330] Thereafter, the upper-level control device 400 determines whether the power consumption $E1$ is lower than the power consumption $E2$ (S2105). When the upper-level control device 400 determines that the power consumption $E1$ is lower than the power consumption $E2$ (YES in S2105), the upper-level control device 400 outputs a control signal to prevent frosting to the exhaust unit group (S2106). Note that the method for preventing frosting may be the process illustrated in the above-described embodiment, and the description thereof will be omitted. Thereafter, the upper-level control device 500 performs the process from step S2101 again.

[0331] Thereafter, when it is determined that the power consumption $E1$ is equal to or greater than the power consumption $E2$ (not less) (NO in S2105), the upper-level control device 400 outputs a control signal to the exhaust unit group for allowing frosting, and executing the defrosting operation after determining that frosting has oc-

curred according to the detection result (S2107). The defrosting operation method may be any method, regardless of whether the method is known, and the description thereof will be omitted.

[0332] Thereafter, the upper-level control device 400 according to the present embodiment receives the detection result of the second heat exchanger 12 from each exhaust unit in the exhaust unit group via the control unit 452 of the compressor unit 450 (S2108). The detection result is the temperature or the pressure of the refrigerant flowing through the second heat exchanger 12.

[0333] Based on the detection result, the upper-level control device 400 determines whether a defrosting end reference is satisfied (S2109). For example, as the defrosting end reference of the second heat exchanger 12, the reference is whether the detected (evaporation) temperature of the refrigerant is higher than a predetermined temperature $t+\alpha$, or whether the detected (evaporation) pressure of the refrigerant is lower than a predetermined pressure $p+\beta$. As for the defrosting end reference, any reference may be used as long as the completion of the defrosting can be determined by the reference. The variables α and β are positive numbers determined according to the embodiment, and descriptions thereof are omitted. It is determined whether the defrosting end reference is satisfied (S2109). If it is determined that the defrosting end reference is not satisfied (NO in S2109), the process is performed again from S2108. It is considered that the determination is made every predetermined time (for example, y minutes).

[0334] On the other hand, when the upper-level control device 400 determines that the defrosting end reference is satisfied based on the detection result (YES in S2109), the upper-level control device outputs a control signal for ending the defrosting operation to the exhaust unit group (S2110) and ends the process. Thereafter, the upper-level control device 500 performs processing from step S2101 again.

[0335] By implementing the above control, the upper-level control device 500 according to the present embodiment can perform control to cause the temperature of the second heat exchanger 12 to become a temperature at which frosting in the second heat exchanger 12 does not occur when it is determined that the predetermined reference is satisfied, by controlling the temperature of the refrigerant flowing to the second heat exchanger 12 such that the temperature of the second heat exchanger 12 becomes a temperature at which frosting in the second heat exchanger 12 does not occur or by controlling the operation to defrost the second heat exchanger 12 after frosting occurs on the second heat exchanger 12, based on the power consumption required when the temperature of the refrigerant flowing through the second heat exchanger 12 is controlled or the power consumption required for the operation for defrosting the second heat exchanger 12 after frosting occurs on the second heat exchanger 12.

[0336] Thus, in the present embodiment, power con-

sumption can be prevented when preventing frosting in the exhaust unit group or when performing defrosting.

[0337] In the above-described embodiments and modified examples, an example has been described in which the air supply unit is a casing (an example of the first casing) that houses at least a part of the first heat exchanger 22 and the air flow path (an example of the first air flow path), and the exhaust unit is a casing (an example of the second casing) that houses at least a part of the second heat exchanger 12 and the air flow path (an example of the second air flow path), so that the units are separated by casings.

[0338] Thus, the exhaust unit and the air supply unit can be arranged at positions away from each other. Thus, the degree of freedom of arrangement of the ventilation apparatus capable of recovering heat can be increased compared with the conventional technology.

[0339] However, the above-described embodiments and modified examples are not limited to the example where the casings of the air supply unit and the exhaust unit are separated, and the air supply unit and the exhaust unit may be integrated. That is, when the first heat exchanger 22 and the second heat exchanger 12 are connected by a refrigerant circuit, and the fan 21 corresponding to the first heat exchanger 22 and the fan corresponding to the second heat exchanger 12 are provided, the air volume adjustment and the temperature adjustment of the refrigerant as described in the above-described embodiments and modified examples may be applied. As described above, the method illustrated in the above-described embodiments and modified examples may be applied when the air supply unit and the exhaust unit are integrated.

(Overview of the ventilation system)

[0340] In the air conditioning system, by starting the compressor and using the first heat exchanger of the air supply unit as the condenser and using the second heat exchanger of the exhaust unit as the evaporator, the heat of the exhaust air (indoor air) can be recovered to the refrigerant in the refrigerant circuit while the indoor air can be ventilated. In an air conditioning system, when a second heat exchanger into which the exhaust air flows is used as an evaporator, frosting occurs in the second heat exchanger when the temperature of the exhaust air (indoor air) is lower than a predetermined value, and the low pressure of the refrigerant circuit is lowered. In this case, it becomes difficult to cause the started compressor to operate continuously.

[0341] In the following embodiment, a ventilation system with a refrigerant circuit enables reliable continuous operation of the compressor when a heat exchanger is used as an evaporator.

[0342] FIG. 14 is a schematic configuration diagram of the ventilation system of the present disclosure. FIG. 15 is a control block diagram of the ventilation system of the present disclosure. In the following description, a venti-

lation system 1E according to the thirteenth embodiment (see FIG. 17) is referred to as the thirteenth ventilation system 1F, a ventilation system 1E according to the fourteenth embodiment (see FIG. 18 and FIG. 19) is referred to as the fourteenth ventilation system 1G, a ventilation system 1E according to the fifteenth embodiment (see FIG. 20) is referred to as the fifteenth ventilation system 1H, a ventilation system 1E according to the sixteenth embodiment (see FIG. 21) is referred to as the sixteenth ventilation system 1I, a ventilation system 1E according to the seventeenth embodiment (see FIG. 22) is referred to as the seventeenth ventilation system 1J, and a ventilation system 1E according to the eighteenth embodiment (see FIG. 23) is referred to as the eighteenth ventilation system 1K. In the following description, when the term "ventilation system 1E" is simply used, the common configuration among the thirteenth to eighteenth ventilation systems 1F to 1K is described.

[0343] The ventilation system 1E illustrated in FIG. 14 is an embodiment of the ventilation apparatus of the present disclosure and is installed in a building, such as a factory, to implement ventilation of a target space in the building. The ventilation system 1E includes an air supply unit 1020, an exhaust unit 1030, a compressor unit 1040, and a refrigerant circuit 1050.

[0344] As illustrated in FIG. 14, the air supply unit 1020 includes a first casing 1021, an air supply fan 1022, and a first heat exchanger 1023. The first casing 1021 of the present embodiment is a cube-shaped box body composed of panel members having thermal insulation properties, and an intake port 1024 and a blowout port 1025 are formed on the side surfaces. The air supply fan 1022 and the first heat exchanger 1023 are arranged in the first casing 1021. When the air supply fan 1022 is driven, the air supply unit 1020 takes the air (outside air OA) of the outdoor (hereinafter referred to as outdoors 1000S2, see FIGS. 17 and 19) into the first casing 1021, causes the taken in air to exchange heat with the refrigerant in the first heat exchanger 1023, and then supplies the air (air supply SA) from the blowout port 1025 to the indoor (hereinafter referred to as indoors 1000S1, see FIGS. 17 and 19). The ventilation system 1E has an air supply flow path P1001 (an example of the first air flow path) for supplying the taken in outside air OA from the blowout port 1025 to the indoors 1000S1 through the first casing 1021.

[0345] The first heat exchanger 1023 configures a refrigerant circuit 1050 which will be described later. The first heat exchanger 1023 is a crossfin tube type or a microchannel type heat exchanger, and is used to cause the refrigerant flowing in the first heat exchanger 1023 to perform heat exchange with the air (outside air OA) of the outdoors 1000S2.

[0346] The air supply unit 1020 includes an air supply temperature sensor 1026 and an outside air temperature sensor 1027. The air supply temperature sensor 1026 is arranged in the air flow that has passed through the first heat exchanger 1023 in the first casing 1021, and detects the temperature T1 (hereinafter referred to as the blowout

air temperature T1) of the air supply SA. The outside air temperature sensor 1027 is arranged in the air flow before passing through the first heat exchanger 1023 in the first casing 1021, and detects the temperature T2 (hereinafter referred to as the outside air temperature T2) of the outside air OA.

[0347] The air supply unit 1020 includes a first heat exchange temperature sensor 1055 and a first refrigerant temperature sensor 1056. The first heat exchange temperature sensor 1055 detects the temperature Tb1 of the first heat exchanger 1023 (that is, the refrigerant in the first heat exchanger 1023). The first refrigerant temperature sensor 1056 detects the temperature Ta2 of the refrigerant after passing through the first heat exchanger 1023 (outlet). The first heat exchange temperature sensor 1055 may be a pressure sensor for detecting the pressure in the first heat exchanger 1023, and in this case, the refrigerant temperature in the first heat exchanger 1023 is converted from the detected pressure value.

[0348] The exhaust unit 1030 includes a second casing 1031, an exhaust fan 1032, and a second heat exchanger 1033. The second casing 1031 of the present embodiment is a cube-shaped box body composed of panel members having thermal insulation properties, and an intake port 1034 and a blowout port 1035 are formed on the side surfaces. The exhaust fan 1032 and the second heat exchanger 1033 are arranged in the second casing 1031. When the exhaust fan 1032 is driven, the exhaust unit 1030 takes the air (return air RA) of the indoors 1000S1 into the second casing 1031, causes the taken in air to exchange heat with the refrigerant in the second heat exchanger 1033, and then releases the air (exhaust air EA) from the blowout port 1035 to the outdoors 1000S2. The ventilation system 1E has a return air flow path P1002 (an example of the second air flow path) for releasing the air (return air RA) of the indoors 1000S1 from the blowout port 1035 to the outdoors 1000S2 through the second casing 1031.

[0349] The second heat exchanger 1033 constitutes a refrigerant circuit 1050 which will be described later. The second heat exchanger 1033 is a crossfin tube type or a microchannel type heat exchanger and is used for heat exchange of a refrigerant flowing in the second heat exchanger 1033 with air (return air RA) of the indoors 1000S1.

[0350] The exhaust unit 1030 includes a return air temperature sensor 1036. The return air temperature sensor 1036 is arranged in the air flow before passing through the second heat exchanger 1033 in the second casing 1031, and detects the temperature T3 of the air flowing into the second heat exchanger 1033. In the following description, this temperature T3 is referred to as the intake air temperature T3. In the present disclosure, the intake air temperature T3 in the case where only the air taken in from the indoors 1000S1 passes through the second heat exchanger 1033 is the temperature of the air in the indoors 1000S1. The temperature in the indoors 1000S1 may be detected by a sensor (not illustrated)

provided in the indoors 1000S1.

[0351] The exhaust unit 1030 includes a second heat exchanger temperature sensor 1057 and a second refrigerant temperature sensor 1058. The second heat exchanger temperature sensor 1057 detects the temperature Tb2 (that is, the refrigerant in the second heat exchanger 1033) of the second heat exchanger 1033. The second refrigerant temperature sensor 1058 detects the temperature Tb3 of the refrigerant after passing through the second heat exchanger 1033 (outlet). The second heat exchange temperature sensor 1057 may be a pressure sensor for detecting the pressure in the second heat exchanger 1033, and in this case, the refrigerant temperature in the first heat exchanger 1023 is converted from the pressure detection value.

[0352] The compressor unit 1040 includes a third casing 1041, a compressor 1042, a four-way switching valve 1043, and an expansion valve 1044. The compressor unit 1040 of the present embodiment includes a third casing 1041, but the third casing 1041 may be omitted. In this case, the compressor 1042 and the four-way switch valve 1043 are preferably housed in the first casing 1021 of the air supply unit 1020 or the second casing 1031 of the exhaust unit 1030. Although the ventilation system 1E of the present embodiment houses the expansion valve 1044 in the compressor unit 1040, the expansion valve 1044 may be housed in the first casing 1021 of the air supply unit 1020 or the second casing 1031 of the exhaust unit 1030.

[0353] The compressor unit 1040 includes a low pressure sensor 1052, a discharge pressure sensor 1053, and a discharge temperature sensor 1054. The low pressure sensor 1052 detects the pressure PL of the refrigerant taken into the compressor 1042. In the following description, this pressure PL is also referred to as the low pressure PL. The discharge pressure sensor 1053 detects the pressure PH of the refrigerant discharged from the compressor 1042. In the following description, this pressure PH is also referred to as the high-pressure pressure PH. The discharge temperature sensor 1054 detects the temperature Ta1 of the refrigerant discharged from the compressor 1042.

[0354] The compressor 1042 takes in the low pressure gaseous refrigerant and discharges the high-pressure gaseous refrigerant. The compressor 1042 includes a motor that can adjust the operating speed by inverter control. The compressor 1042 is a variable capacity type (variable performance type) that can change the capacity (performance) by inverter control of the motor. However, the compressor 1042 may be a constant capacity type. The compressor 1042 used in the ventilation system 1E of the present disclosure may be configured by connecting two or more compressors in parallel.

[0355] The four-way switch valve 1043 inverts the flow of refrigerant in the refrigerant pipe and supplies refrigerant discharged from the compressor 1042 to one of the first heat exchanger 1023 and the second heat exchanger 1033. Thus, the ventilation system 1E can switch be-

tween a cooling operation mode (hereinafter also referred to as the first operation mode M1) for cooling the outside air OA and a heating operation mode (hereinafter also referred to as the second operation mode M2) for heating the outside air OA. The expansion valve 1044 is composed of an electric valve capable of adjusting the flow rate and pressure of the refrigerant. In the ventilation system 1E, the opening degree of the expansion valve 1044 is controlled to adjust the pressure of the refrigerant supplied to the first heat exchanger 1023 or the second heat exchanger 1033.

[0356] The refrigerant circuit 1050 includes a compressor 1042, a four-way switching valve 1043, an expansion valve 1044, a first heat exchanger 1023, a second heat exchanger 1033, and a refrigerant pipe 1051 (a liquid pipe 1051L and a gas pipe 1051G) connecting these elements. The refrigerant circuit 1050 circulates the refrigerant between the first heat exchanger 1023 and the second heat exchanger 1033.

[0357] In the ventilation system 1E having the above configuration, when the outside air OA is cooled by the air supply unit 1020 and is supplied (in the first operation mode M1), the four-way switch valve 1043 is held in the state illustrated by a solid line in FIG. 14. The high-temperature and high-pressure gaseous refrigerant discharged from the compressor 1042 flows into the second heat exchanger 1033 of the exhaust unit 1030 through the four-way switch valve 1043. At this time, the second heat exchanger 1033 functions as a condenser, and the refrigerant flowing through the second heat exchanger 1033 is condensed and liquefied by heat exchange with the return air RA by the operation of the exhaust fan 1032. The liquefied refrigerant is decompressed by the expansion valve 1044 and flows into the first heat exchanger 1023. At this time, the first heat exchanger 1023 functions as an evaporator, and in the first heat exchanger 1023, the refrigerant evaporates by exchanging heat with the outside air OA. The outside air OA cooled by the evaporation of the refrigerant is supplied to the indoors 1000S1 as the supply air SA by the air supply fan 1022. The refrigerant evaporated in the first heat exchanger 1023 returns to the compressor unit 1040 through the refrigerant pipe 1051 (the gas pipe 1051G) and is taken into the compressor 1042 through the four-way switch valve 1043.

[0358] In the ventilation system 1E having the above configuration, when the outside air OA is heated by the air supply unit 1020 and is supplied (in the second operation mode M2), the four-way switch valve 1043 is held in the state indicated by a dashed line in FIG. 14. The high-temperature and high-pressure gaseous refrigerant discharged from the compressor 1042 passes through the four-way switch valve 1043 and flows into the first heat exchanger 1023 of the air supply unit 1020. At this time, the first heat exchanger 1023 functions as a condenser, and in the first heat exchanger 1023, the refrigerant is condensed and liquefied by exchanging heat with the outside air OA. The outside air OA heated by the

condensation of the refrigerant is supplied to the indoors 1000S1 by an air supply fan 1022. The refrigerant liquefied in the first heat exchanger 1023 passes through the refrigerant pipe 1051 (liquid pipe 1051L) to the compressor unit 1040, is decompressed to a predetermined low pressure by an expansion valve 1044, and flows into the second heat exchanger 1033. At this time, the second heat exchanger 1033 functions as an evaporator, and in the second heat exchanger 1033, the refrigerant evaporates by exchanging heat with the return air RA. The refrigerant evaporated and vaporized in the second heat exchanger 1033 is taken into the compressor 1042 through the four-way switch valve 1043.

(Control unit)

[0359] FIG. 15 is a control block diagram of the ventilation system 1E. As illustrated in FIG. 15, the ventilation system 1E has a control unit 1018. The control unit 1018 is a device for controlling the operation of the ventilation system 1E, and is composed of, for example, a micro-computer equipped with a processor such as a CPU, and a memory such as a RAM, a ROM, etc. The control unit 1018 may be implemented as hardware using an LSI, an ASIC, an FPGA, or the like. The control unit 1018 performs a predetermined function by the processor executing a program installed in the memory.

[0360] The control unit 1018 is connected to an air supply fan 1022, an exhaust fan 1032, a compressor 1042, a four-way switching valve 1043, and an expansion valve 1044. The control unit 1018 is connected to an air supply temperature sensor 1026, an outside air temperature sensor 1027, a return air temperature sensor 1036, a low pressure sensor 1052, a discharge pressure sensor 1053, an discharge temperature sensor 1054, a first heat exchange temperature sensor 1055, a first refrigerant temperature sensor 1056, a second heat exchange temperature sensor 1057, and a second refrigerant temperature sensor 1058. The control unit 1018 controls the operation of the air supply fan 1022, the exhaust fan 1032, the compressor 1042, the four-way switching valve 1043, the expansion valve 1044, and the low pressure raising means 1080 based on the detected values of the sensors.

[0361] During operation in the second operation mode M2, the control unit 1018 calculates the saturation temperature TS of the second heat exchanger 1033 functioning as an evaporator based on the detected value (high-pressure pressure PH) of the discharge pressure sensor 1053. The control unit 1018 obtains the low pressure PL of the refrigerant circuit 1050 from the detected value of the low pressure sensor 1052. The control unit 1018 obtains the evaporation temperature TE of the second heat exchanger 1033 from the detected value (temperature Tb2) of the second heat exchange temperature sensor 1057. Alternatively, the control unit 1018 obtains the evaporation temperature TE of the second heat exchanger 1033 from the acquired low pressure PL.

[0362] As described above, the ventilation system 1E of the present disclosure has a first operation mode M1 and a second operation mode M2 as operation modes selectable by the user. When the user selects the first operation mode M1 and starts the operation of the ventilation system 1E, the control unit 1018 switches the four-way switch valve 1043 so that the first heat exchanger 1023 can be used as an evaporator and the second heat exchanger 1033 can be used as a condenser. When the user selects the second operation mode M2 and starts the operation of the ventilation system 1E, the control unit 1018 switches the four-way switch valve 1043 so that the first heat exchanger 1023 can be used as a condenser and the second heat exchanger 1033 can be used as an evaporator. In this description, "when the user selects the second operation mode M2 and starts the operation of the ventilation system 1E" includes a case where the switching of the four-way switch valve 1043 has already been completed and a case where the switching of the four-way switch valve 1043 has not yet been completed.

[0363] When the ventilation system 1E of the present disclosure is started upon selecting the second operation mode M2, the control unit 1018 may execute low pressure raising control (first control). In the following description, the operation mode of the ventilation system 1E when the control unit 1018 executes low pressure raising control is referred to as low pressure raising mode M3. When the user selects the second operation mode M2 and the operation of the ventilation system 1E is started, the control unit 1018 starts the compressor 1042 and detects the low pressure PL of the refrigerant circuit 1050 or the evaporation temperature TE of the second heat exchanger 1033. When the control unit 1018 determines that the low pressure PL or the evaporation temperature TE has fallen below the threshold (in this description, referred to as the first threshold) set for each of these values, the operation mode of the ventilation system 1E is switched to the low pressure raising mode M3, and the low pressure raising control is executed. When the control unit 1018 does not determine that the low pressure PL or the evaporation temperature TE has fallen below the first threshold, the operation mode of the ventilation system 1E is not switched to the low pressure raising mode M3 (the low pressure raising control is not executed).

[0364] When operating in the second operation mode M2, the ventilation system 1E having the refrigerant circuit 1050 can recover the heat of the exhaust air EA to the refrigerant in the refrigerant circuit 1050 by using the first heat exchanger 1023 as a condenser and the second heat exchanger 1033 as an evaporator. In the ventilation system 1E in this case, when the temperature of the exhaust air EA becomes low, frosting may occur in the second heat exchanger 1033, and in this case, the low pressure PL of the refrigerant circuit 1050 decreases, making it difficult to continue the operation of the compressor 1042. In such a case, the control unit 1018 selects the low pressure raising mode M3 to enable the continued

operation of the compressor 1042. The term "continued operation of the compressor" here means that the operation can be continued without reaching a state where the operation cannot be continued (must be stopped) due to a decrease in the low pressure of the refrigerant circuit or the like after the start of the compressor.

[0365] When the ventilation system 1E is started upon selecting the second operation mode M2, the control unit 1018 stores a first threshold X for determining whether the conditions under which the second operation mode M2 can operate are satisfied. In the ventilation system 1E of the present disclosure, as the first threshold X, a pressure threshold X1, which is the first threshold X for the low pressure PL of the refrigerant circuit 1050, a refrigerant temperature threshold X2, which is the first threshold X for the evaporation temperature TE of the second heat exchanger 1033, an indoor temperature threshold X3, which is the first threshold X for the intake air temperature T3 which is the temperature of the air in the indoors 1000S1, and an outside air temperature threshold X4, which is the first threshold X for the outside air temperature T2 which is the temperature of the air in the outdoors 1000S2, are stored. While the control unit 1018 of the present embodiment stores the pressure threshold X1, the refrigerant temperature threshold X2, the indoor temperature threshold X3, and the outdoor temperature threshold X4 as the first threshold X, the ventilation system 1E of the present disclosure may store any one of the respective thresholds X1 to X4 in the control unit 1018.

[0366] The control unit 1018 stores a second threshold Y for determining whether conditions enabling operation by the second operation mode M2 are satisfied when the control unit 1018 executes low pressure raising control (that is, when ventilation system 1E is operated in low pressure raising mode M3). In the ventilation system 1E of the present disclosure, as the second threshold Y, a pressure threshold Y1 which is the second threshold Y for the low pressure PL of the refrigerant circuit 1050, a saturation temperature threshold Y2 which is the second threshold Y for the saturation temperature TS of the second heat exchanger 1033, and an air temperature threshold Y3 which is the second threshold Y for the intake air temperature T3 of the second heat exchanger 1033 are stored. Although the control unit 1018 of the present embodiment stores the pressure threshold Y1, the saturation temperature threshold Y2, and the air temperature threshold Y3 as the second threshold Y, the ventilation system 1E of the present disclosure may store at least one of the pressure threshold Y1, the saturation temperature threshold Y2, or the air temperature threshold Y3 in the control unit 1018.

(Control at the start of operation of the ventilation system)

[0367] In the ventilation system 1E, the control unit 1018 controls the operation at the start of operation according to the flow illustrated in FIG. 16.

[0368] As illustrated in FIG. 16, when the operation of the ventilation system 1E is started, the control unit 1018 first determines whether the operation has been started upon selecting the second operation mode M2 (S2501). If, in step S2501, the control unit 1018 determines that the operation has been started upon selecting the second operation mode M2 (YES), the next step (S2502) is executed. If, in step S2501, the control unit 1018 determines that the operation has not been started upon selecting the second operation mode M2 (NO), the control unit 1018 ends the control at the start of operation. In step S2502, the control unit 1018 starts the compressor 1042 and proceeds to the next step (S2503).

[0369] In step S2503, the control unit 1018 makes a determination with respect to the low pressure PL of the refrigerant circuit 1050. In step S2503, when the control unit 1018 determines that the low pressure PL is not below the first threshold X (pressure threshold X1) for the low pressure PL (NO), the next step S2504 is executed. In step S2503, when the control unit 1018 determines that the low pressure PL is below the first threshold X (pressure threshold X1) (YES), the next step S2507 is executed.

[0370] In step S2504, the control unit 1018 makes a determination with respect to the evaporation temperature TE of the second heat exchanger 1033. In step S2504, when the control unit 1018 determines that the evaporation temperature TE is not lower than the first threshold X (refrigerant temperature threshold X2) for the evaporation temperature TE (NO), the next step S2505 is executed. In step S2504, when the control unit 1018 determines that the evaporation temperature TE is lower than the first threshold X (refrigerant temperature threshold X2) (YES), the next step S2507 is executed.

[0371] In step S2505, the control unit 1018 makes a determination with respect to the intake air temperature T3, which is the air temperature of the indoors 1000S1. In step S2505, when the control unit 1018 determines that the intake air temperature T3 is not lower than the first threshold X (indoor temperature threshold X3) for the intake air temperature T3 (NO), the next step S2506 is executed. In step S2505, when the control unit 1018 determines that the intake air temperature T3 is lower than the first threshold X (indoor temperature threshold X3) (YES), the next step S2507 is executed.

[0372] In step S2506, the control unit 1018 makes a determination with respect to the outside air temperature T2, which is the air temperature of the outdoors 1000S2. In step S2506, when the control unit 1018 determines that the outside air temperature T2 is not lower than the first threshold X (outside air temperature threshold X4) for the outside air temperature T2 (NO), the next step S2512 is executed. In step S2506, when the control unit 1018 determines that the outside air temperature T2 is lower than the first threshold X (outside air temperature

threshold X4) (YES), the next step S2507 is executed.

[0373] In step S2507, the control unit 1018 executes low pressure raising control. Specifically, in step S2507, the control unit 1018 switches the operation mode of the ventilation system 1E to a low pressure raising mode M3 to operate the ventilation system 1E. When the control unit 1018 executes low pressure raising control, the ventilation system 1E uses the low pressure raising means 1080, which will be described later. The control unit 1018 executes a further step (S2508) after starting execution of the low pressure raising control.

[0374] In the step (S2508), the control unit 1018 makes a determination with respect to the low pressure PL of the refrigerant circuit 1050 during execution of the low pressure raising control. In step S2508, if the control unit 1018 determines that the low pressure PL does not exceed the second threshold Y (pressure threshold Y1) for the low pressure PL (NO), step S2509 is executed. In step S2508, if the control unit 1018 determines that the low pressure PL exceeds the pressure threshold Y1 (YES), step S2511 is executed.

[0375] In step S2509, the control unit 1018 makes a determination with respect to the saturation temperature TS of the second heat exchanger 1033. If it is determined in step S2509 that the saturation temperature TS does not exceed the second threshold Y (saturation temperature threshold Y2) for the saturation temperature TS (NO), step S2510 is executed. If it is determined in step S2509 that the saturation temperature TS exceeds the saturation temperature threshold Y2 (YES), step S2511 is executed.

[0376] In step S2510, the control unit 1018 makes a determination with respect to the intake air temperature T3 of the second heat exchanger 1033. When it is determined in step S2510 that the intake air temperature T3 does not exceed the second threshold Y (air temperature threshold Y3) for the intake air temperature T3 (NO), the process returns to step S2508. When it is determined in step S2510 that the intake air temperature T3 exceeds the air temperature threshold Y3 (YES), the control unit 1018 executes step S2511.

[0377] In step S2511, the control unit 1018 ends the low pressure raising control. After ending the low pressure raising control, the control unit 1018 executes step S2512. In step S2512, the control unit 1018 switches the operation mode of the ventilation system 1E to the second operation mode M2 to operate the ventilation system 1E. Accordingly, the control unit 1018 ends the operation control at the start of the operation (flow illustrated in FIG. 16).

[0378] The determination conditions in each step (S2508) to (S2510) are conditions for determining whether the compressor 1042 can be reliably continuously operated in the second operation mode M2. That is, if any of the conditions are satisfied in the steps (S2508) to (S2510), conditions are satisfied to ensure continuous operation of the compressor 1042 in the second operation mode M2. By executing the low pressure raising con-

trol (first control), the ventilation system 1E can satisfy conditions to ensure continuous operation of the compressor 1042. The ventilation system 1E can ensure continuous operation of the compressor 1042 by starting operation in the second operation mode M2 after satisfying conditions to ensure continuous operation of the compressor 1042. In the present disclosure, whether to proceed to the step (S2507) is determined based on the determination with respect to the low pressure PL in the step (S2503), the determination with respect to the evaporation temperature TE in the step (S2504), the determination with respect to the intake air temperature T3 in the step (S2505), and the determination with respect to the outside air temperature T2 in the step (S2506); however, whether to proceed to the step (S2507) may be determined based on only one of the steps (S2503) to (S2506). In the present disclosure, whether to proceed to the step (S2511) is determined based on the determination with respect to the low pressure PL in the step (S2508), the determination with respect to the saturation temperature TS in the step (S2509), and the determination with respect to the intake air temperature T3 in the step (S2510); however, whether to proceed to the step (S2511) may be determined based on only one of the steps (S2508) to (S2510).

(Detailed embodiment of ventilation system)

[0379] As illustrated in FIG. 15, the ventilation system 1E of the present disclosure includes a low pressure raising means 1080. The first to sixth ventilation systems 1F to 1K described below have different configurations of the low pressure raising means 1080. When the ventilation system 1E is started upon selecting the second operation mode M2, the low pressure raising means 1080 is used during execution of the above-described low pressure raising control (see FIG. 16). In the following description, the common parts of the first to sixth ventilation systems 1F to 1K are denoted by the same reference numerals, and with respect to the parts denoted by the same reference numerals, repetitive descriptions will be omitted.

(Thirteenth ventilation system 1F)

[0380] FIG. 17 illustrates a thirteenth ventilation system 1F according to a thirteenth embodiment of the ventilation system 1E of the present disclosure. The thirteenth ventilation system 1F illustrated in FIG. 17 includes an air supply unit 1020, an exhaust unit 1030, and a compressor unit 1040. In the thirteenth ventilation system 1F, the air supply unit 1020, the exhaust unit 1030, and the compressor unit 1040 are integrally configured. Although the thirteenth ventilation system 1F described in the present embodiment includes the air supply unit 1020, the exhaust unit 1030, and the compressor unit 1040 configured integrally, in the ventilation system 1E of the present disclosure, air supply unit 1020 (the first

heat exchanger 1023 and the air supply fan 1022), the exhaust unit 1030 (the second heat exchanger 1033 and the exhaust fan 1032), and the compressor unit 1040 (the compressor 1042) may be arranged separately.

[0381] The thirteenth ventilation system 1F may be arranged outdoors 1000S2, for example. In the thirteenth ventilation system 1F illustrated in FIG. 17, the blowout port 1025 of the air supply unit 1020 and the intake port 1034 of the exhaust unit 1030 are directly attached to the outer wall surface of the building 1000B. Although the present embodiment illustrates a case where the thirteenth ventilation system 1F is arranged in the outdoors 1000S2, the thirteenth ventilation system 1F may be arranged entirely or partially in the indoors 1000S1.

[0382] As illustrated in FIG. 17, the thirteenth ventilation system 1F includes an air conditioner 1081 which is the first low pressure raising means 1080. The air conditioner 1081 includes a refrigerant circuit 1081d including an indoor unit 1081a, an outdoor unit 1081b, and a refrigerant pipe 1081c.

(Air conditioner)

[0383] The air conditioner 1081 is installed in a building 1000B to implement air conditioning of the air conditioning target space (indoors 1000S1). The air conditioner 1081 heats and cools the air conditioning target space by performing a steam compression type refrigeration cycle operation. Although the present embodiment illustrates the air conditioner 1081 performing steam compression type refrigeration cycle operation, the system of the air conditioner as the low pressure raising means 1080 is not limited to this, and may be an air conditioner which implements air conditioning of the target space by, for example, cold and hot water supplied from a heat source device.

[0384] In the air conditioner 1081, the indoor unit 1081a is arranged indoors 1000S1 and the outdoor unit 1081b is arranged outdoors 1000S2. The indoor unit 1081a and the outdoor unit 1081b are connected by a refrigerant pipe 1081c. The air conditioner 1081 has a refrigerant circuit 1081d for air conditioning. The refrigerant circuit 1081d for air conditioning includes a compressor, a four-way switching valve, an outdoor heat exchanger, an expansion valve, an indoor heat exchanger, and the like (none of which are illustrated). The refrigerant circuit 1081d for air conditioning circulates the refrigerant between the indoor unit 1081a and the outdoor unit 1081b through the refrigerant pipe 1081c. The refrigerant circuit 1081d for air conditioning is separated from the refrigerant circuit 1050 of the thirteenth ventilation system 1F and constitutes an independent circuit. The air conditioner 1081 detects the temperature of the indoors 1000S1.

[0385] In the thirteenth ventilation system 1F, the temperature of the indoors 1000S1 is increased by operating the air conditioner 1081 when the low pressure raising control is executed. In the thirteenth ventilation system 1F, when the control unit 1018 determines that the tem-

perature of the air in the indoors 1000S1 detected by the air conditioner 1081 exceeds the second threshold Y (air temperature threshold Y3 for intake air temperature T3) (see FIG. 15), the operation of the exhaust fan 1032 is started. In the thirteenth ventilation system 1F, this causes the second heat exchanger 1033 to take in air having a temperature higher than the air temperature threshold Y3 for the intake air temperature T3. In the thirteenth ventilation system 1F, the frosting in the second heat exchanger 1033 is prevented by operating the air conditioner 1081. In the thirteenth ventilation system 1F, the intake air temperature T3 of the second heat exchanger 1033 functioning as an evaporator can be increased by the air conditioner 1081, thereby preventing the frosting in the second heat exchanger 1033 and preventing the lowering of the low pressure PL of the refrigerant circuit 1050.

[0386] In the thirteenth ventilation system 1F, when the second operation mode M2 is selected and the air conditioner 1081 is started, the control unit 1018 may forcibly start the air conditioner 1081. In the thirteenth ventilation system 1F, when the second operation mode M2 is selected and the air conditioner 1081 is started, the control unit 1018 may provide information urging the user to start the air conditioner 1081 and the user may start the air conditioner 1081. When the thirteenth ventilation system 1F and the air conditioner 1081 are not in coordination, after the control unit 1018 provides information urging the user to start the air conditioner 1081, the exhaust fan 1032 may be operated to measure the intake air temperature T3 after a predetermined time, and the control unit 1018 may start the air conditioner 1081 based on the measured value. In the thirteenth ventilation system 1F, the control unit 1018 may be configured to detect the operation state of the air conditioner 1081, and when the control unit 1018 detects that the air conditioner 1081 is in operation when the second operation mode M2 is selected and the air conditioner 1081 is started, the control unit 1018 may execute low pressure raising control.

[0387] In the thirteenth ventilation system 1F, when the low pressure raising control is finished, the control unit 1018 may stop the air conditioner 1081, or the control unit 1018 may continue the operation of the air conditioner 1081.

(Fourteenth ventilation system 1G)

[0388] FIG. 18 is a schematic configuration diagram of a ventilation system according to a fourteenth embodiment of the present disclosure. FIG. 19 is a schematic configuration diagram illustrating a state of installation of a ventilation system according to fourteenth and fifteenth embodiments of the present disclosure in a building. The fourteenth ventilation system 1G illustrated in FIGS. 18 and 19 is a fourteenth embodiment of the ventilation system 1E of the present disclosure. The fourteenth ventilation system 1G differs from the thirteenth ventilation system 1F in that the fourteenth ventilation system 1G

includes a second low pressure raising means 1082 which is a second low pressure raising means 1080.

[0389] As illustrated in FIG. 18, the fourteenth ventilation system 1G includes a second low pressure raising means 1082. The second low pressure raising means 1082 includes a bypass pipe 1082a and a valve 1082b. The valve 1082b is, for example, a motor-driven valve, a solenoid valve, or the like. The bypass pipe 1082a bypasses the discharge pipe 45 of the compressor 1042 and the liquid pipe 1051L. The bypass pipe 1082a can supply high temperature and high pressure gaseous refrigerant discharged from the compressor 1042 to the second heat exchanger 1033 through the liquid pipe 1051L. The valve 1082b can switch the flow of refrigerant in the bypass pipe 1082a. When the valve 1082b is opened, the gaseous refrigerant can flow into the bypass pipe 1082a, and when the valve 1082b is closed, the flow of the gaseous refrigerant in the bypass pipe 1082a can be stopped.

[0390] The fourteenth ventilation system 1G raises the temperature of the refrigerant flowing through the second heat exchanger 1033 by supplying the gaseous refrigerant to the second heat exchanger 1033 through the bypass pipe 1082a with the valve 1082b open, thereby preventing frosting in the second heat exchanger 1033. In the fourteenth ventilation system 1G, the saturation temperature TS at the outlet of the second heat exchanger 1033 functioning as an evaporator can be increased by the second low pressure raising means 1082, thereby preventing frosting in the second heat exchanger 1033 and preventing lowering of the low pressure PL of the refrigerant circuit 1050.

[0391] In the fourteenth ventilation system 1G, the control unit 1018 closes the valve 1082b to end the low pressure raising control.

(Fifteenth ventilation system 1H)

[0392] FIG. 20 is a schematic configuration diagram of a ventilation system according to a fifteenth embodiment of the present disclosure. The fifteenth ventilation system 1H illustrated in FIGS. 19 and 20 is a fifteenth embodiment of the ventilation system 1E of the present disclosure. As illustrated in FIG. 20, the fifteenth ventilation system 1H differs from the thirteenth and fourteenth ventilation systems 1F and 1G in that the fifteenth ventilation system 1H includes a third low pressure raising means 1083, which is a third low pressure raising means 1080.

[0393] The fifteenth ventilation system 1H includes a third low pressure raising means 1083. The third low pressure raising means 1083 includes a bypass duct 1083a and a damper 1083b. The bypass duct 1083a is formed in the third casing 1041 and communicates with the discharge side of the first casing 1021 and the intake side of the second casing. The bypass duct 1083a can supply a part of the air flow (air supply SA) generated by the air supply unit 1020 to the intake side of the exhaust fan 1032 in the exhaust unit 1030. The damper 1083b

includes a valve and an opening/closing mechanism for opening/closing the flow of the air supply SA in the bypass duct 1083a. When the damper 1083b is opened, the supply air SA can flow in the bypass duct 1083a, and when the damper 1083b is closed, the flow of the supply air SA in the bypass duct 1083a can be stopped.

[0394] In the fifteenth ventilation system 1H, when the control unit 1018 determines that the blowout air temperature T1 detected by the supply air temperature sensor 1026 exceeds the second threshold Y (air temperature threshold Y3 for the intake air temperature T3) (see FIG. 15), the damper 1083b is opened. The fifteenth ventilation system 1H can raise the intake air temperature T3 of the second heat exchanger 1033 by supplying the supply air SA to the intake side of the second heat exchanger 1033 through the bypass duct 1083a while the damper 1083b is opened. In the fifteenth ventilation system 1H, the third low pressure raising means 1083 can raise the intake air temperature T3 of the second heat exchanger 1033 functioning as an evaporator, thereby preventing frosting in the second heat exchanger 1033 and preventing lowering of the low pressure PL of the refrigerant circuit 1050.

[0395] In the fifteenth ventilation system 1H, the control unit 1018 closes the damper 1083b to end the low pressure raising control.

(Sixteenth ventilation system 1I)

[0396] FIG. 21 is a schematic configuration diagram of a ventilation system according to the sixteenth embodiment of the present disclosure. The sixteenth ventilation system 1I illustrated in FIG. 21 is a sixteenth embodiment of the ventilation system 1E of the present disclosure. As illustrated in FIG. 21, the configuration of the low pressure raising means 1080 of the sixteenth ventilation system 1I differs from that of the thirteenth to fifteenth ventilation systems 1F to 1H. The sixteenth ventilation system 1I differs from the thirteenth to fifteenth ventilation systems 1F to 1H in that the air supply unit 1020, the exhaust unit 1030, and the compressor unit 1040 are respectively separated from each other and are arranged in the indoors 1000S1. In the sixteenth ventilation system 1I, the air supply unit 1020, the exhaust unit 1030, and the compressor unit 1040 are arranged in the space (hereinafter referred to as a ceiling space R2) behind the ceiling of the room R1, which is the space to be ventilated in the indoors 1000S1. Although the present embodiment illustrates the case where the sixteenth ventilation system 1I is arranged in the indoors 1000S1, the sixteenth ventilation system 1I may be arranged entirely or partially in the outdoors 1000S2.

[0397] In the sixteenth ventilation system 1I, the air supply unit 1020 forms a part of the air supply flow path 1028. The air supply flow path 1028 is an air flow path communicating with the indoors 1000S1 and the outdoors 1000S2. The air supply flow path 1028 includes a first air supply duct 1028a, a second air supply duct

1028b, and an air supply unit 1020. The first air supply duct 1028a connects the outdoors 1000S2 and the air supply unit 1020. Specifically, the first air supply duct 1028a has an intake port 1028c at one end, and the intake port 1028c is connected to an opening in the outer wall of the building 1000B and communicates with the outdoors 1000S2. The other end of the first air supply duct 1028a is connected to the air supply unit 1020. The second air supply duct 1028b connects the air supply unit 1020 to the indoors 1000S1. Specifically, the second air supply duct 1028b has a blowout port 1028d as one end, and the blowout port 1028d is connected to an opening on the ceiling surface of the indoors 1000S1 to communicate with the indoors 1000S1. The other end of the second air supply duct 1028b is connected to the air supply unit 1020.

[0398] In the sixteenth ventilation system 1I, the exhaust unit 1030 forms a part of the exhaust air flow path 1038. The exhaust air flow path 1038 is an air flow path communicating with the indoors 1000S1 and the outdoors 1000S2. The exhaust air flow path 1038 includes a first exhaust duct 1038a, a second exhaust duct 1038b, and an exhaust unit 1030. The first exhaust duct 1038a connects the outdoors 1000S2 and the exhaust unit 1030. Specifically, the first exhaust duct 1038a has an exhaust port 1038c at one end, and the exhaust port 1038c is connected to an opening in the outer wall of the building 1000B and communicates with the outdoors 1000S2. The other end of the first exhaust duct 1038a is connected to the exhaust unit 1030. The second exhaust duct 1038b connects the exhaust unit 1030 to the indoors 1000S1. Specifically, the second exhaust duct 1038b has an intake port 1038d at one end, and the intake port 1038d is connected to an opening on the ceiling surface of the indoors 1000S1 to communicate with the indoors 1000S1. The other end of the second exhaust duct 1038b is connected to the exhaust unit 1030.

[0399] The sixteenth ventilation system 1I includes a fourth low pressure raising means 1084. The fourth low pressure raising means 1084 includes a bypass duct 1084a and a damper 1084b. The bypass duct 1084a communicates with the second air supply duct 1028b connected to the blowout side of the air supply unit 1020 and the second exhaust duct 1038b connected to the intake side of the exhaust unit 1030. The bypass duct 1084a can supply a part of the air flow (supply air SA) generated by the air supply unit 1020 to the intake side of the exhaust fan 1032 in the exhaust unit 1030. The damper 1084b includes a valve and an opening/closing mechanism for opening/closing the flow of the supply air SA in the bypass duct 1084a. When the damper 1084b is opened, the supply air SA can flow in the bypass duct 1084a, and when the damper 1084b is closed, the flow of the supply air SA in the bypass duct 1084a can be stopped.

[0400] In the sixteenth ventilation system 1I, when the control unit 1018 determines that the blowout air temperature T1 detected by the supply air temperature sensor

1026 exceeds the second threshold Y (the air temperature threshold Y3 for the intake air temperature T3), the damper 1084b is opened. The sixteenth ventilation system 1I can raise the intake air temperature T3 of the second heat exchanger 1033 by supplying the supply air SA to the intake side of the second heat exchanger 1033 through the bypass duct 1084a while the damper 1084b is opened. In the sixteenth ventilation system 1I, the intake air temperature T3 of the second heat exchanger 1033 functioning as an evaporator can be raised by the fourth low pressure raising means 1084, thereby preventing frosting in the second heat exchanger 1033 and preventing lowering of the low pressure PL of the refrigerant circuit 1050.

[0401] In the sixteenth ventilation system 1I, the control unit 1018 closes the damper 1084b to end the low pressure raising control.

(Seventeenth ventilation system 1J)

[0402] FIG. 22 is a schematic configuration diagram of a ventilation system according to a seventeenth embodiment of the present disclosure. The seventeenth ventilation system 1J illustrated in FIG. 22 is a seventeenth embodiment of the ventilation system 1E of the present disclosure. As illustrated in FIG. 22, the configuration of the low pressure raising means 1080 of the seventeenth ventilation system 1J is different from that of the sixteenth ventilation system 1I. The seventeenth ventilation system 1J includes a fifth low pressure raising means 1085 which is a fifth low pressure raising means 1080.

[0403] The fifth low pressure raising means 1085 includes an intake duct 1085a, a damper 1085b, and a ceiling space temperature sensor 1085c. The intake duct 1085a is connected to the second exhaust duct 1038b and is opened in the ceiling space R2 so that air in the ceiling space R2 can be taken into the exhaust unit 1030 by driving the exhaust fan 1032. In the seventeenth ventilation system 1J, air in the ceiling space R2 taken into the exhaust unit 1030 can be passed into the second heat exchanger 1033. The damper 1085b is a valve for opening and closing the air flow in the intake duct 1085a. When the damper 1085b is opened, the air in the ceiling space R2 can be taken into the intake duct 1085a, and when the damper 1085b is closed, the air flow in the intake duct 1085a can be stopped.

[0404] In the seventeenth ventilation system 1J, the ceiling space temperature sensor 1085c is connected to the control unit 1018. The ceiling space temperature sensor 1085c can detect the temperature of the air in the ceiling space R2. In the seventeenth ventilation system 1J, when the control unit 1018 determines that the temperature T4 of the air in the ceiling space R2 has exceeded the second threshold Y (the air temperature threshold Y3 for the intake air temperature T3), the damper 1085b is opened and the air in the ceiling space R2 is passed to the second heat exchanger 1033 through the intake duct 1085a.

[0405] The seventeenth ventilation system 1J can raise the intake air temperature T3 of the second heat exchanger 1033 by supplying the air in the ceiling space R2 to the intake side of the second heat exchanger 1033 through the intake duct 1085a while the damper 1085b is opened. In the seventeenth ventilation system 1J, the intake air temperature T3 of the second heat exchanger 1033 functioning as an evaporator can be raised by the fifth low pressure raising means 1085, thereby preventing frosting in the second heat exchanger 1033 and preventing lowering of the low pressure PL of the refrigerant circuit 1050.

[0406] In the seventeenth ventilation system 1J, the control unit 1018 closes the damper 1085b, thereby ending the low pressure raising control.

(Eighteenth ventilation system 1K)

[0407] FIG. 23 is a schematic configuration diagram of a ventilation system according to an eighteenth embodiment of the present disclosure. The eighteenth ventilation system 1K illustrated in FIG. 23 is an eighteenth embodiment of the ventilation system 1E of the present disclosure. As illustrated in FIG. 23, the configuration of the low pressure raising means 1080 of the eighteenth ventilation system 1K is different from those of the sixteenth and seventeenth ventilation systems 1I and 1J.

[0408] The eighteenth ventilation system 1K includes a sixth low pressure raising means 1086 which is a sixth low pressure raising means 1080. The sixth low pressure raising means 1086 includes a louver 1086a which is turnably arranged around a rotation axis and a mechanism (not illustrated) for turning the louver 1086a. The louver 1086a is arranged in the vicinity of the blowout port 1028d in the indoors 1000S1. The louver 1086a is turnably configured between a housing position 1000P1 which does not change the blowout direction of the supply air SA blown out from the blowout port 1028d, and an operating position 1000P2 which changes the blowout direction of the supply air SA blown out from the blowout port 1028d.

[0409] In the eighteenth ventilation system 1K, when the control unit 1018 determines that the blowout air temperature T1 detected by the air supply temperature sensor 1026 has exceeded the second threshold Y (the air temperature threshold Y3 for the intake air temperature T3), the louver 1086a is rotated from the housing position 1000P1 to the operating position 1000P2. In the eighteenth ventilation system 1K, the blowout direction of the air supply SA blown out from the blowout port 1028d is changed by hitting the louver 1086a and flows toward the intake port 1038d. In the eighteenth ventilation system 1K, the intake air temperature T3 of the second heat exchanger 1033 is increased by actively taking in the air supply SA having a higher temperature than that of the indoor air 1000S1 through the intake port 1038d. In the eighteenth ventilation system 1K, the intake air temperature T3 of the second heat exchanger 1033 functioning

as an evaporator can be increased by the sixth low pressure raising means 1086, whereby frosting in the second heat exchanger 1033 can be prevented and lowering of the low pressure PL of the refrigerant circuit 1050 can be prevented.

[0410] In the eighteenth ventilation system 1K, the control unit 1018 changes the turning position of the louver 1086a from the operating position 1000P2 to the housing position 1000P1, thereby ending the low pressure raising control.

[Effects of the embodiments]

[0411]

(1) The ventilation system 1E illustrated in the above embodiment includes the compressor 1042, the first heat exchanger 1023, and the second heat exchanger 1033 connected by the refrigerant pipe 1051, the refrigerant circuit 1050 through which refrigerant flows, the air supply fan 1022 for supplying air from the outdoors 1000S2 to the indoors 1000S1 through the first heat exchanger 1023, the exhaust fan 1032 for exhausting air from the indoors 1000S1 to the outdoors 1000S2 through the second heat exchanger 1033, and the control unit 1018. When the second heat exchanger 1033 functions as an evaporator, the control unit 1018 starts the compressor 1042, and when it is determined that the low pressure PL of the refrigerant circuit 1050, or the evaporation temperature TE of the second heat exchanger 1033, or the temperature of the indoors 1000S1 (intake air temperature T3), or the temperature of the outdoors 1000S2 (outside air temperature T2) has fallen below the first threshold X for the low pressure PL of the refrigerant circuit 1050, or the evaporation temperature TE of the second heat exchanger 1033, or the intake air temperature T3, or the outside air temperature T2, the control unit performs low pressure raising control to raise the low pressure PL of the refrigerant circuit 1050.

According to the ventilation system 1E having such a configuration, when the second heat exchanger 1033 functions as an evaporator in the ventilation system provided with the refrigerant circuit 1050 capable of recovering heat from the exhaust air EA, the compressor 1042 can be reliably continuously operated.

(2) In the fourteenth ventilation system 1G illustrated in the above embodiment, the refrigerant circuit 1050 has the bypass pipe 1082a connecting the discharge pipe 45 of the compressor 1042 and the second heat exchanger 1033 or the liquid pipe 1051L connected to the second heat exchanger 1033, and the valve 1082b provided in the bypass pipe 1082a. In the fourteenth ventilation system 1G, the control unit 1018 opens the valve 1082b in the low pressure raising control (first control).

In this case, the gas refrigerant of high temperature and high pressure can be supplied to the second heat exchanger 1033 in the low pressure raising control. Thus, frosting in the second heat exchanger 1033 can be prevented.

(3) In the fourteenth ventilation system 1G illustrated in the above embodiment, when the valve 1082b is opened, the control unit 1018 closes the valve 1082b when the control unit 1018 determines that the low pressure PL of the refrigerant circuit 1050, the saturation temperature TS of the second heat exchanger 1033, or the intake air temperature T3 of the exhaust fan 1032 exceeds the second threshold Y for the low pressure PL of the refrigerant circuit 1050, the saturation temperature TS of the second heat exchanger 1033, or the intake air temperature T3 of the second heat exchanger 1033.

In this case, when conditions are satisfied for the second heat exchanger 1033 to function as an evaporator during the execution of the low pressure raising control, the low pressure raising control can be ended.

(4) In each ventilation system 1F, 1H to 1K illustrated in the above embodiments, the control unit 1018 causes the second heat exchanger 1033 to take in air at a temperature higher than the second threshold Y (air temperature threshold Y3) for the intake air temperature T3 in the low pressure raising mode M3 for performing the low pressure raising control.

In this case, air at a temperature higher than the second threshold Y (air temperature threshold Y3) can flow into the second heat exchanger 1033 during the execution of the low pressure raising control. Thus, frosting in the second heat exchanger 1033 can be prevented.

(5) In the eighteenth ventilation system 1K illustrated in the above embodiment, the control unit 1018 adjusts the blowout direction of the air supply fan 1022 so as to guide the air blown out from the air supply fan 1022 to the intake side of the exhaust fan 1032 in the low pressure raising mode M3 for performing the low pressure raising control.

In this case, air having a temperature higher than the second threshold Y (air temperature threshold Y3) for the intake air temperature T3 can flow into the second heat exchanger 1033 during the execution of the low pressure raising control.

(6) In the thirteenth ventilation system 1F illustrated in the above embodiment, an air conditioner 1081 for air conditioning the indoors 1000S1 is further provided, and the control unit 1018 drives the exhaust fan 1032 when the air temperature of the indoors 1000S1 becomes higher than the second threshold Y (air temperature threshold Y3) by the air conditioner 1081 in the low pressure raising mode M3 for performing the low pressure raising control.

In this case, air having a higher temperature than the second threshold Y (air temperature threshold

Y3) for the intake air temperature T3 can flow into the second heat exchanger 1033 during the execution of the low pressure raising control.

[0412] The above-described embodiments and modified examples illustrate a method for preventing frosting. The method illustrated in the above-described embodiments and modified examples is not limited to the use of the method alone, but may be used in combination with one or more methods described in other embodiments and modified examples.

[0413] According to the above-described embodiments and modified examples, by performing the above-described control, it is possible to prevent frosting (for example, with respect to the second heat exchanger) and to continue the ventilation operation by supplying air to an indoor space and exhausting air to the outdoors without stopping. The prevention of frosting is not limited to avoiding frosting, but means controlling such that frost does not grow even if frosting occurs. In a ventilation apparatus or ventilation system according to an embodiment and a modified example, it is possible to maintain the comfort of a living room space by controlling frosting and continuing the ventilation operation.

[0414] The number of air supply units and exhaust units described in the above-described embodiments and the modified examples is indicated as an example. The number of air supply units and the number of exhaust units may be determined according to the living room space. For example, the number of air supply units may be one or more, and the number of exhaust units may be one or more. Further, the control unit illustrated in the above-described embodiments and the modified examples is described as an embodiment, and may be included in any device.

[0415] Although the embodiments have been described above, it will be understood that various changes in form and details are possible without departing from the object and scope of the claims. Various modified examples and improvements such as combinations and substitutions with some or all of the other embodiments are possible.

[0416] The present international application is based upon and claims priority to Japanese patent application no. 2021-204798 filed on December 17, 2021 and Japanese patent application no. 2021-205609 filed on December 17, 2021, the entire contents of which are incorporated herein by reference.

Reference Signs List

[0417]

1, 1A, 1B, 1C, 1D_1, 1D_2, 1D_3 ventilation apparatus
2, 2C air conditioner
10, 110, 210, 310, 410A, 410B, 510A, 510B, 510C, 730 exhaust unit

11 fan
 12 second heat exchanger
 13, 113, 213, 313, 413A, 413B control unit
 14 temperature detecting unit
 15 driving motor
 16 electric valve
 20, 220A, 220B, 320A, 320B, 420A, 420B, 520A, 520B, 520C air supply unit
 21 fan
 22 first heat exchanger
 23, 423A, 423B control unit
 24 temperature detecting unit
 25 driving motor
 26 electric valve
 40 opening/closing damper
 50, 350, 450, 550A, 550B, 550C, 650 compressor unit
 51 driving motor
 52, 452 control unit
 53 compressor
 54 four-way valve
 55 electric valve
 56 bypass electric valve
 70, 470, 571, 572, 573 outdoor unit
 71, 471 control unit
 81, 82, 581, 582, 583, 584, 585, 586, 587, 588 air conditioning indoor unit
 400, 500, 600 upper-level control device
 601, 602 electric Valve
 732 third heat exchanger
 733 control unit
 F1, F2, F3, F4, F401, F402, F403, F404 refrigerant circuit
 F5, F501, F502, F503, F601, F602, F603 connection pipe
 F6 bypass flow path
 P1, P101 air supply flow path
 P2, P103 return air flow path
 P2A first return air branch path
 P2B second return air branch path
 P102 bypass flow path
 P201, P401 first air supply flow path
 P202, P402 second air supply flow path
 P203 return air flow path
 P403 first return air flow path
 P404 second return air flow path
 1E ventilation system
 1F thirteenth ventilation system
 1G fourteenth ventilation system
 1H fifteenth ventilation system
 1I sixteenth ventilation system
 1J seventeenth ventilation system
 1K eighteenth ventilation system
 1018 control unit
 1022 air supply fan
 1023 first heat exchanger
 1032 exhaust fan
 1033 second heat exchanger
 1042 compressor

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1045 discharge pipe
 1050 refrigerant circuit
 1051 refrigerant pipe
 1051L liquid pipe
 1080 low pressure raising means
 1081 air conditioner
 1082a bypass pipe
 1082b valve
 1000S1 indoor
 1000S2 outdoor
 PL low pressure
 TE evaporation temperature
 TS saturation temperature
 T2 outdoor air temperature
 T3 intake air temperature
 X first threshold
 Y second threshold
 Y3 air temperature threshold (second threshold for intake air temperature)
 SA air supply (air blown out of air supply fan)

Claims

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1. A ventilation apparatus comprising:

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a compressor;
 a first heat exchanger configured to function as a condenser or an evaporator;
 a first air flow path configured to supply air taken in from outdoors to an indoor space after passing through the first heat exchanger;
 a second heat exchanger configured to function as a condenser or an evaporator;
 a second air flow path configured to exhaust air taken in from the indoor space to the outdoors after passing through the second heat exchanger;
 a refrigerant circuit through which a refrigerant flows, the refrigerant circuit being connected to the compressor, the first heat exchanger, and the second heat exchanger by a refrigerant pipe; and

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a control unit configured to detect whether a pre-determined reference indicating a possibility of frosting in the second heat exchanger is satisfied while the second heat exchanger is functioning as an evaporator, and to control a temperature of the refrigerant flowing through the second heat exchanger such that the second heat exchanger will have a temperature at which frosting does not occur in the second heat exchanger, when the control unit detects that the pre-determined reference is satisfied.

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2. The ventilation apparatus according to claim 1, wherein the control unit detects whether the pre-determined reference is satisfied while the second heat

exchanger is functioning as an evaporator, and outputs a signal for controlling an air conditioner provided in the indoor space to control the temperature of the refrigerant flowing through the second heat exchanger, when the control unit detects that the predetermined reference is satisfied.

3. The ventilation apparatus according to claim 2, wherein the control unit outputs a signal for increasing a temperature currently set for the air conditioner, with respect to the air conditioner provided in the indoor space, when the control unit detects that the predetermined reference is satisfied.

4. The ventilation apparatus according to claim 2, further comprising:

a second ventilation unit configured to adjust an air volume flowing to the second heat exchanger upon flowing through the second air flow path, wherein the control unit drives the second ventilation unit when an air temperature in the indoor space becomes higher than a second threshold, after outputting the signal for controlling the air conditioner.

5. The ventilation apparatus according to claim 1, wherein

the refrigerant circuit includes a bypass pipe configured to pass the refrigerant to the second heat exchanger without involving the first heat exchanger while the second heat exchanger is functioning as an evaporator, wherein the control unit implements control to cause the refrigerant that has been compressed at the compressor to flow to the second heat exchanger via the bypass pipe, when the predetermined reference is satisfied.

6. The ventilation apparatus according to claim 5, wherein after the control unit implements control to cause the refrigerant to flow to the second heat exchanger via the bypass pipe, the control unit implements control to close a valve part for causing the refrigerant that has been compressed at the compressor to flow to the second heat exchanger via the bypass pipe, when a low pressure of the refrigerant circuit or a saturation temperature of the second heat exchanger or an intake air temperature of the second heat exchanger is determined to exceed a second threshold with respect to the low pressure of the refrigerant circuit or the saturation temperature of the second heat exchanger or the intake air temperature of the second heat exchanger.

7. The ventilation apparatus according to claim 1, fur-

ther comprising:

a third air flow path configured to take in air from a space that is different from a space from which the second air flow path takes in air in the indoor space, and to pass the taken in air to the second heat exchanger; and

a first guide mechanism configured to switch between whether or not to guide air to the second heat exchanger through the third air flow path, wherein

the control unit controls the first guide mechanism to guide air to the second heat exchanger through the third air flow path when the predetermined reference is satisfied.

8. The ventilation apparatus according to claim 1, further comprising:

a second ventilation unit configured to adjust an air volume flowing to the second heat exchanger upon flowing through the second air flow path, wherein

the control unit controls the second ventilation unit to increase the air volume flowing to the second heat exchanger compared to before the predetermined reference is satisfied, when the predetermined reference is satisfied.

9. The ventilation apparatus according to claim 8, further comprising:

a plurality of the second heat exchangers; and the second ventilation unit associated with each of the plurality of the second heat exchangers, wherein

the control unit controls the second ventilation unit associated with any one of the plurality of the second heat exchangers, to increase the air volume flowing to the corresponding second heat exchanger compared to before the predetermined reference is satisfied, when the predetermined reference is satisfied, while the plurality of the second heat exchangers are functioning as an evaporator.

10. The ventilation apparatus according to claim 9, wherein the control unit controls the second ventilation unit associated with any other one of the plurality of the second heat exchangers, to reduce the air volume flowing to the corresponding second heat exchanger compared to before the predetermined reference is satisfied, when controlling the second ventilation unit associated with the one of the plurality of the second heat exchangers to increase the air volume.

11. The ventilation apparatus according to claim 9, fur-

ther comprising:

a first ventilation unit configured to adjust an air volume flowing to the first heat exchanger upon flowing through the first air flow path, wherein the control unit controls the first ventilation unit to increase the air volume flowing to the first heat exchanger compared to before the predetermined reference is satisfied, based on the air volume increased with respect to the second ventilation unit, when the second ventilation unit associated with the one of the plurality of the second heat exchangers is controlled to increase the air volume.

12. The ventilation apparatus according to claim 1, further comprising:

a first ventilation unit configured to adjust an air volume flowing to the first heat exchanger upon flowing through the first air flow path; and a second ventilation unit configured to adjust an air volume flowing to the second heat exchanger upon flowing through the second air flow path, wherein the control unit controls the first ventilation unit to increase the air volume flowing to the first heat exchanger and controls the second ventilation unit to increase the air volume flowing to the second heat exchanger compared to before the predetermined reference is satisfied, upon determining that the predetermined reference is satisfied when a signal indicating to perform a defrosting operation is received from an air conditioner provided in the indoor space, while the second heat exchanger is functioning as an evaporator.

13. The ventilation apparatus according to claim 1, further comprising:

a bypass flow path configured to guide air that has undergone heat exchange by the first heat exchanger to the second heat exchanger; and a second guide mechanism configured to switch between whether or not to guide air to the second heat exchanger through the bypass flow path, wherein the control unit controls the second guide mechanism to guide air to the second heat exchanger through the bypass flow path when the predetermined reference is satisfied.

14. The ventilation apparatus according to claim 1, wherein the control unit adjusts a flow of air by a flow adjustment mechanism so as to guide, to an intake side of the second air flow path, air blown out from the first air flow path to the indoor space, when the

predetermined reference is satisfied.

15. The ventilation apparatus according to claim 1, further comprising:

a second ventilation unit configured to adjust an air volume flowing to the second heat exchanger upon flowing through the second air flow path, wherein the control unit implements control to stop the compressor and to control the second ventilation unit to cause air that has passed through the second air flow path to flow to the second heat exchanger, when the predetermined reference is satisfied.

16. The ventilation apparatus according to claim 1, further comprising:

a plurality of the second heat exchangers; and the second ventilation unit associated with each of the plurality of the second heat exchangers, wherein the refrigerant circuit includes a first valve part configured to adjust an opening of a flow path flowing to the second heat exchanger for each of the second heat exchangers, and the control unit implements control to close a plurality of the first valve parts associated with the second heat exchanger satisfying the predetermined reference in a predetermined order, and controls the second ventilation unit associated with the second heat exchanger satisfying the predetermined reference to cause air that has passed through the second air flow path to flow to the second heat exchanger, when information relating to a temperature detected from the plurality of the second heat exchangers has satisfied the predetermined reference.

17. The ventilation apparatus according to claim 1, further comprising:

a first ventilation unit configured to adjust an air volume flowing to the first heat exchanger upon flowing through the first air flow path; and a second ventilation unit configured to adjust an air volume flowing to the second heat exchanger upon flowing through the second air flow path, wherein the control unit controls the first ventilation unit and the second ventilation unit such that an air volume exhausted to the outdoors by the second air flow path is greater than an air volume supplied to the indoor space by the first air flow path, when the predetermined reference is satisfied.

18. The ventilation apparatus according to claim 1,

wherein the control unit controls the first heat exchanger such that a temperature of air that has passed through the first heat exchanger becomes lower than a temperature set in an air conditioner provided in the indoor space, when the predetermined reference is satisfied.

19. The ventilation apparatus according to claim 1, wherein

a plurality of combinations of the compressor, the first heat exchanger, the second heat exchanger, the refrigerant circuit, and the second ventilation unit associated with the second heat exchanger are provided, and the control unit implements control to stop the compressor associated with the second heat exchanger satisfying the predetermined reference in a predetermined order, and controls the second ventilation unit associated with the second heat exchanger satisfying the predetermined reference such that air that has passed through the second air flow path flows to the second heat exchanger, when information relating to a temperature detected from a plurality of the second heat exchanger satisfies the predetermined reference.

20. The ventilation apparatus according to any one of claims 1 to 19, wherein as the predetermined reference indicating a possibility of frosting in the second heat exchanger, the control units determines whether a low pressure of the refrigerant circuit or an evaporation temperature of the second heat exchanger or a temperature of the indoor space or a temperature of the outdoors has dropped below a first threshold with respect to the low pressure of the refrigerant circuit or the evaporation temperature of the second heat exchanger or the temperature of the indoor space or the temperature of the outdoors.

21. The ventilation apparatus according to any one of claims 1 to 20, further comprising:

a first casing configured to house the first heat exchanger and at least a part of the first air flow path; and
a second casing configured to house the second heat exchanger and at least a part of the second air flow path, wherein
the first casing and the second casing are separable.

22. The ventilation apparatus according to claim 21, wherein the control unit implements control to reduce a rotational speed of the compressor compared to before the predetermined reference is satisfied, when the predetermined reference is satisfied.

23. The ventilation apparatus according to claim 21, further comprising:

the refrigerant circuit including a second valve part configured to adjust an opening of a flow path, the second valve part being provided between the first heat exchanger and the second heat exchangers, wherein
the control unit implements control to increase an opening of the second valve part compared to before the predetermined reference is satisfied, when the predetermined reference is satisfied.

24. The ventilation apparatus according to claim 1, further comprising:

a third valve part provided downstream from the second heat exchanger in a flow of the refrigerant in the refrigerant circuit when the second heat exchanger functions as an evaporator, wherein
the control unit implements control to throttle the third valve part compared to before the predetermined reference is satisfied, when the predetermined reference is satisfied, when the second heat exchanger functions as an evaporator.

25. The ventilation apparatus according to claim 24, further comprising:

a third heat exchanger configured to function as a condenser or an evaporator; and
a fourth air flow path configured to exhaust, to the outdoors, air obtained by performing heat exchange between air of the outdoors and the refrigerant flowing through the third heat exchanger, wherein
the refrigerant circuit is connected to the third heat exchanger by the refrigerant pipe in addition to the compressor, the first heat exchanger, and the second heat exchanger.

26. An air conditioning system comprising:

a ventilation apparatus including:

a compressor configured to operate when a heat recovery ventilation operation is performed;
a first heat exchanger configured to function as a condenser or an evaporator;
a first air flow path configured to supply air taken in from outdoors to an indoor space after passing through the first heat exchanger;
a second heat exchanger configured to function as a condenser or an evaporator;

a second air flow path configured to exhaust air taken in from the indoor space to the outdoors after passing through the second heat exchanger; and
 a refrigerant circuit through which a refrigerant flows, the refrigerant circuit being connected to the compressor, the first heat exchanger, and the second heat exchanger by a refrigerant pipe,

an air conditioner including:

a third heat exchanger configured to function as a condenser or an evaporator; and
 an air conditioning indoor unit configured to exhaust, to the indoor space, air obtained by performing heat exchange between air of the indoor space and the refrigerant flowing through the third heat exchanger, and

a control unit configured to detect whether a predetermined reference indicating a possibility of frosting in the second heat exchanger is satisfied, and when the predetermined reference is determined to be satisfied, the control unit controls a temperature of the refrigerant flowing through the second heat exchanger such that the second heat exchanger will have a temperature at which frosting does not occur in the second heat exchanger, or controls an operation to defrost the second heat exchanger after frosting has occurred in the second heat exchanger, based on power consumption of the ventilation apparatus the air conditioner required for controlling the temperature of the refrigerant flowing through the second heat exchanger such that the second heat exchanger will have a temperature at which frosting does not occur in the second heat exchanger and power consumption of the ventilation apparatus the air conditioner required for defrosting the second heat exchanger after frosting has occurred in the second heat exchanger.

27. A ventilation method performed to control a ventilation apparatus including

a compressor;
 a first heat exchanger configured to function as a condenser or an evaporator;
 a first air flow path configured to supply air taken in from outdoors to an indoor space after passing through the first heat exchanger;
 a second heat exchanger configured to function as a condenser or an evaporator;
 a second air flow path configured to exhaust air taken in from the indoor space to the outdoors after passing through the second heat exchanger;

er; and

a refrigerant circuit through which a refrigerant flows, the refrigerant circuit being connected to the compressor, the first heat exchanger, and the second heat exchanger by a refrigerant pipe, the ventilation method comprising:
 detecting whether a predetermined reference indicating a possibility of frosting in the second heat exchanger is satisfied while the second heat exchanger is functioning as an evaporator, and controlling a temperature of the refrigerant flowing through the second heat exchanger such that the second heat exchanger will have a temperature at which frosting does not occur in the second heat exchanger, when the predetermined reference is detected to be satisfied.

28. A ventilation system comprising:

a refrigerant circuit through which a refrigerant flows, the refrigerant circuit being connected to a compressor, a first heat exchanger, and a second heat exchanger by a refrigerant pipe;
 an air supply fan configured to supply air from outdoors to indoors through the first heat exchanger;
 an exhaust fan configured to exhaust air from the indoors to the outdoors through the second heat exchanger; and
 a control unit, wherein
 when the second heat exchanger functions as an evaporator, the control unit starts the compressor, and when the control unit determines that a low pressure of the refrigerant circuit or an evaporation temperature of the second heat exchanger or a temperature of the indoors or a temperature of the outdoors has dropped below a first threshold with respect to the low pressure of the refrigerant circuit or the evaporation temperature of the second heat exchanger or the temperature of the indoors or the temperature of the outdoors, the control unit performs first control to raise the low pressure of the refrigerant circuit.

29. The ventilation system according to claim 28, wherein

the refrigerant circuit includes:

a bypass pipe configured to connect a discharge pipe of the compressor and the second heat exchanger or a liquid pipe connected to the second heat exchanger; and
 a valve provided in the bypass pipe, wherein

the control unit opens the valve in the first control.

30. The ventilation system according to claim 29, wherein when the valve is opened and the control unit determines that a low pressure of the refrigerant circuit or a saturation temperature of the second heat exchanger or an intake air temperature of the second heat exchanger exceeds a second threshold with respect to the low pressure of the refrigerant circuit or the saturation temperature of the second heat exchanger or the intake air temperature of the second heat exchanger, the control unit opens the valve. 5 10
31. The ventilation system according to claim 28, wherein the control unit causes the second heat exchanger to take in air having a temperature higher than a second threshold with respect to an intake air temperature, in the first control. 15
32. The ventilation system according to claim 31, wherein the control unit adjusts a blowout direction of the air supply fan so as to guide air blown out from the air supply fan toward an intake side of the exhaust fan, in the first control. 20
33. The ventilation system according to claim 31, further comprising: 25
- an air conditioner configured to air condition the indoors, wherein the control unit drives the exhaust fan when air temperature of the indoors becomes higher than the second threshold due to the air conditioner, in the first control. 30

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FIG.1

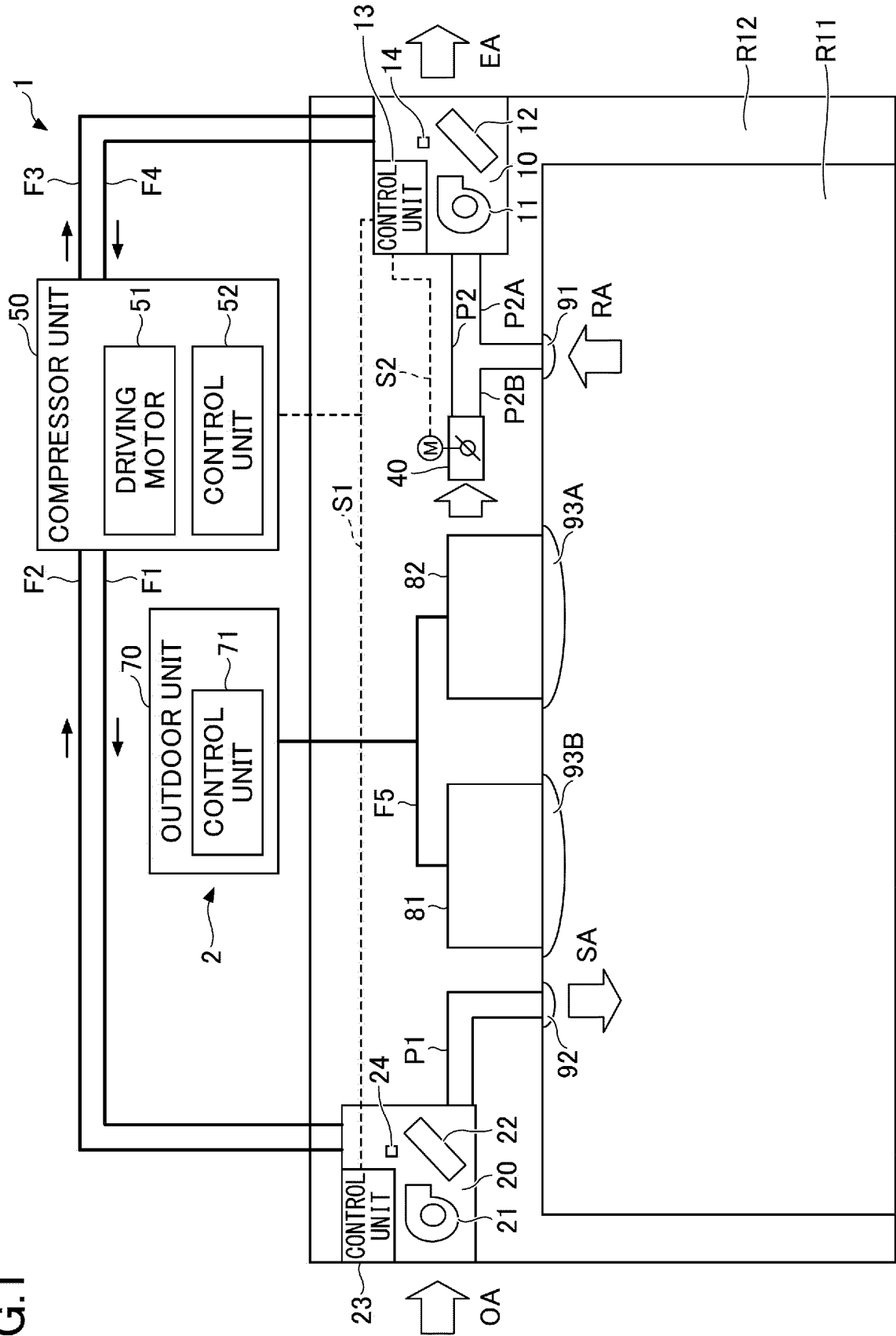


FIG.2

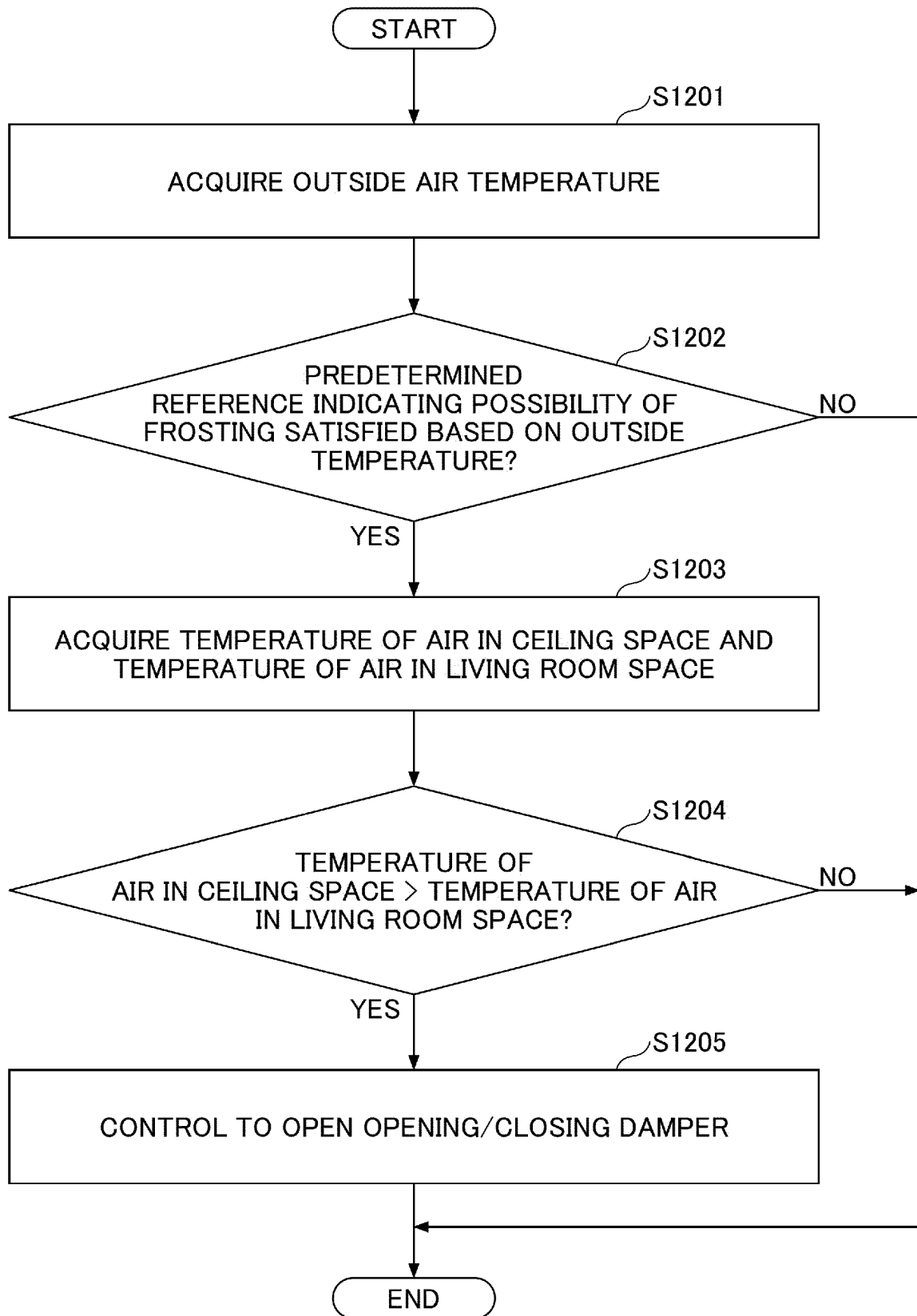


FIG.3

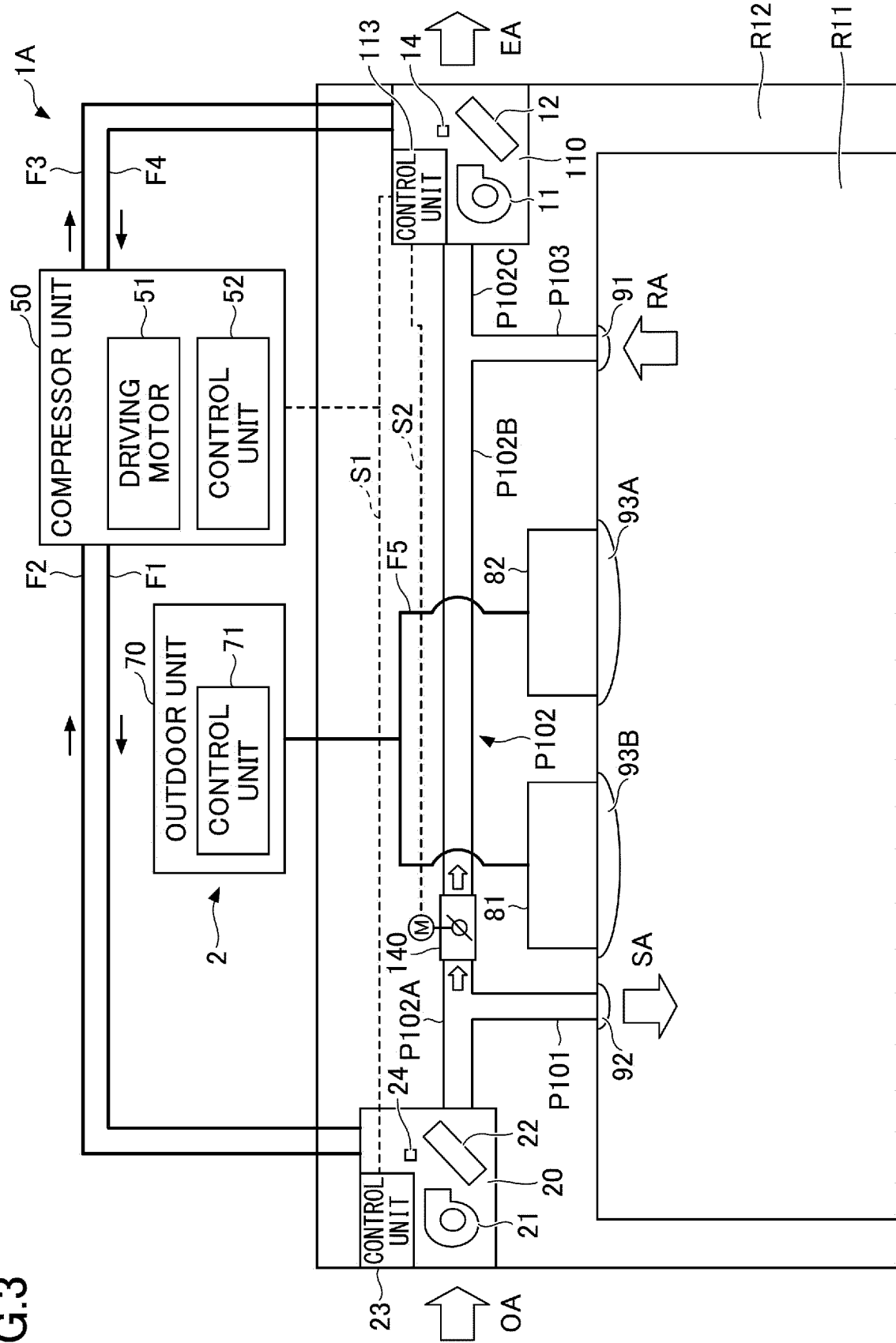
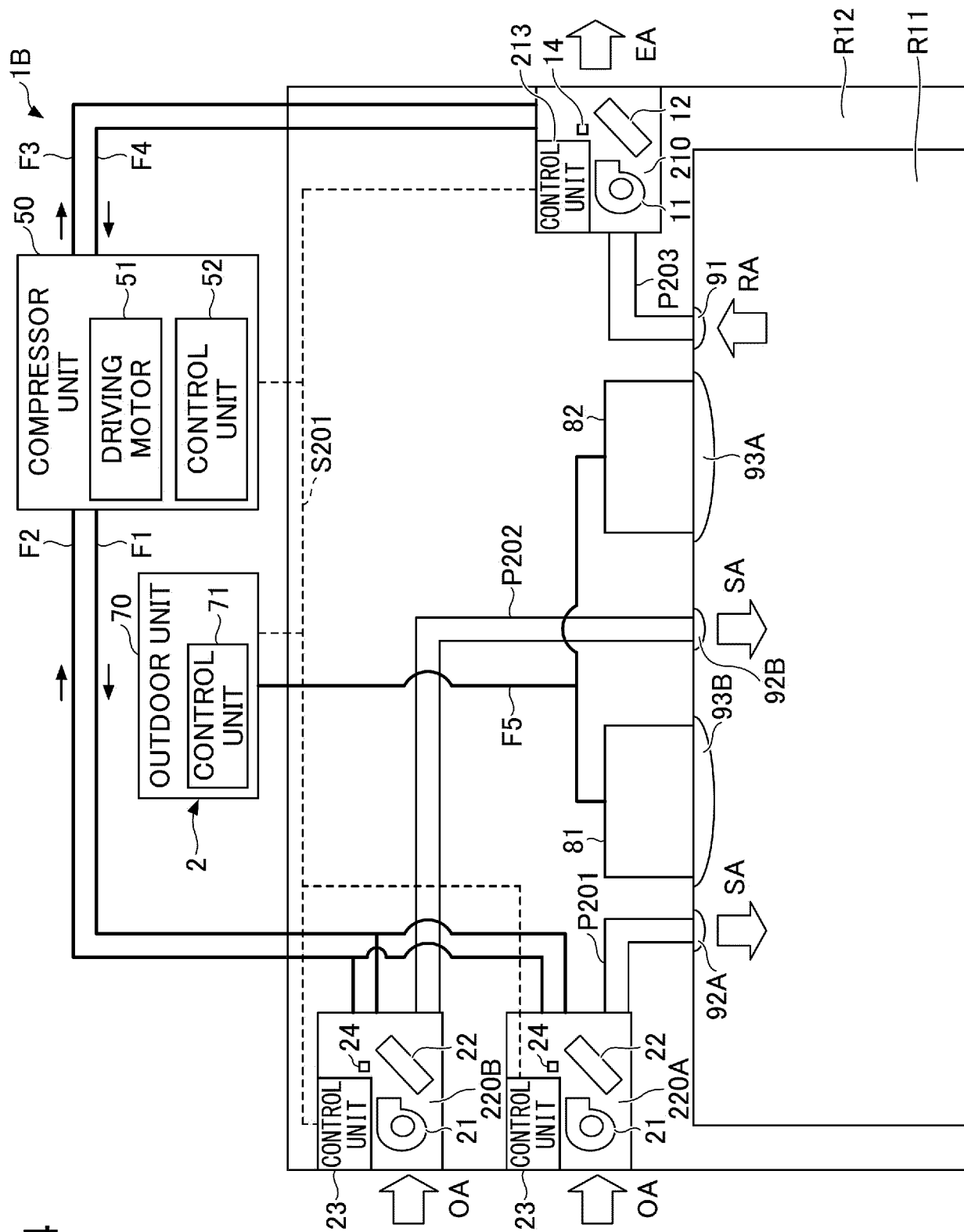


FIG.4



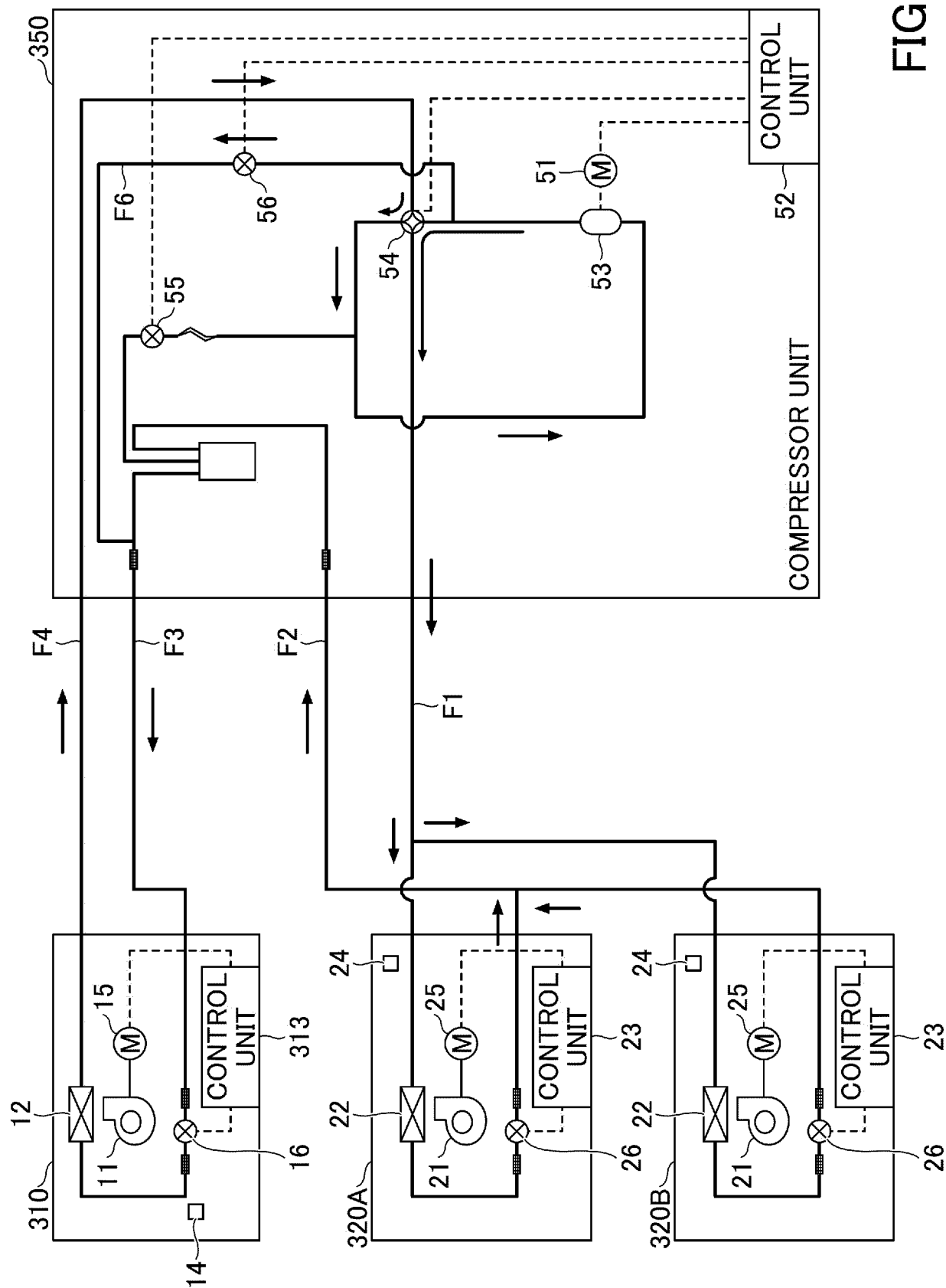
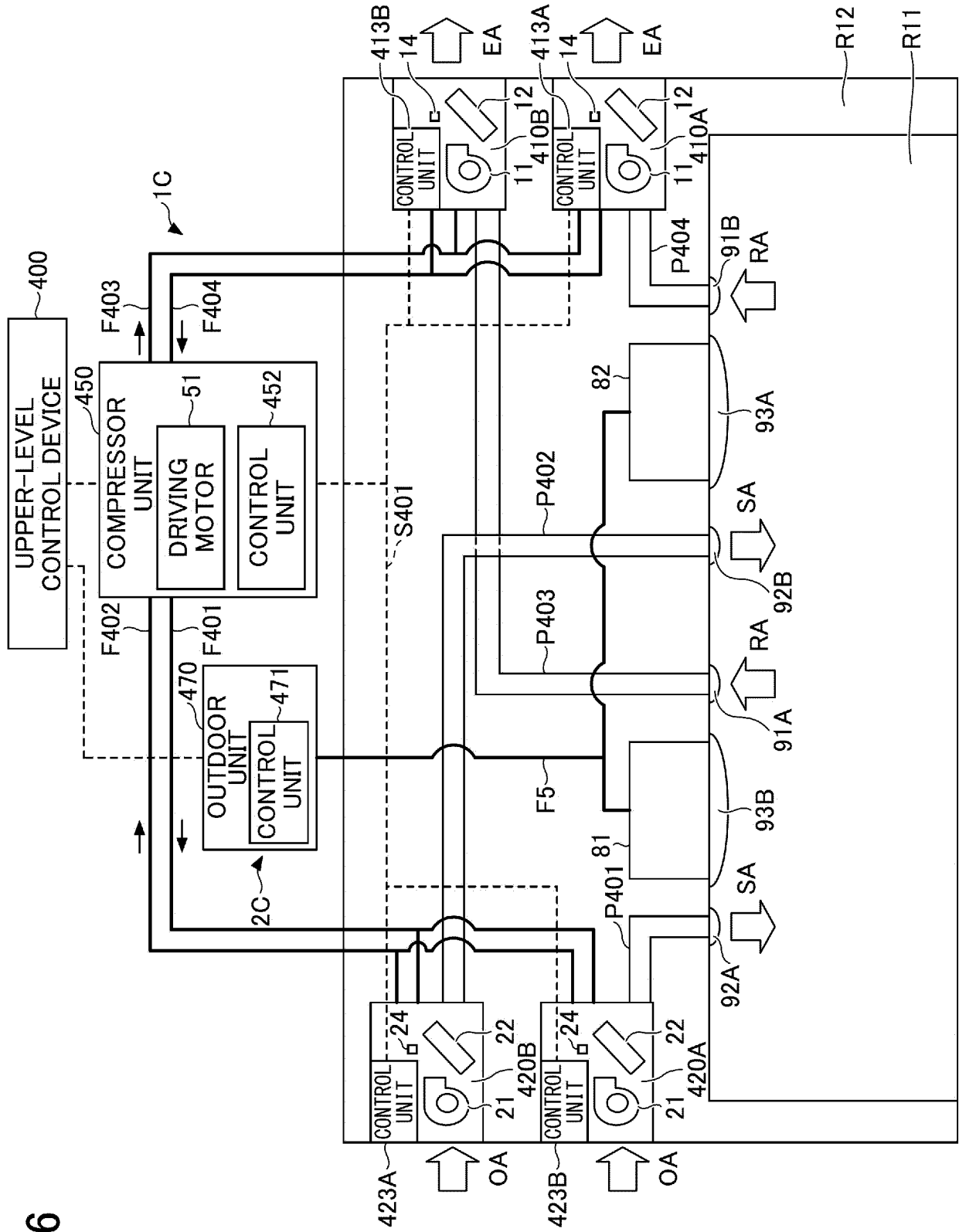


FIG.5

FIG.6



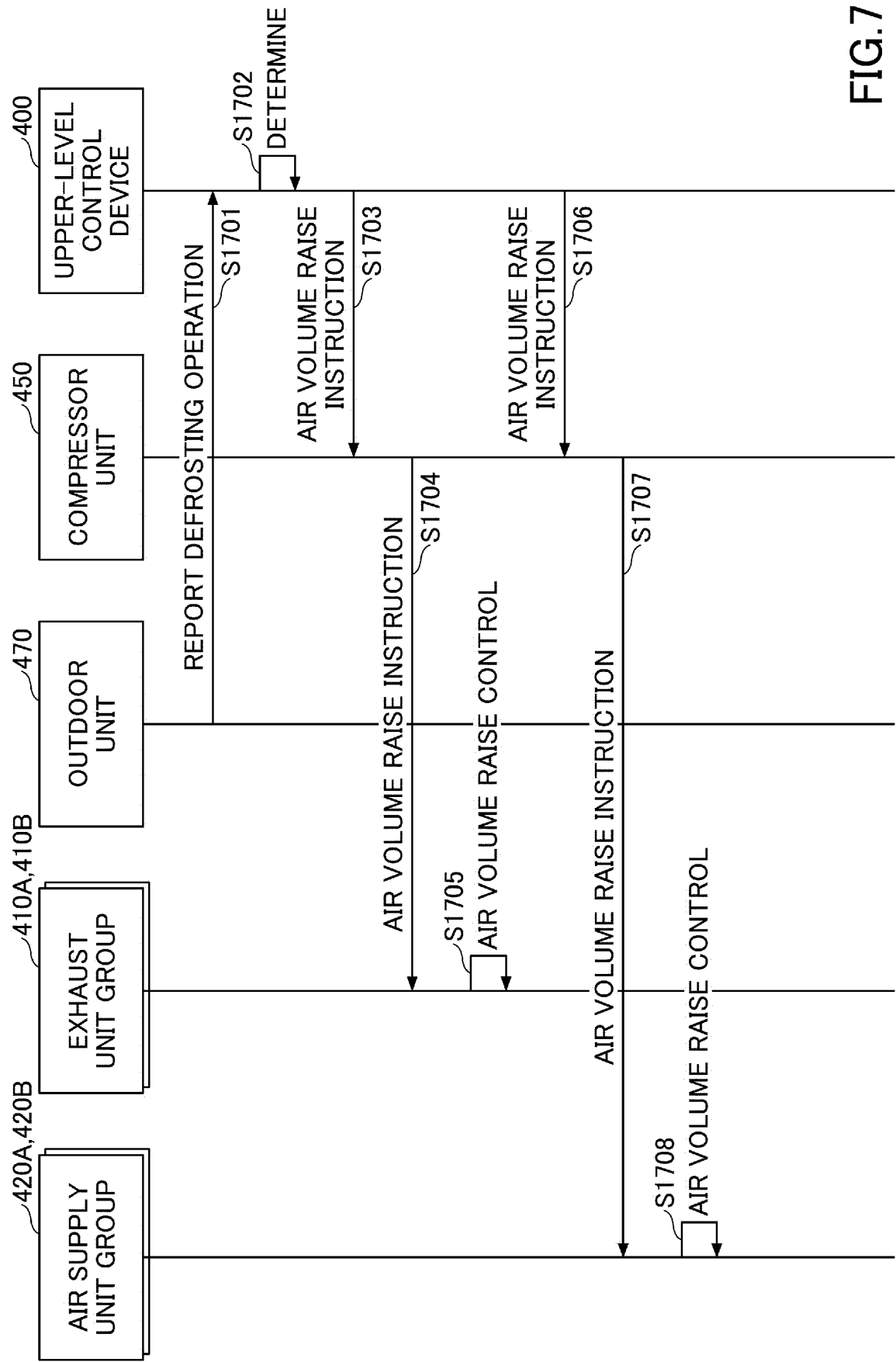


FIG.7

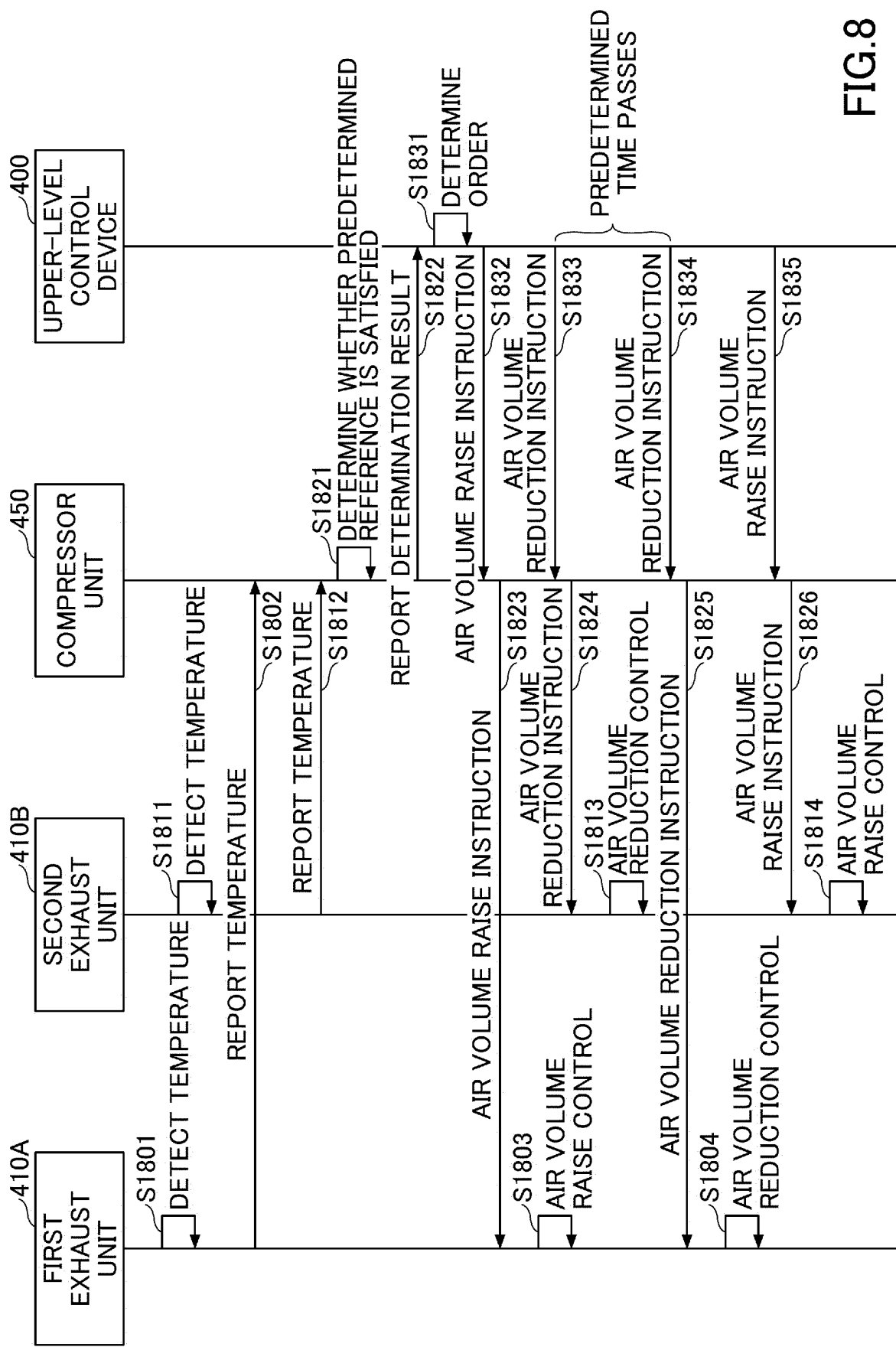


FIG.8

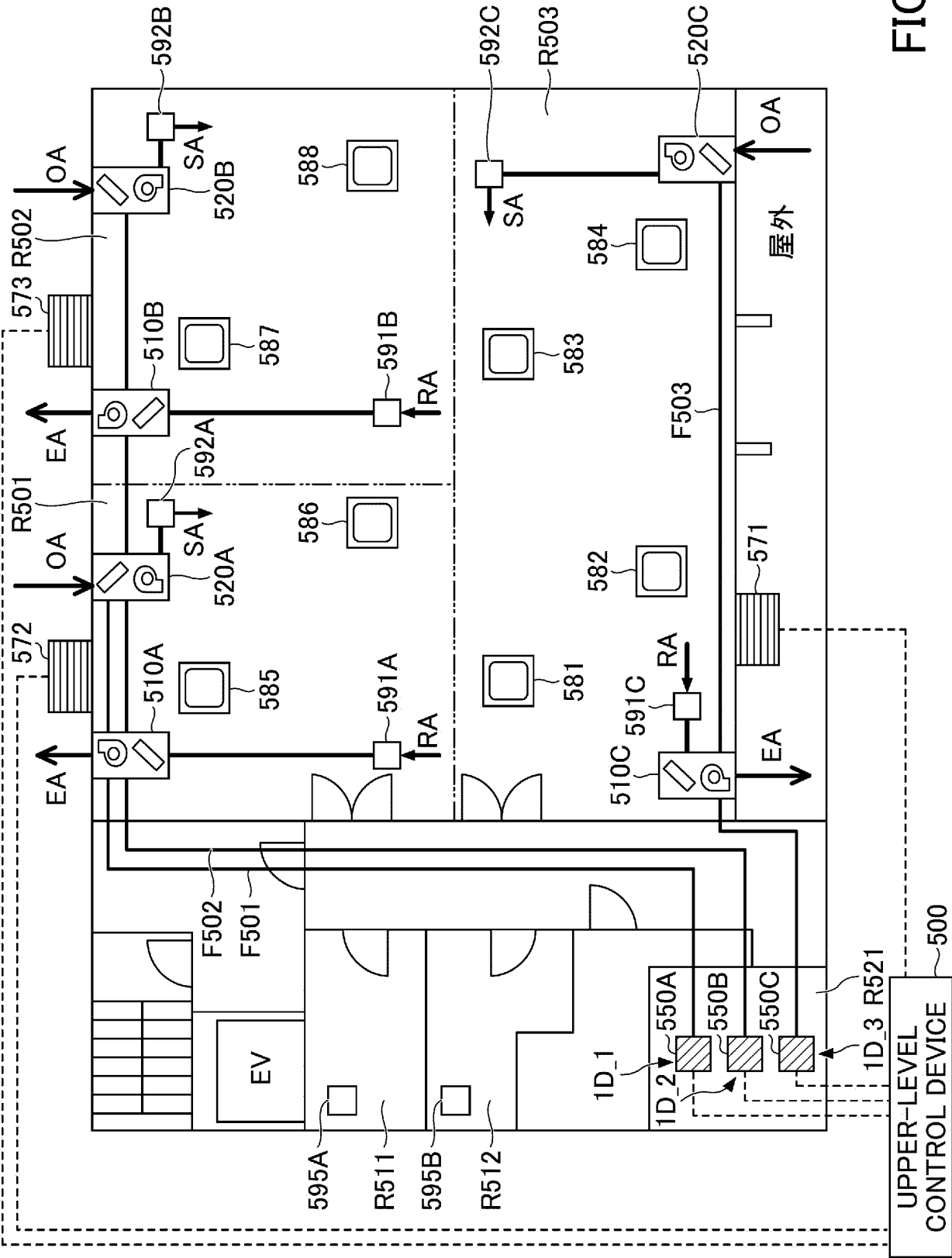


FIG.9

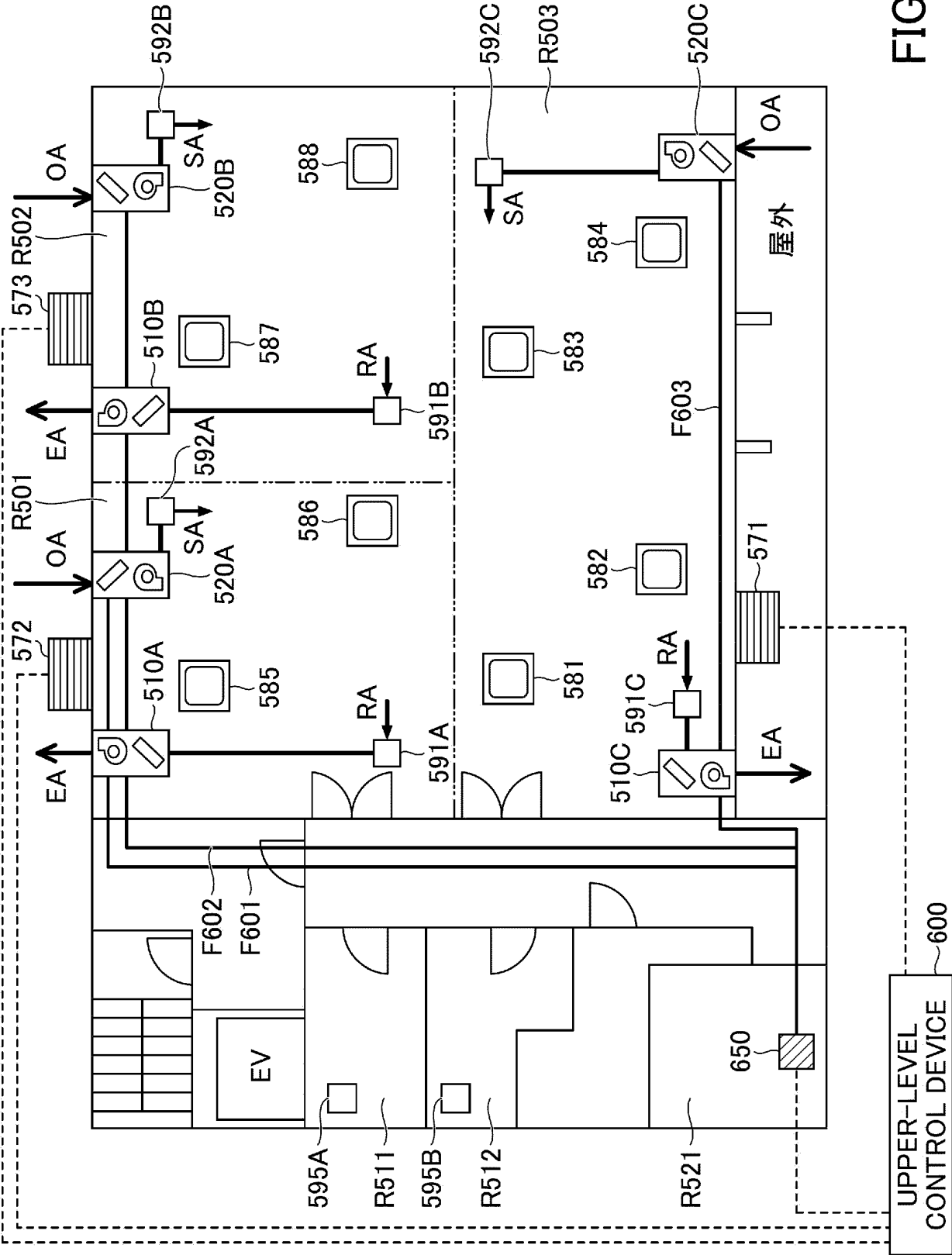


FIG.10

FIG.11

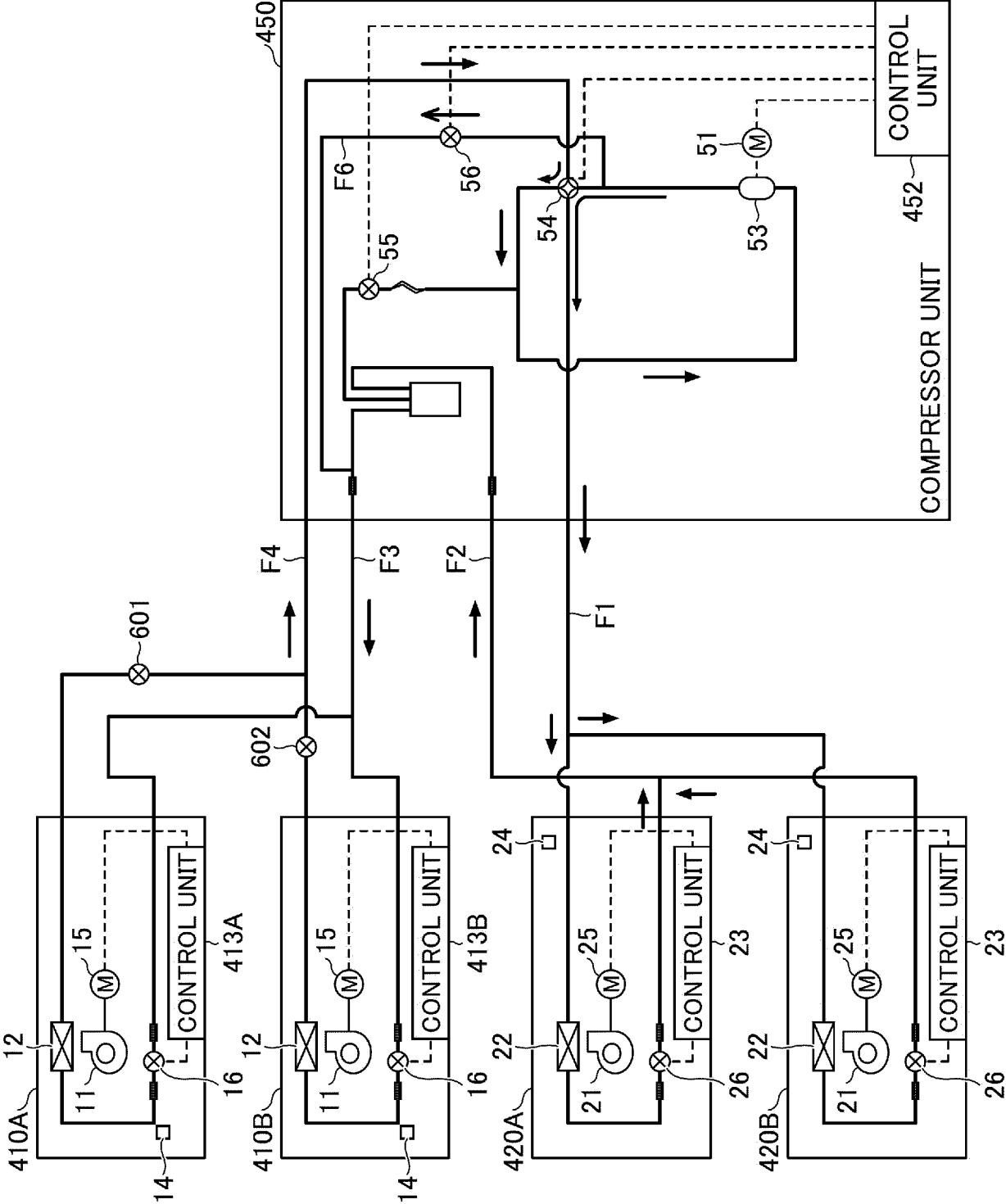


FIG.12

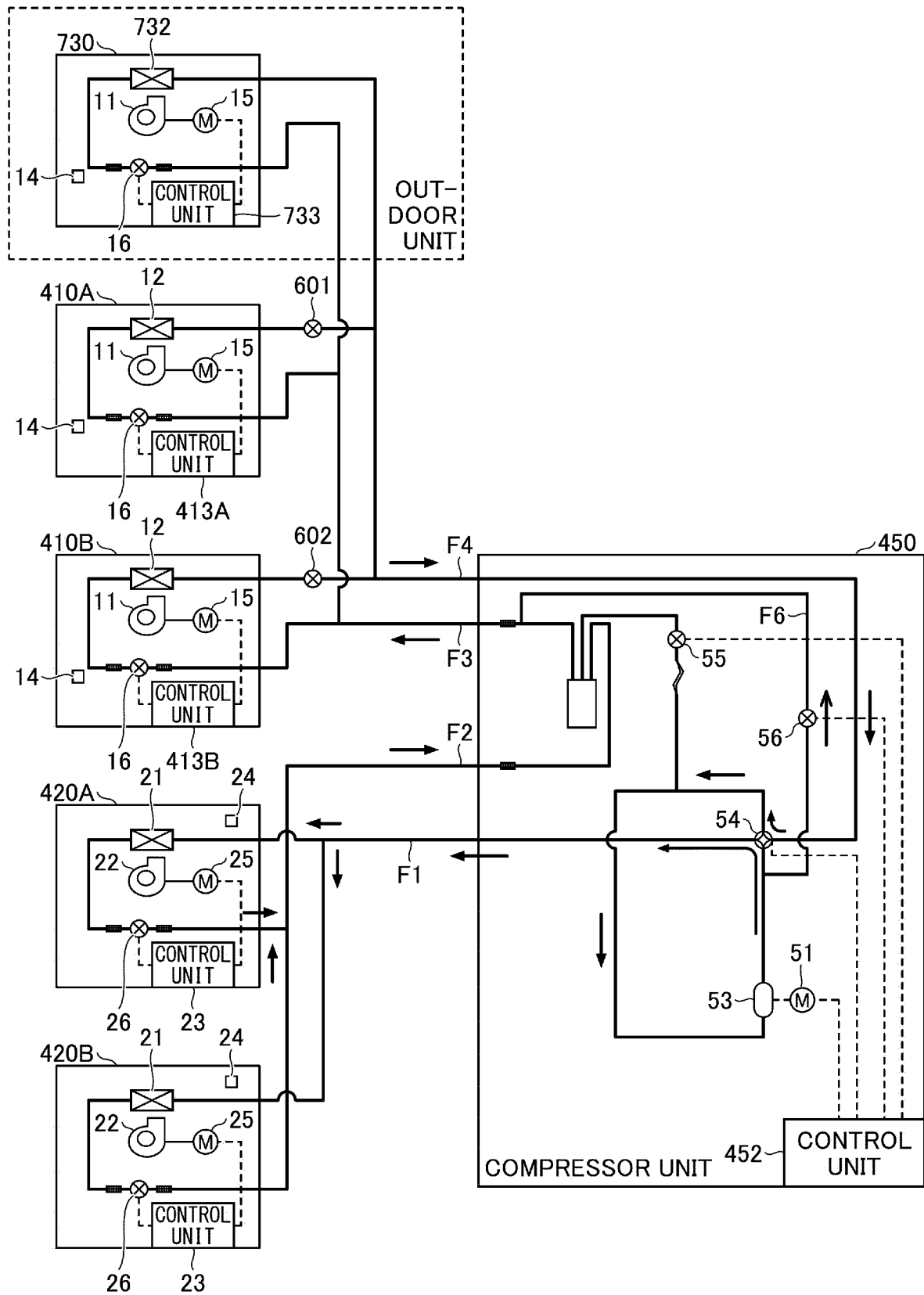


FIG.13

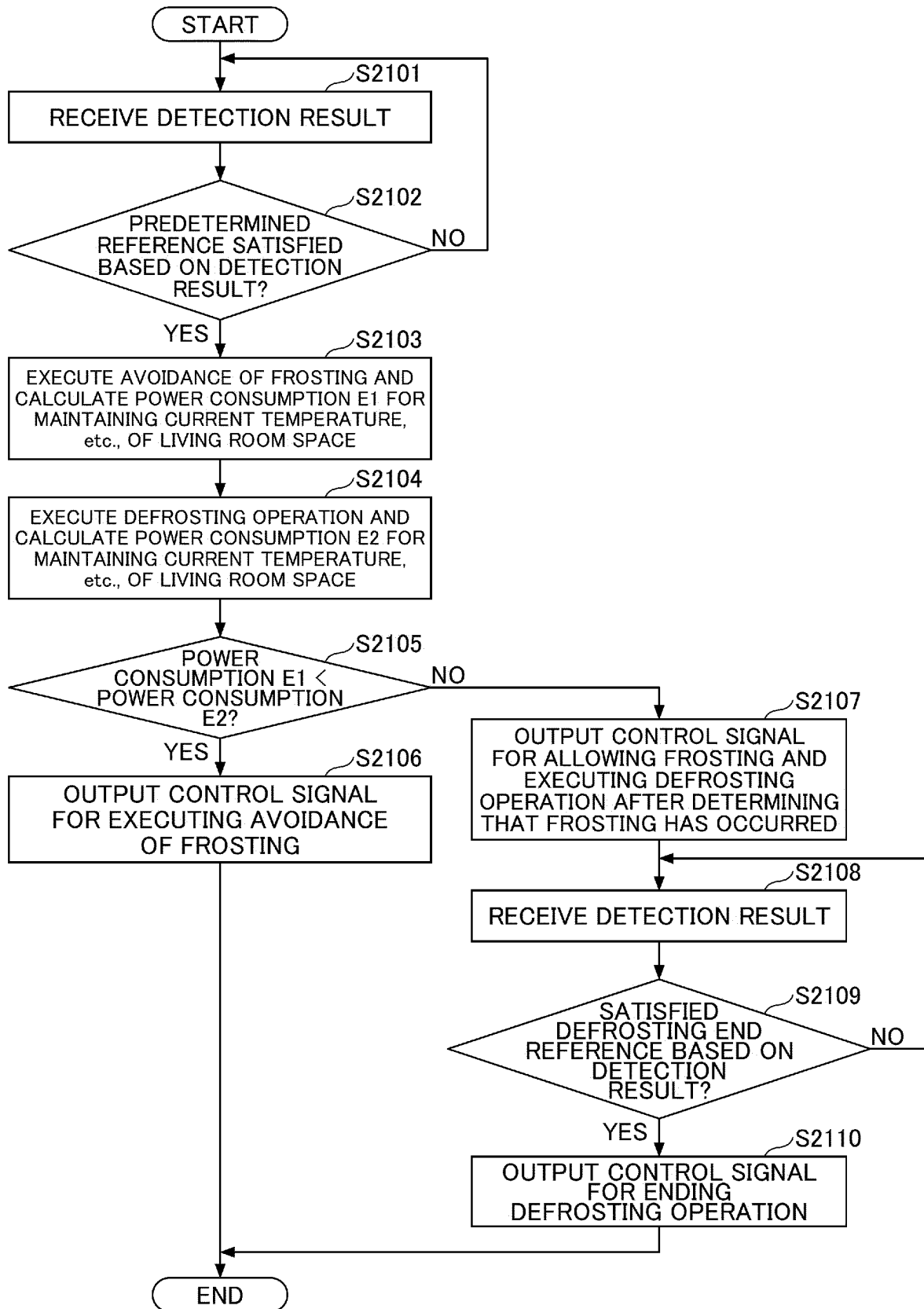
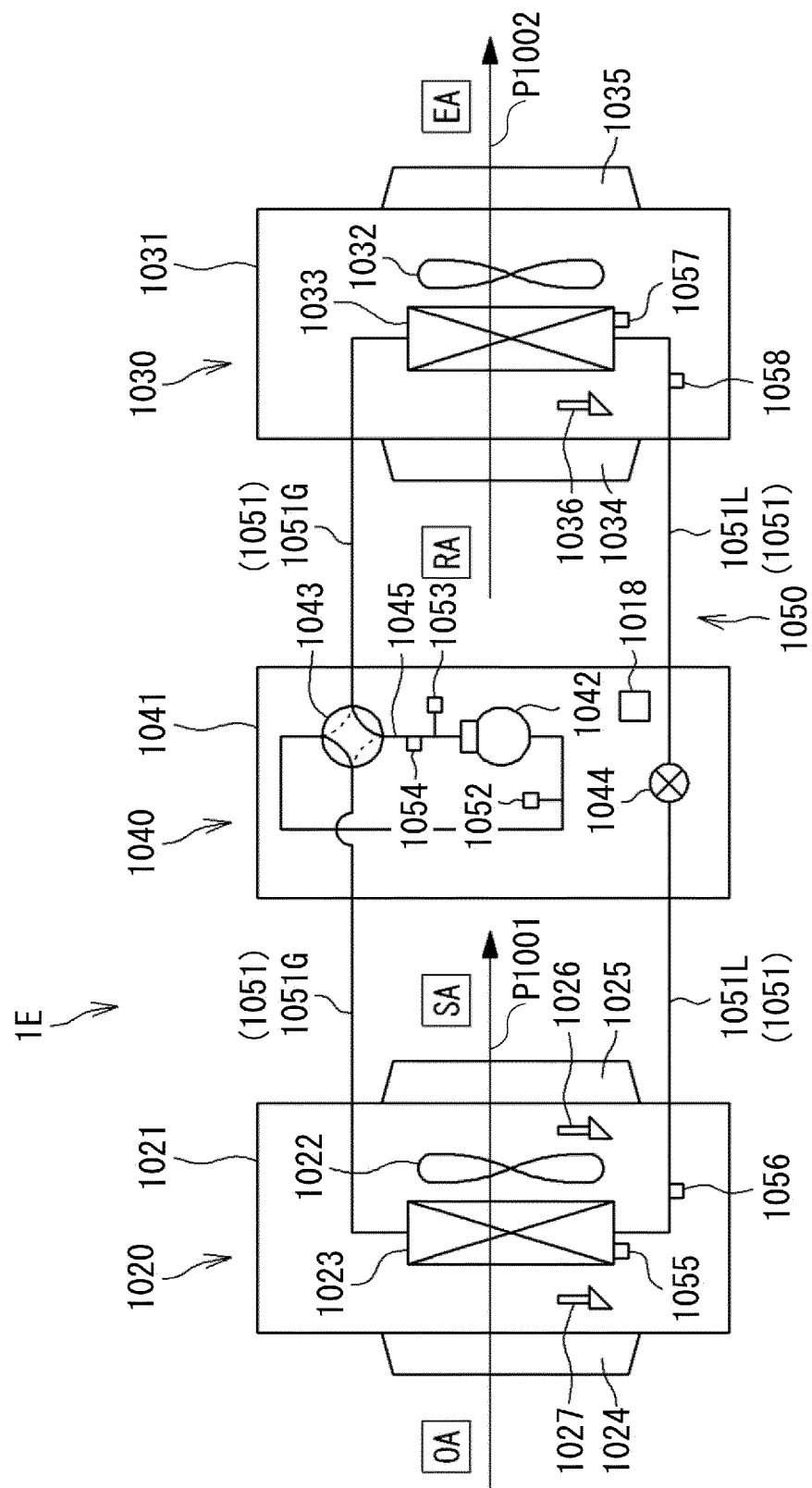


FIG.14



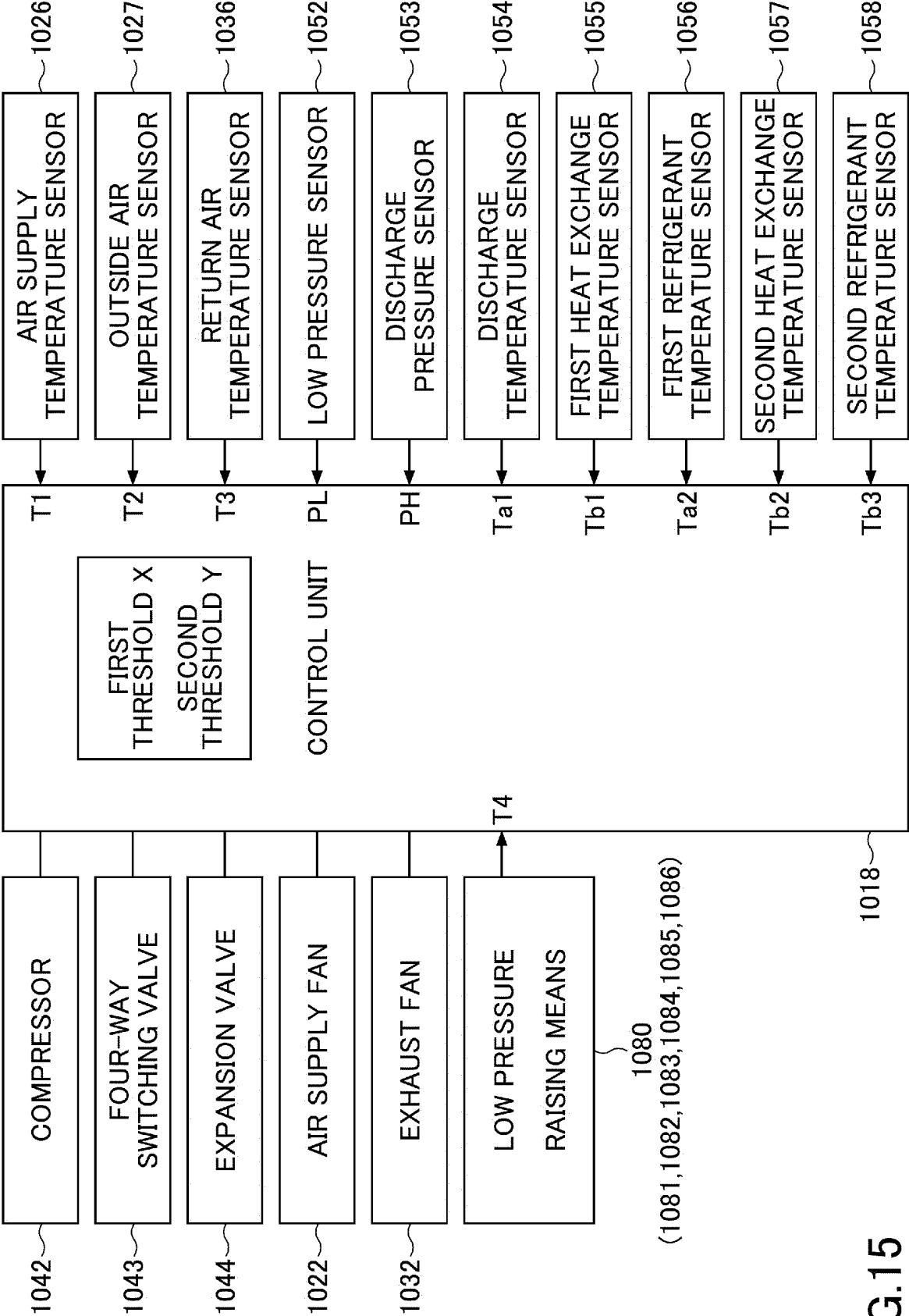


FIG.15

FIG.16

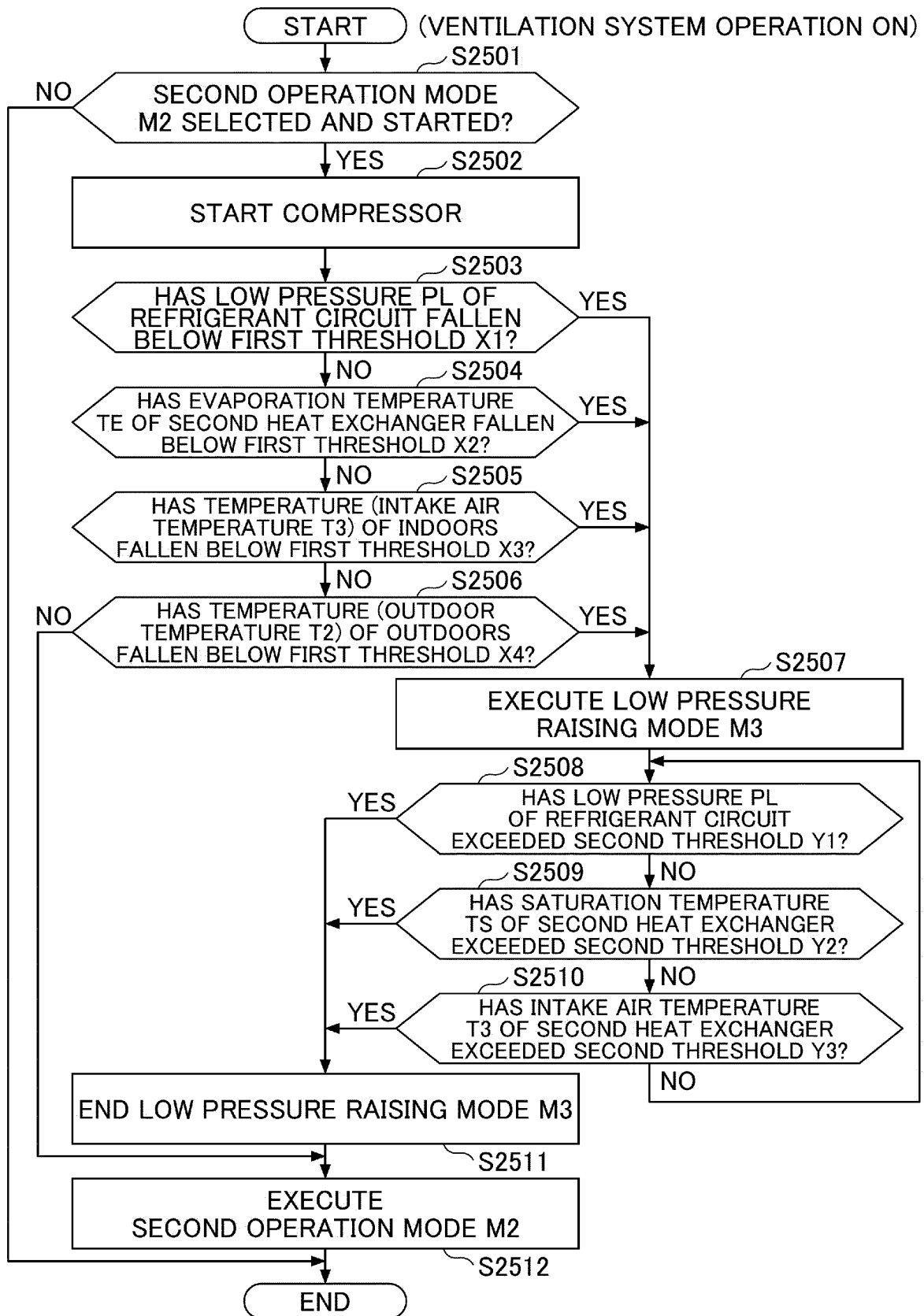


FIG.17

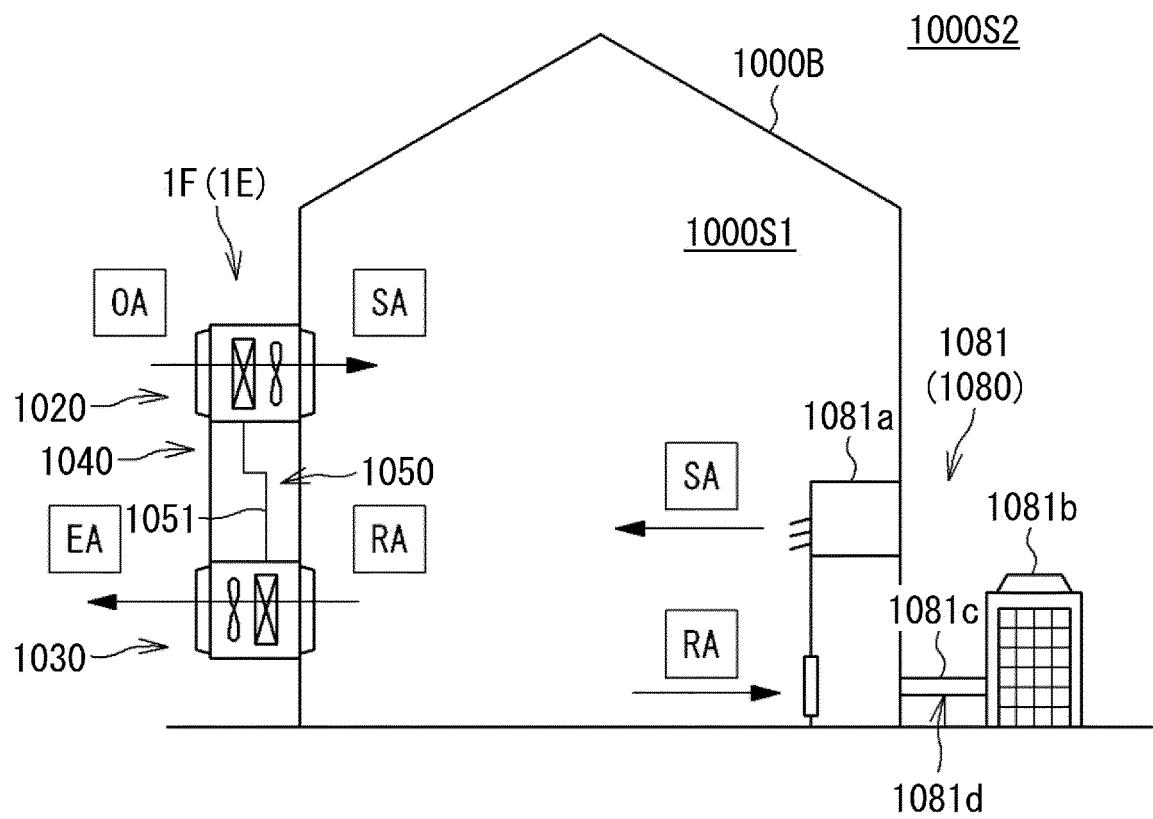


FIG.18

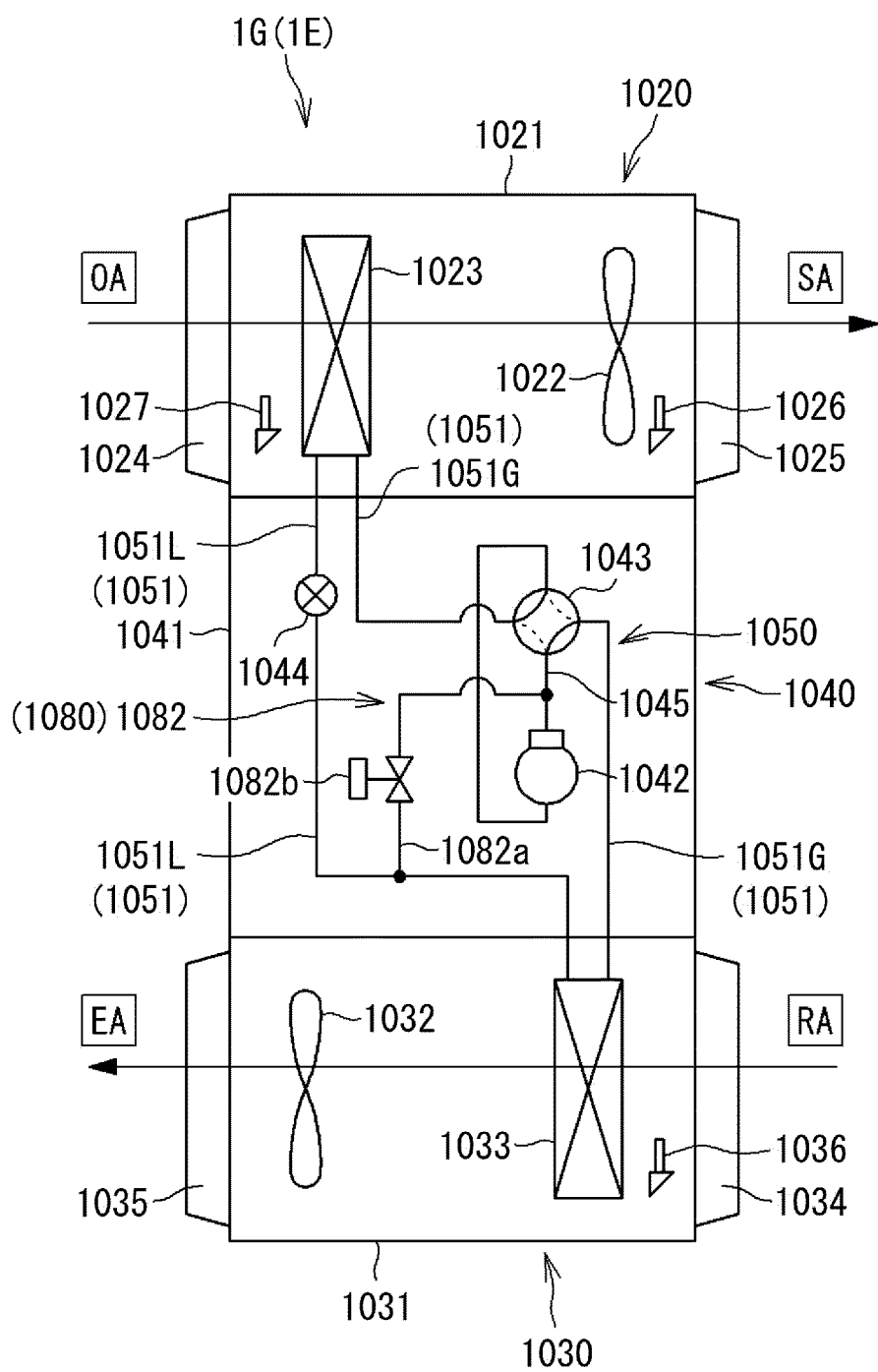


FIG.19

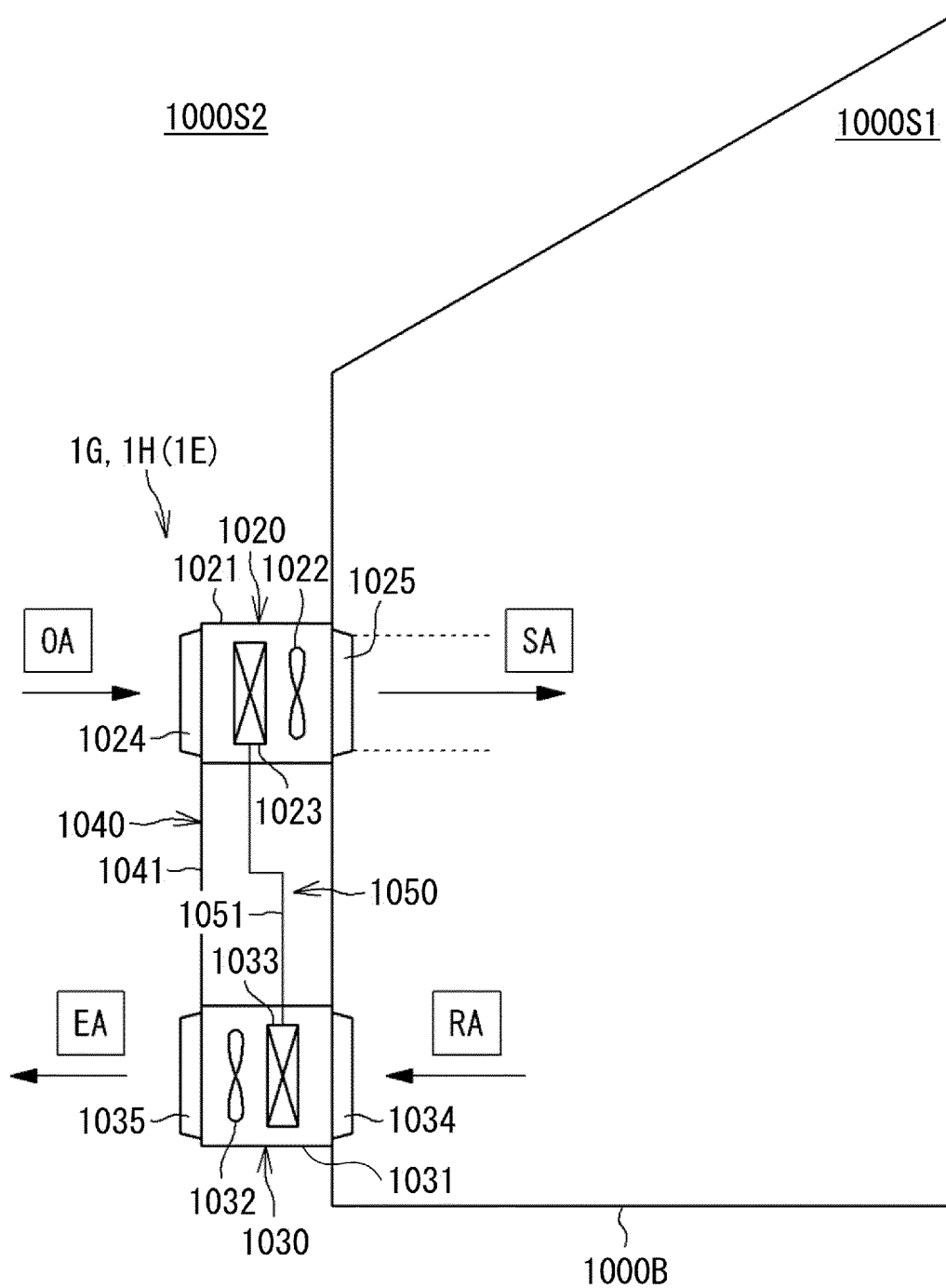


FIG.20

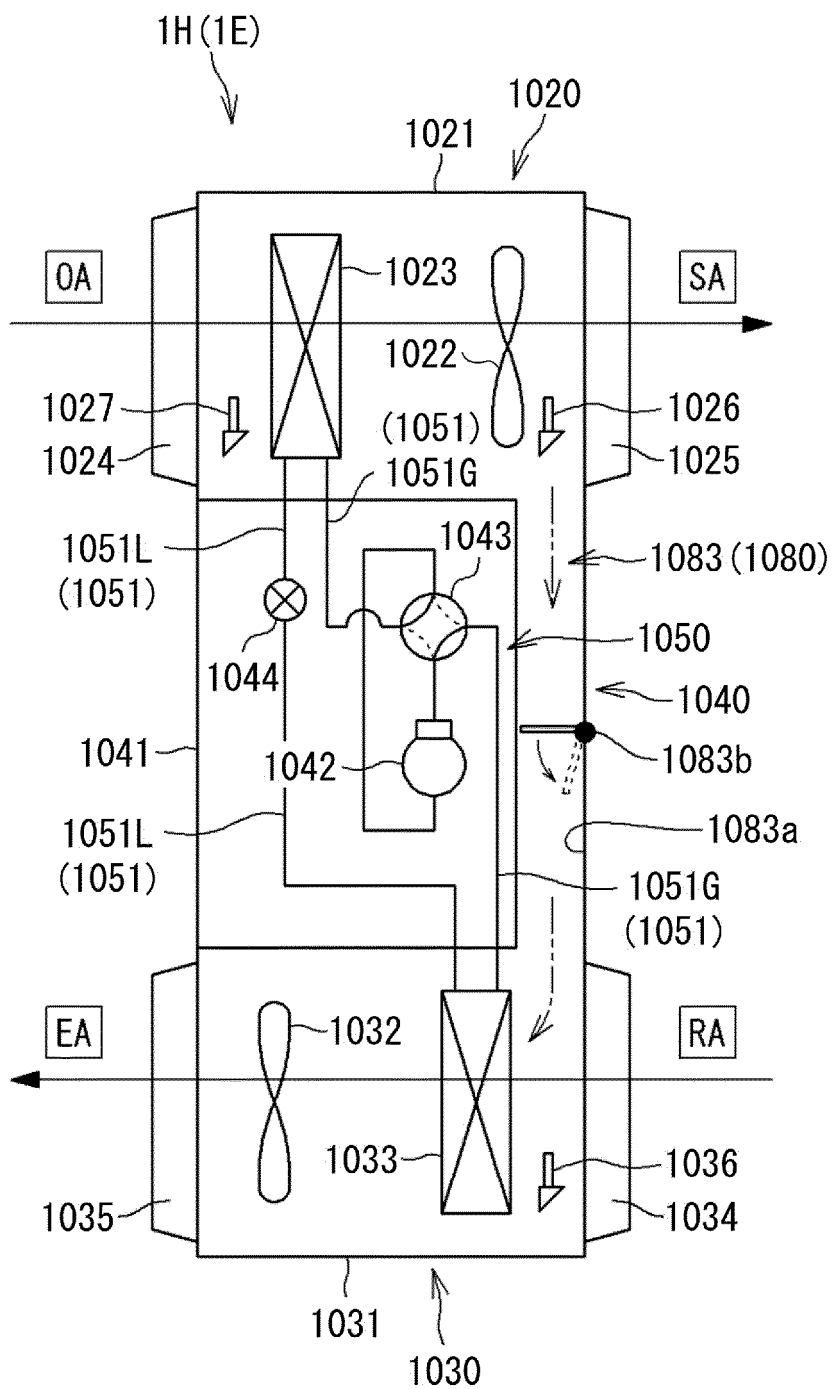


FIG. 21

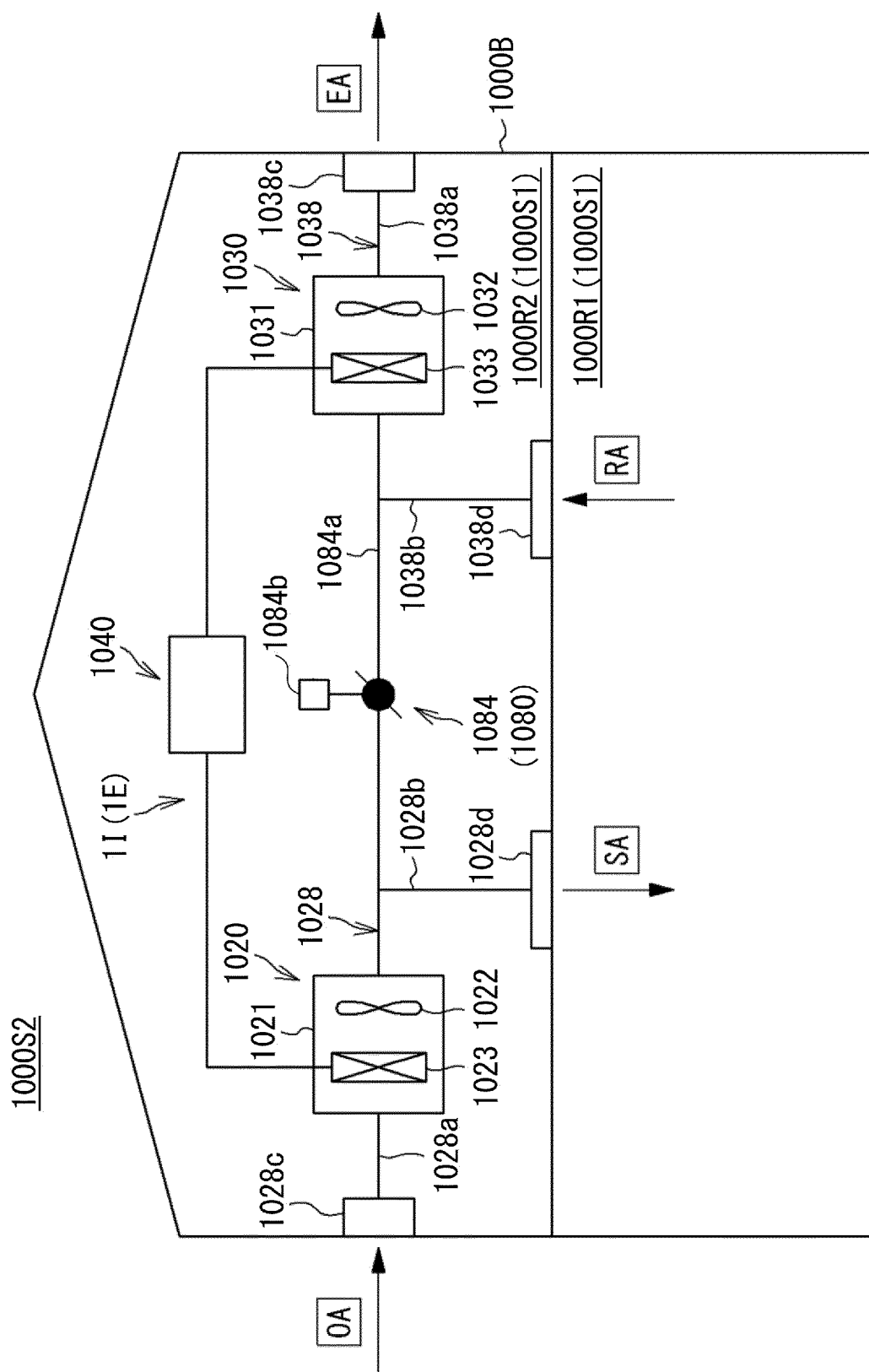


FIG.22

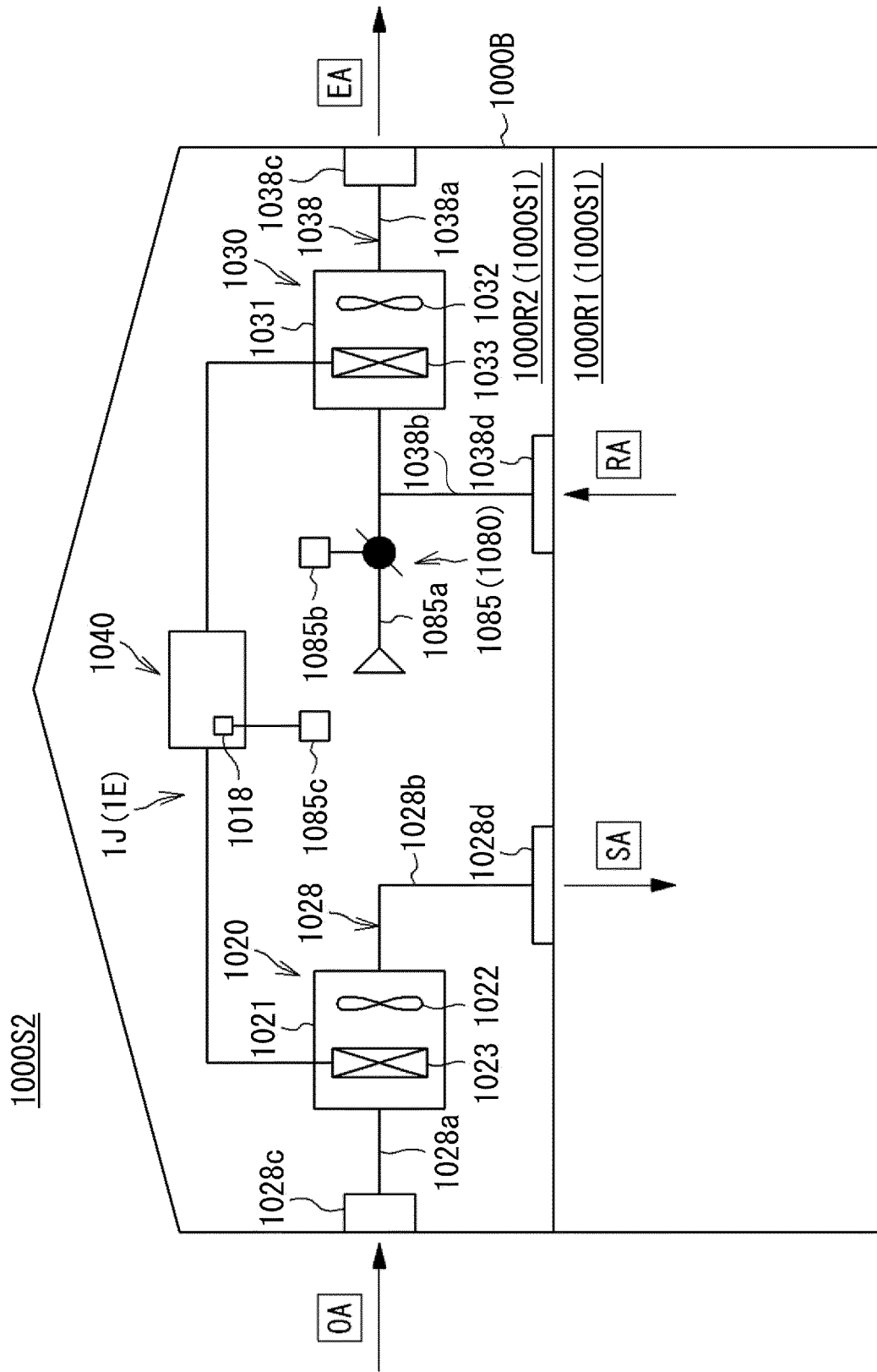
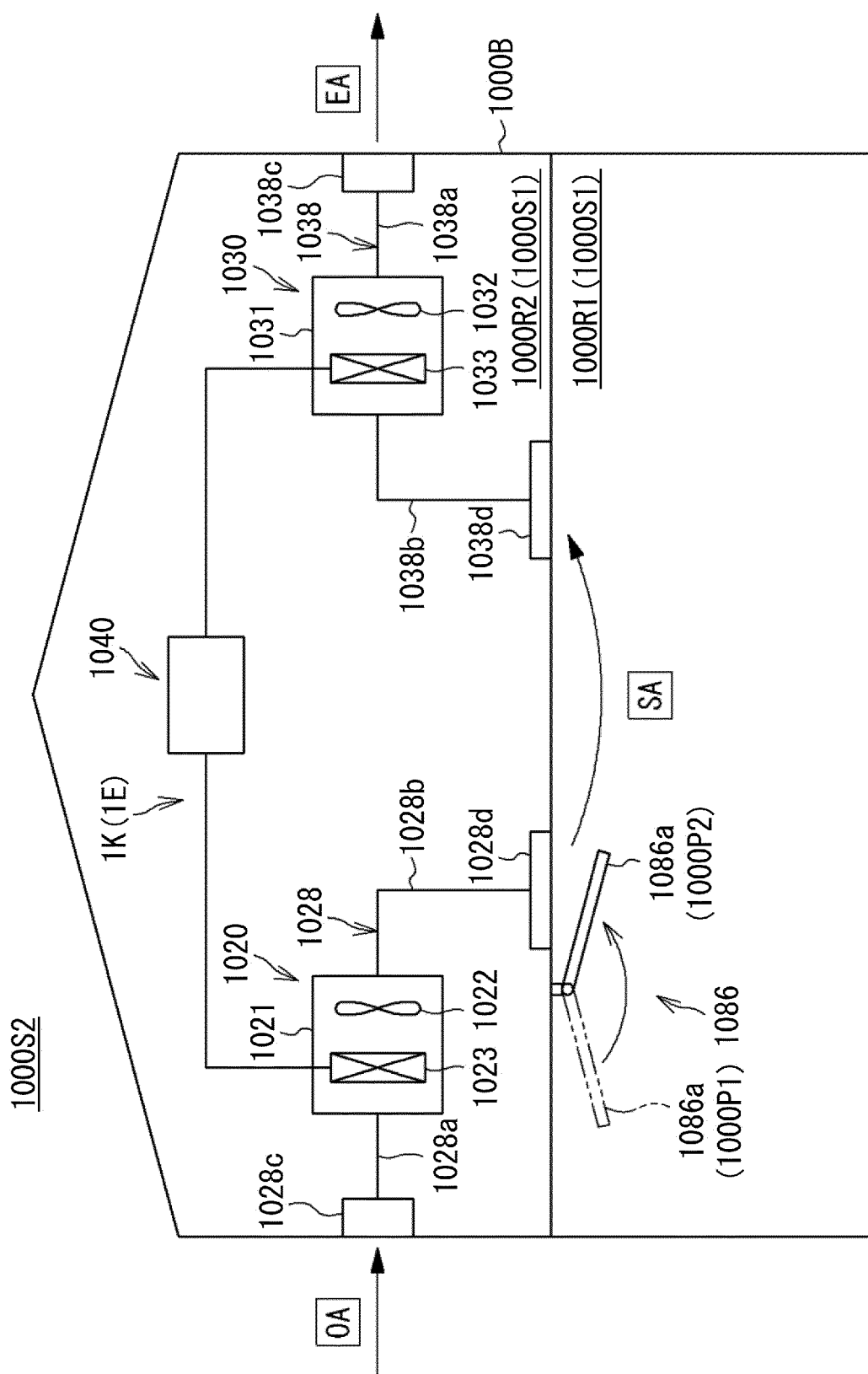


FIG.23



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/036876

A. CLASSIFICATION OF SUBJECT MATTER

F24F 11/41(2018.01)i; **F24F 11/79**(2018.01)i; **F24F 11/86**(2018.01)i; **F24F 110/10**(2018.01)n; **F24F 110/12**(2018.01)n;
F24F 140/12(2018.01)n; **F24F 140/20**(2018.01)n; **F24F 7/007**(2006.01)i; **F24F 7/08**(2006.01)i
 FI: F24F11/41 110; F24F11/41 130; F24F11/86; F24F11/79; F24F7/08 101J; F24F7/007 B; F24F11/41; F24F11/41 240;
 F24F7/08 A; F24F140:12; F24F140:20; F24F110:10; F24F110:12

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)

F24F11/41; F24F11/79; F24F11/86; F24F110/10; F24F110/12; F24F140/12; F24F140/20; F24F7/007; F24F7/08

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 1971-2022
 Registered utility model specifications of Japan 1996-2022
 Published registered utility model applications of Japan 1994-2022

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.
X	WO 2009/028184 A1 (PANASONIC CORP.) 05 March 2009 (2009-03-05) paragraphs [0010]-[0156], fig. 1-6	1, 5-6, 15, 17, 19, 27-31, 33
Y		7-11, 16, 20-25, 32
A		2-4, 12-14, 18, 26
Y	JP 2009-250464 A (PANASONIC CORP.) 29 October 2009 (2009-10-29) paragraphs [0058]-[0112], fig. 1-3	7, 20-23
A		2-4, 12-14, 18, 26
Y	JP 2017-223425 A (DENSO CORP.) 21 December 2017 (2017-12-21) paragraphs [0013]-[0090], fig. 1-10	8-11, 20-23
A		2-4, 12-14, 18, 26
Y	WO 2020/053929 A1 (MITSUBISHI ELECTRIC CORP.) 19 March 2020 (2020-03-19) paragraphs [0032], [0033], fig. 7	9-11, 16, 20-23
A		2-4, 12-14, 18, 26

☒ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

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Date of the actual completion of the international search

06 December 2022

Date of mailing of the international search report

13 December 2022

Name and mailing address of the ISA/IP

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

Authorized officer

Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/036876

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 61-036641 A (MATSUSHITA ELECTRIC IND. CO., LTD.) 21 February 1986 (1986-02-21)	21-23
A	page 5, lower left column, line 18 to page 7, upper right column, line 2, fig. 4-15	2-4, 12-14, 18, 26
Y	JP 2012-251716 A (ESPEC CORP.) 20 December 2012 (2012-12-20)	24-25
A	paragraphs [0031]-[0072], fig. 1-4	2-4, 12-14, 18, 26
Y	WO 2018/025369 A1 (MITSUBISHI ELECTRIC CORP.) 08 February 2018 (2018-02-08)	25
A	paragraphs [0076], [0077], fig. 1, 13	2-4, 12-14, 18, 26
Y	JP 2006-029777 A (DAIKIN IND., LTD.) 02 February 2006 (2006-02-02)	32
A	paragraph [0051], fig. 13	2-4, 12-14, 18, 26
A	US 2012/0180505 A1 (VENMAR CES, INC.) 19 July 2012 (2012-07-19)	1-33
	entire text, all drawings	

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/JP2022/036876

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2009/028184 A1	05 March 2009	US 2011/0100043 A1 paragraphs [0058]-[0204], fig. 1-6 JP 2009-58175 A CN 101790667 A	
JP 2009-250464 A	29 October 2009	(Family: none)	
JP 2017-223425 A	21 December 2017	(Family: none)	
WO 2020/053929 A1	19 March 2020	(Family: none)	
JP 61-036641 A	21 February 1986	(Family: none)	
JP 2012-251716 A	20 December 2012	(Family: none)	
WO 2018/025369 A1	08 February 2018	(Family: none)	
JP 2006-029777 A	02 February 2006	(Family: none)	
US 2012/0180505 A1	19 July 2012	WO 2012/097445 A1 entire text, all drawings CN 103328904 A	

REFERENCES CITED IN THE DESCRIPTION

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- JP H320573 A [0003]
- JP 2021204798 A [0416]
- JP 2021205609 A [0416]