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(54) VENTILATION APPARATUS, AIR CONDITIONING SYSTEM, AND VENTILATION SYSTEM

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(21) Appl. No.: **18/743,804**

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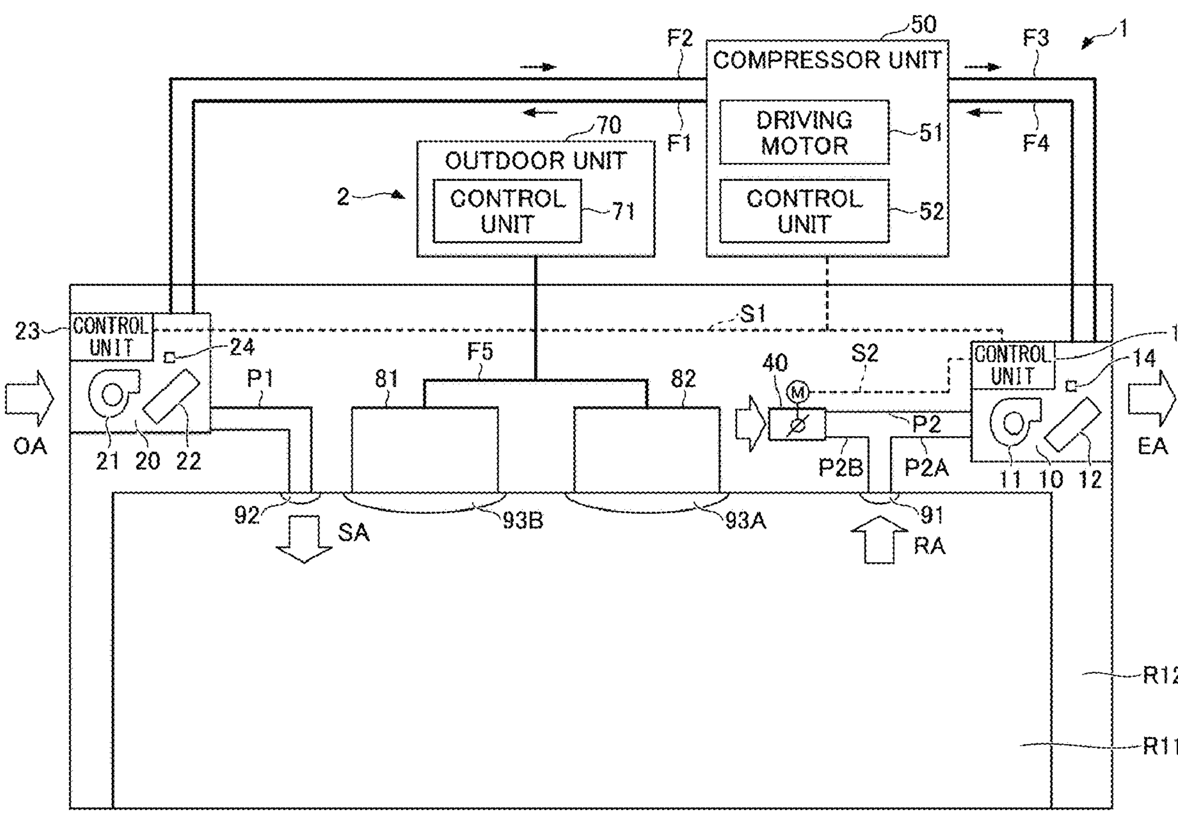
F24F 11/84 (2006.01)
F24F 140/20 (2006.01)

(52) **U.S. Cl.**
CPC ***F24F 11/43*** (2018.01); ***F24F 11/81*** (2018.01); ***F24F 11/84*** (2018.01); *F24F 2140/20* (2018.01)

(57) **ABSTRACT**

A ventilation apparatus includes a processor; a compressor; a first heat exchanger; a first air flow path configured to supply air 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 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, and the first and second heat exchangers. The processor detects 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 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, when the predetermined reference is satisfied.



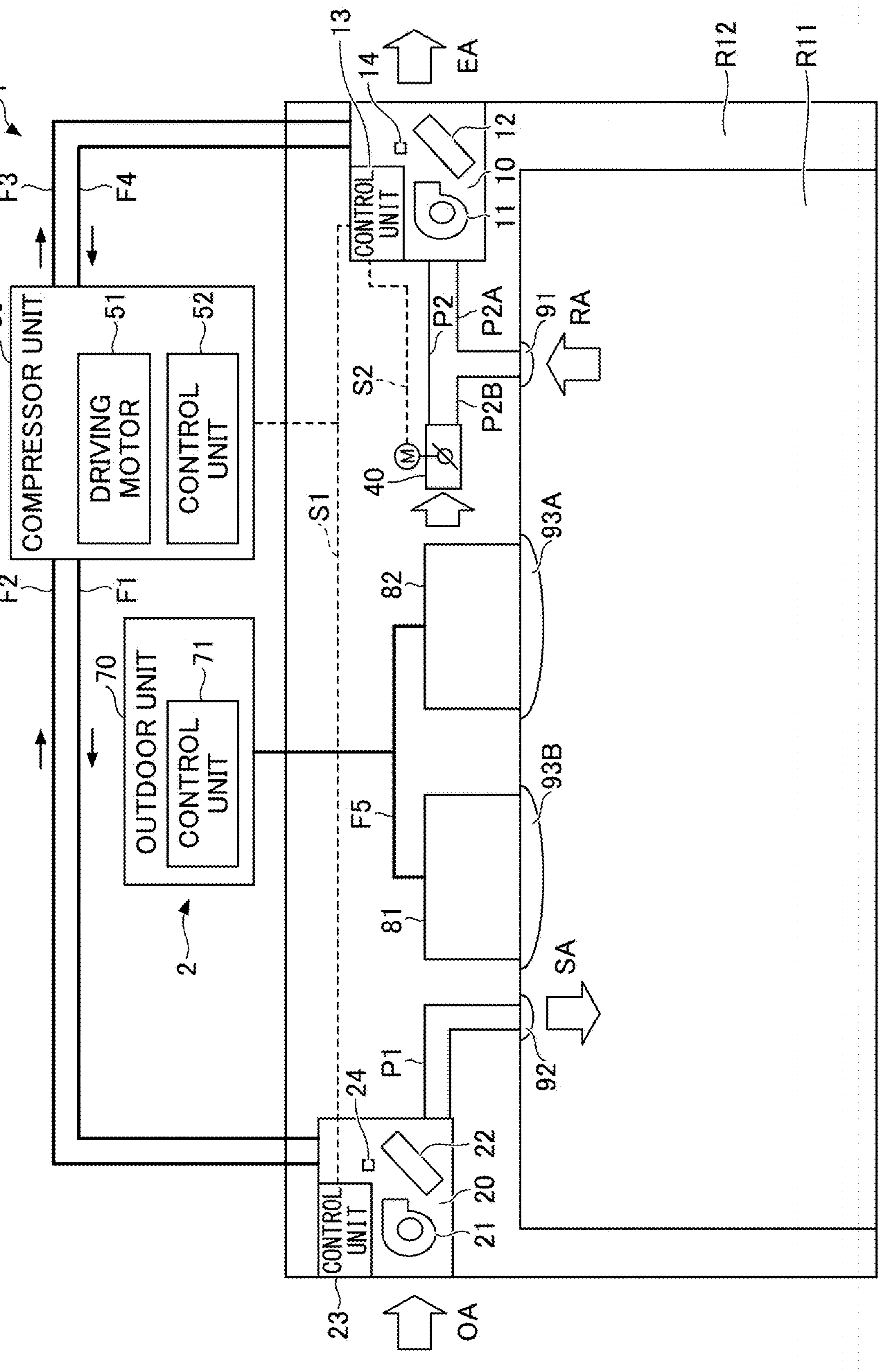

COMPRESSOR UNIT
DRIVING MOTOR
CONTROL UNIT
OUTDOOR UNIT
CONTROL UNIT
CONTROL UNIT
CONTROL UNIT
EA
RA
SA
OA
R11
R12
F1
F2
F3
F4
F5
S1
S2
P1
P2
P2A
P2B
M
1
2
10
11
12
13
14
20
21
22
23
24
40
50
51
52
70
71
81
82
91
92
93A
93B

FIG.1

FIG.2

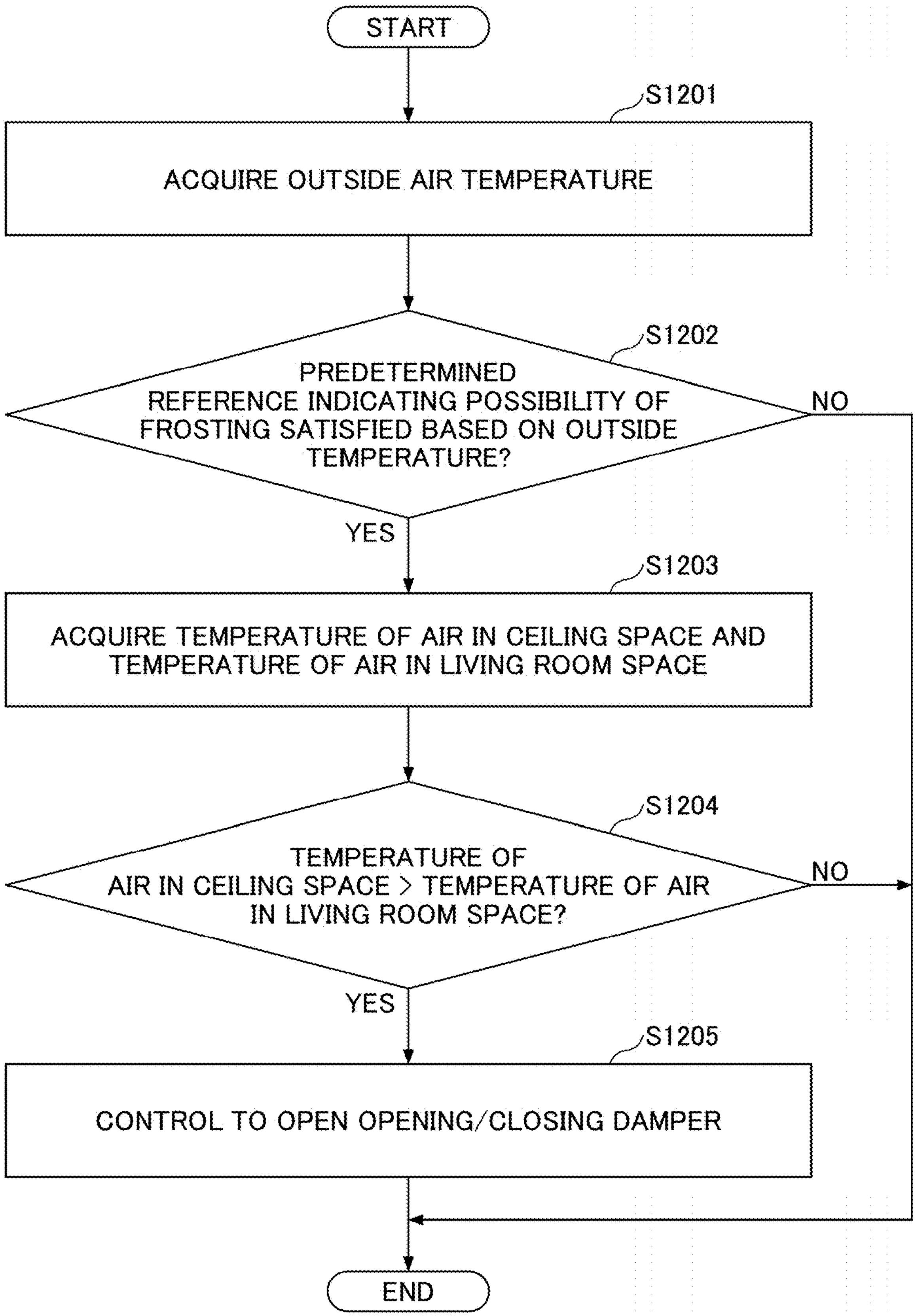

START
S1201
ACQUIRE OUTSIDE AIR TEMPERATURE
S1202
PREDETERMINED REFERENCE INDICATING POSSIBILITY OF FROSTING SATISFIED BASED ON OUTSIDE TEMPERATURE?
NO
YES
S1203
ACQUIRE TEMPERATURE OF AIR IN CEILING SPACE AND TEMPERATURE OF AIR IN LIVING ROOM SPACE
S1204
TEMPERATURE OF AIR IN CEILING SPACE > TEMPERATURE OF AIR IN LIVING ROOM SPACE?
NO
YES
S1205
CONTROL TO OPEN OPENING/CLOSING DAMPER
END

FIG.3

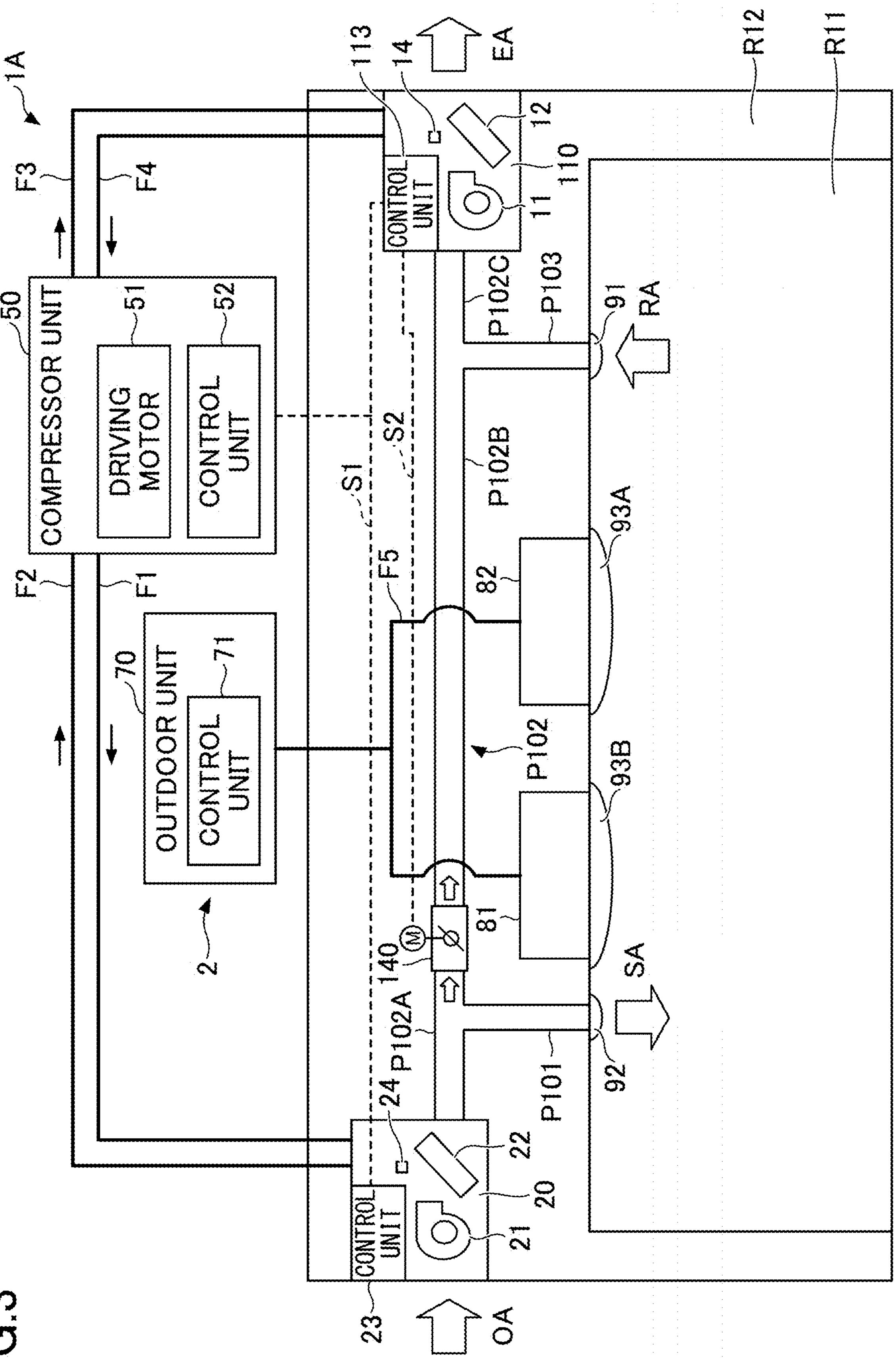
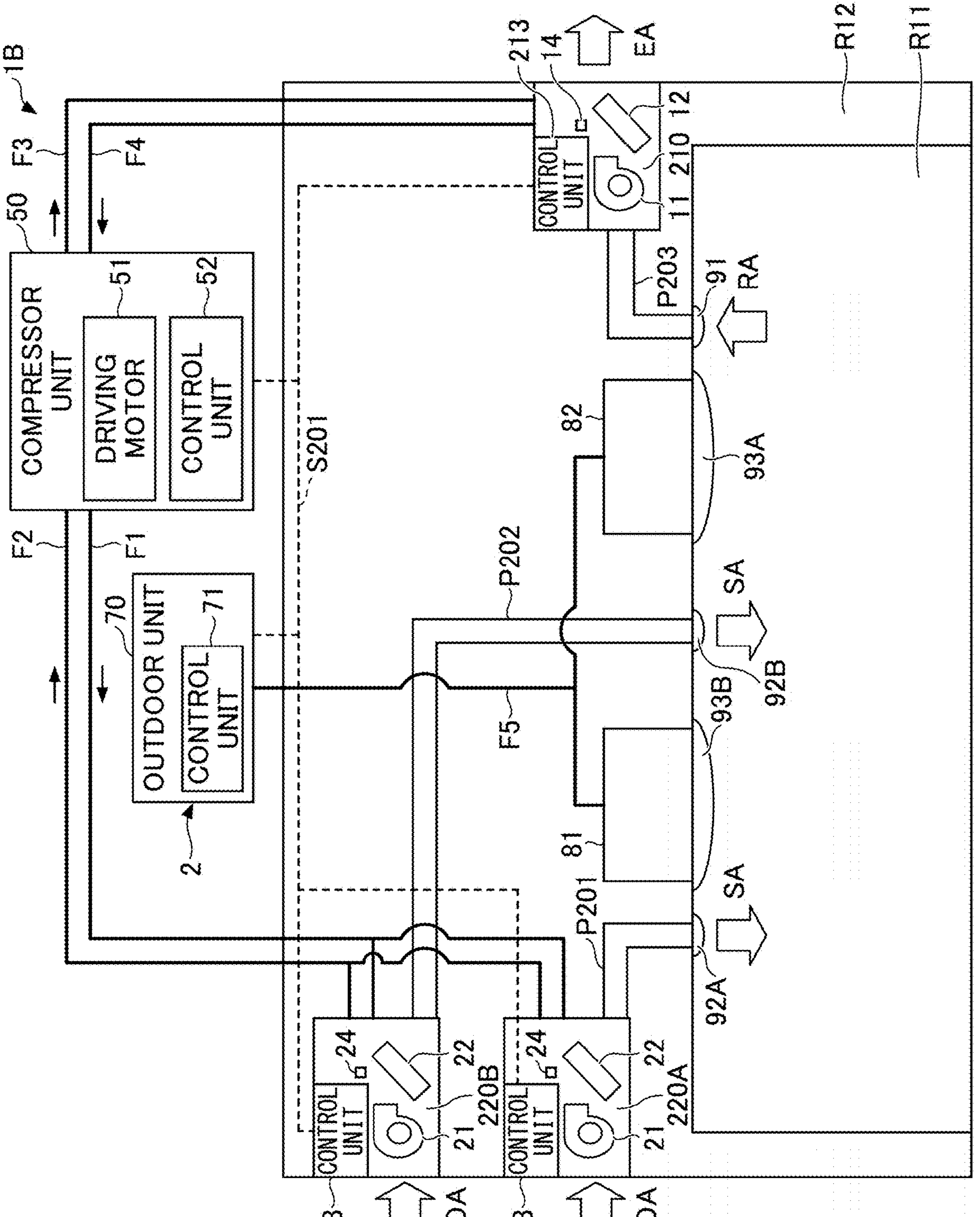

1A
COMPRESSOR UNIT
DRIVING MOTOR
CONTROL UNIT
50
51
52
OUTDOOR UNIT
CONTROL UNIT
70
71
2
F1
F2
F3
F4
F5
S1
S2
CONTROL UNIT
CONTROL UNIT
113
14
12
110
11
23
24
22
20
21
140
M
81
82
P101
P102
P102A
P102B
P102C
P103
91
92
93A
93B
EA
OA
RA
SA
R11
R12

FIG.4



1B
F3
F4
50
COMPRESSOR UNIT
51
DRIVING MOTOR
52
CONTROL UNIT
F2
F1
S201
70
OUTDOOR UNIT
71
CONTROL UNIT
2
213
14
EA
12
210
11
CONTROL UNIT
P203
91
RA
82
93A
P202
SA
92B
93B
F5
81
SA
P201
92A
24
22
220B
21
CONTROL UNIT
23
OA
24
22
220A
21
CONTROL UNIT
23
OA
R12
R11

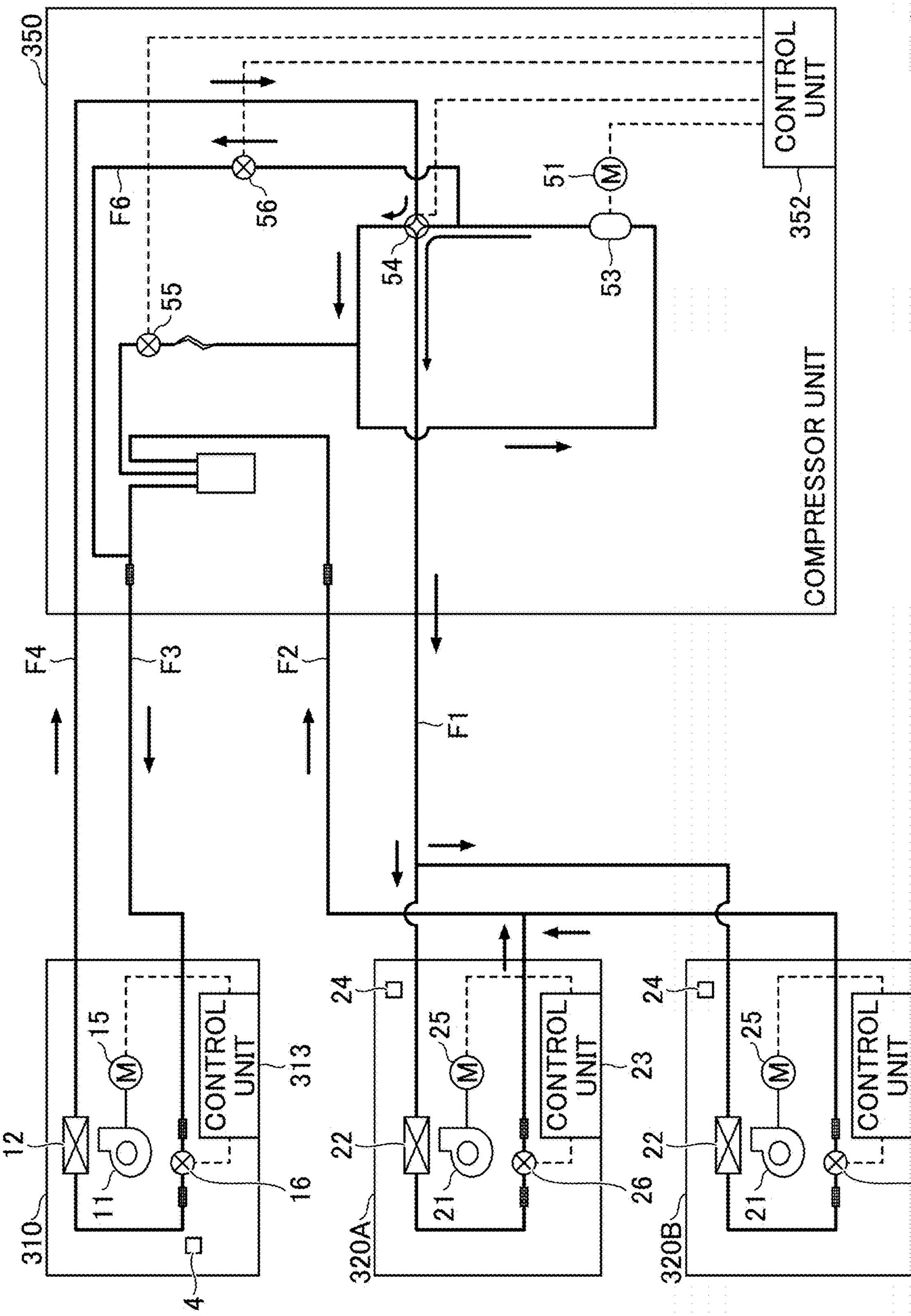
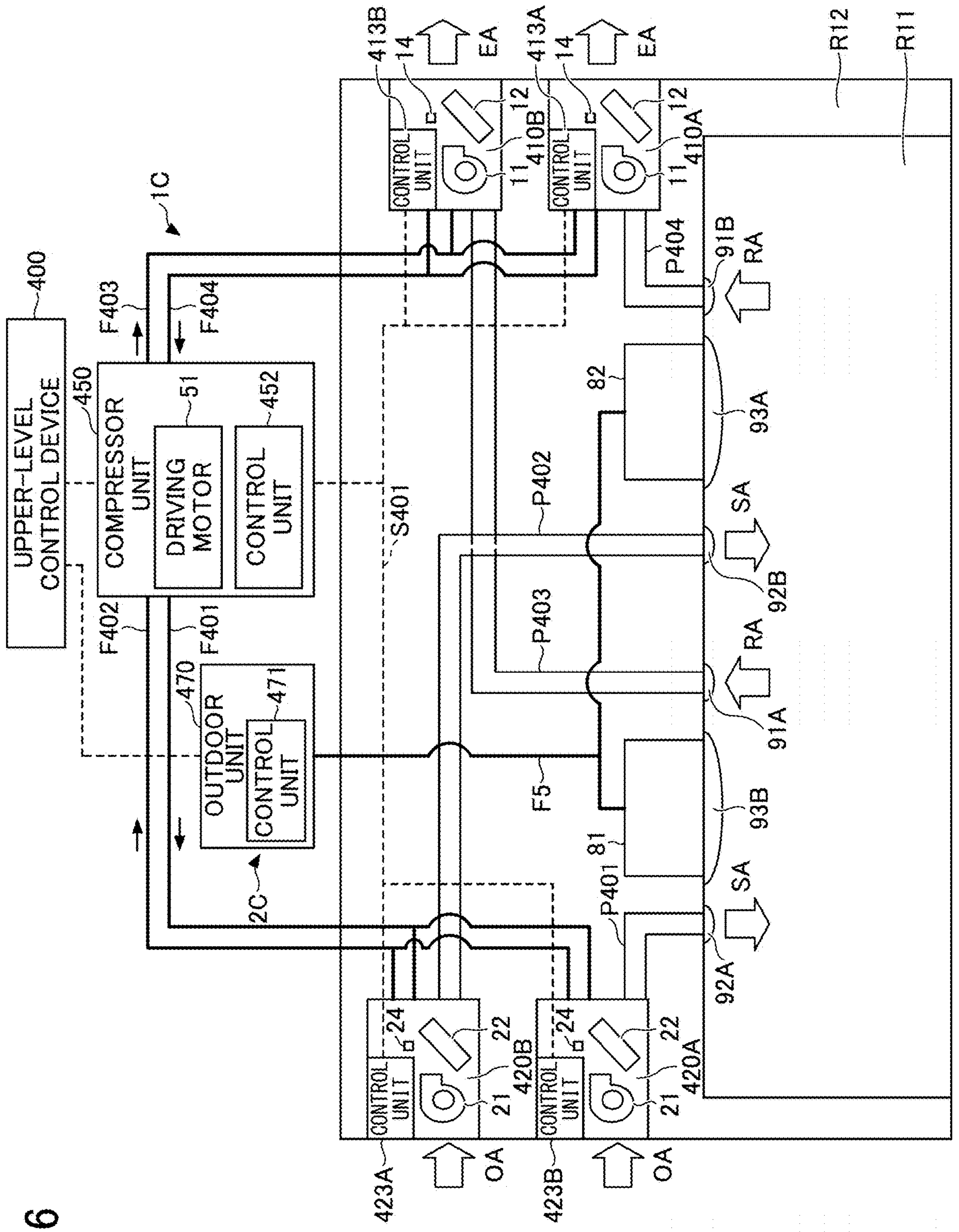

350
CONTROL UNIT
352
51
56
F6
54
55
53
COMPRESSOR UNIT
F4
F3
F2
F1
12
11
15
16
14
CONTROL UNIT
313
310
24
22
21
25
26
CONTROL UNIT
23
320A
24
22
21
25
26
CONTROL UNIT
23
320B

FIG.5

FIG.6


UPPER-LEVEL CONTROL DEVICE
400
COMPRESSOR UNIT
450
DRIVING MOTOR
51
CONTROL UNIT
452
OUTDOOR UNIT
470
CONTROL UNIT
471
2C
1C
F401
F402
F403
F404
F5
S401
P401
P402
P403
P404
CONTROL UNIT
413A
413B
423A
423B
410A
410B
420A
420B
11
12
14
21
22
24
EA
OA
RA
SA
81
82
91A
91B
92A
92B
93A
93B
R11
R12

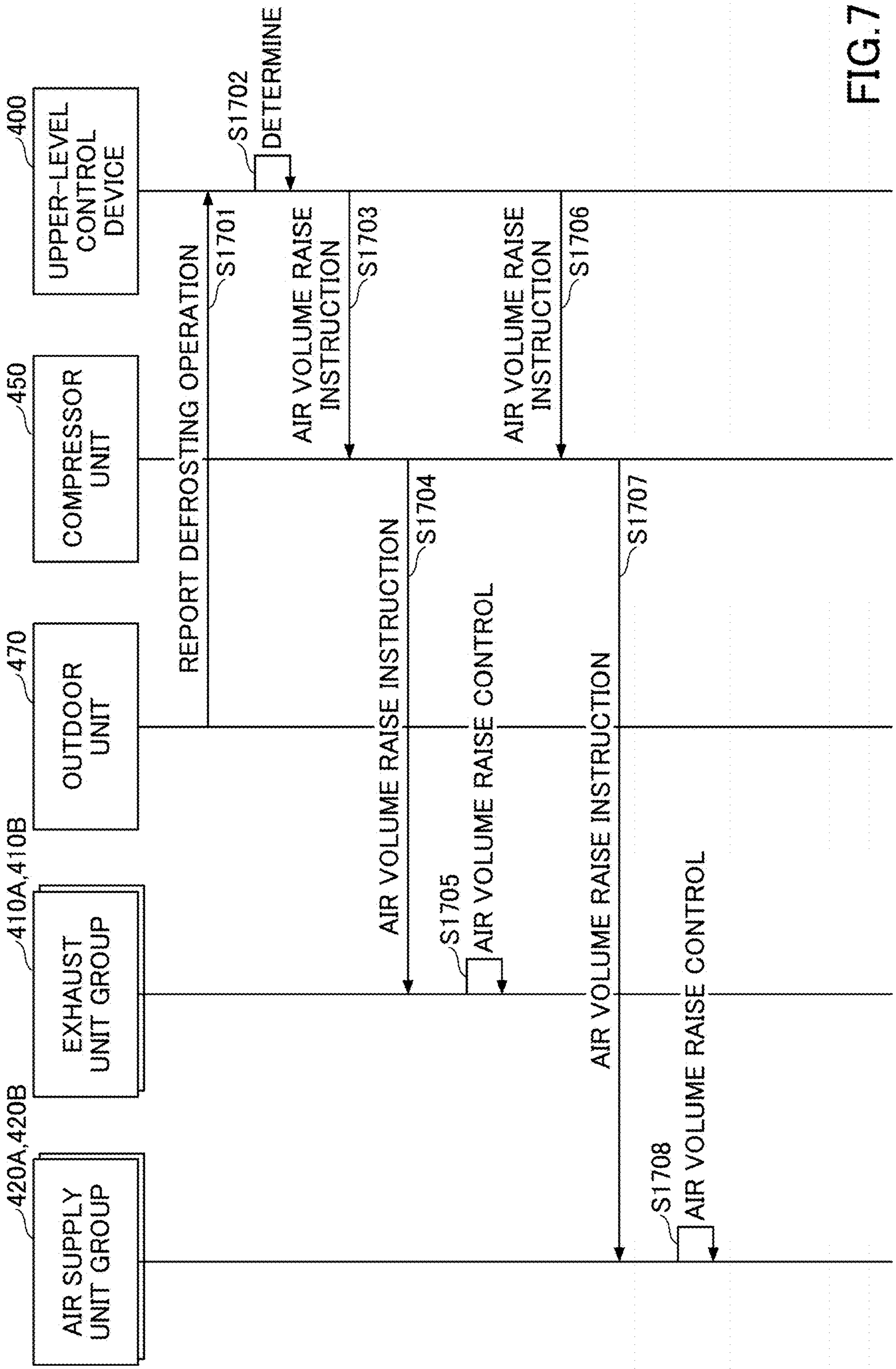
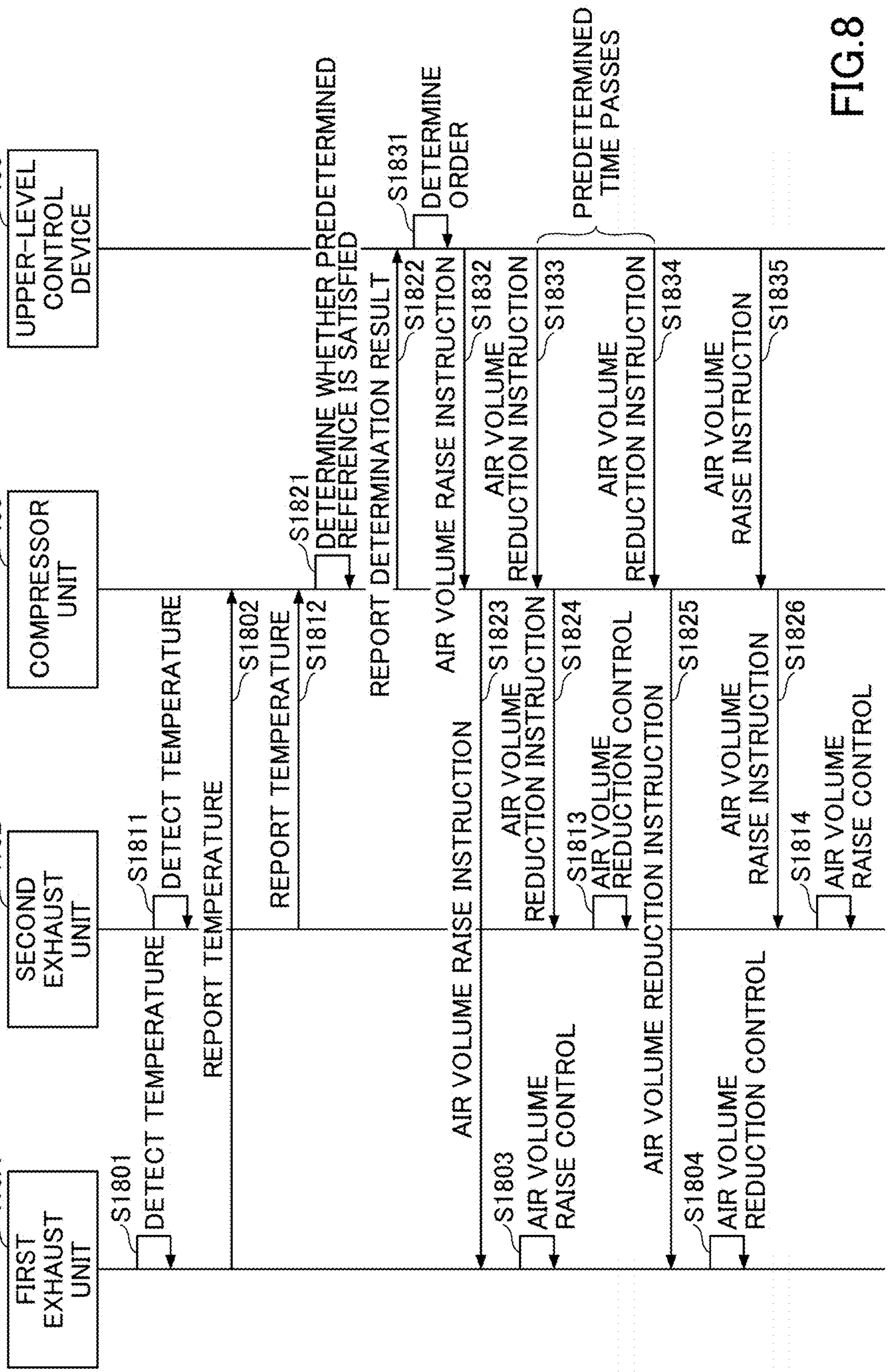

400
UPPER-LEVEL CONTROL DEVICE
450
COMPRESSOR UNIT
470
OUTDOOR UNIT
410A,410B
EXHAUST UNIT GROUP
420A,420B
AIR SUPPLY UNIT GROUP
S1701
REPORT DEFROSTING OPERATION
S1702
DETERMINE
S1703
AIR VOLUME RAISE INSTRUCTION
S1704
AIR VOLUME RAISE INSTRUCTION
S1705
AIR VOLUME RAISE CONTROL
S1706
AIR VOLUME RAISE INSTRUCTION
S1707
AIR VOLUME RAISE INSTRUCTION
S1708
AIR VOLUME RAISE CONTROL

FIG.7



400
UPPER-LEVEL CONTROL DEVICE
450
COMPRESSOR UNIT
410B
SECOND EXHAUST UNIT
410A
FIRST EXHAUST UNIT
S1801
DETECT TEMPERATURE
S1811
DETECT TEMPERATURE
S1802
REPORT TEMPERATURE
S1812
REPORT TEMPERATURE
S1821
DETERMINE WHETHER PREDETERMINED REFERENCE IS SATISFIED
S1822
REPORT DETERMINATION RESULT
S1831
DETERMINE ORDER
S1832
AIR VOLUME RAISE INSTRUCTION
S1823
AIR VOLUME RAISE INSTRUCTION
S1803
AIR VOLUME RAISE CONTROL
S1833
AIR VOLUME REDUCTION INSTRUCTION
S1824
AIR VOLUME REDUCTION INSTRUCTION
S1813
AIR VOLUME REDUCTION CONTROL
PREDETERMINED TIME PASSES
S1834
AIR VOLUME REDUCTION INSTRUCTION
S1825
AIR VOLUME REDUCTION INSTRUCTION
S1804
AIR VOLUME REDUCTION CONTROL
S1835
AIR VOLUME RAISE INSTRUCTION
S1826
AIR VOLUME RAISE INSTRUCTION
S1814
AIR VOLUME RAISE CONTROL

FIG.8

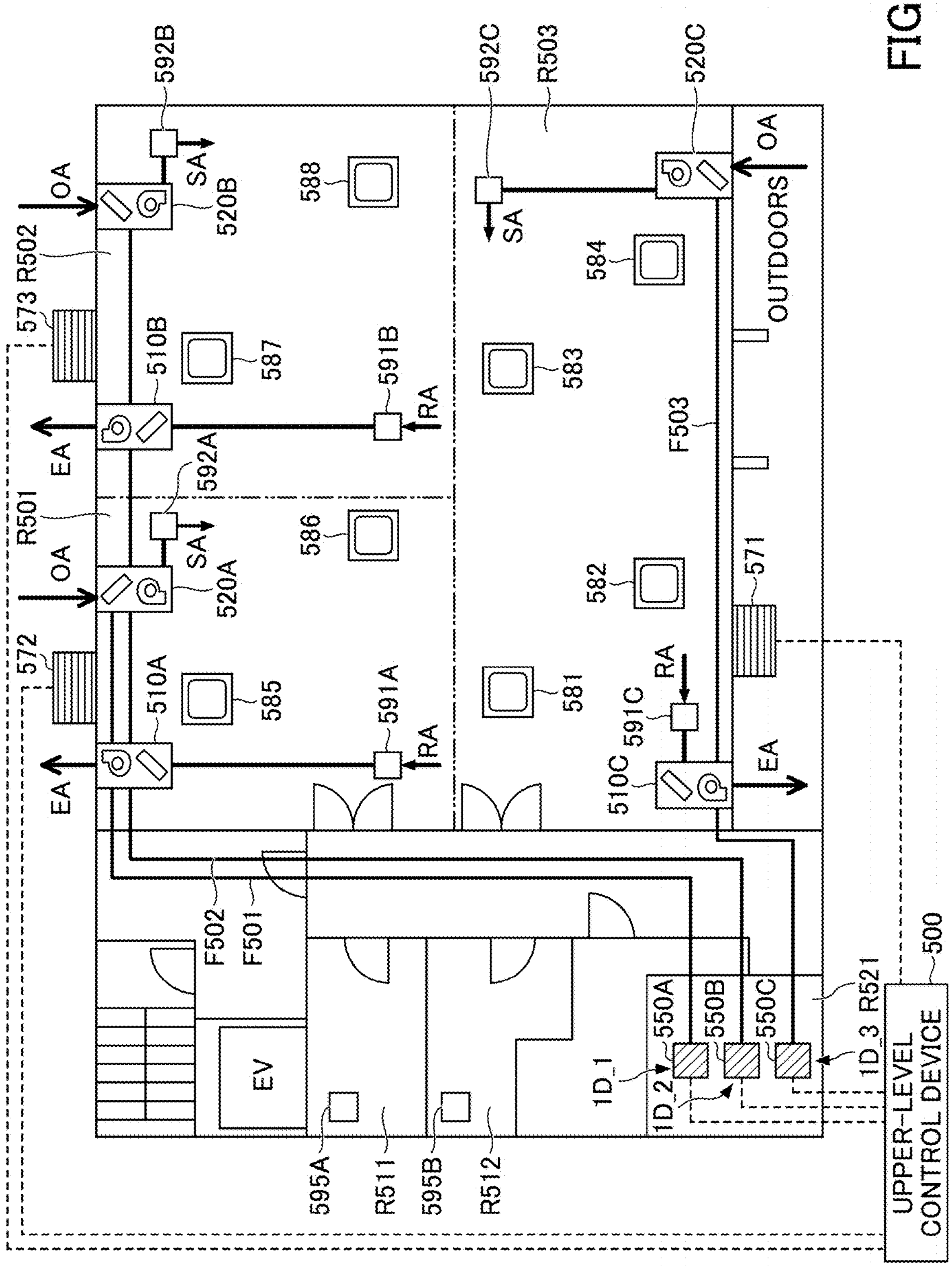
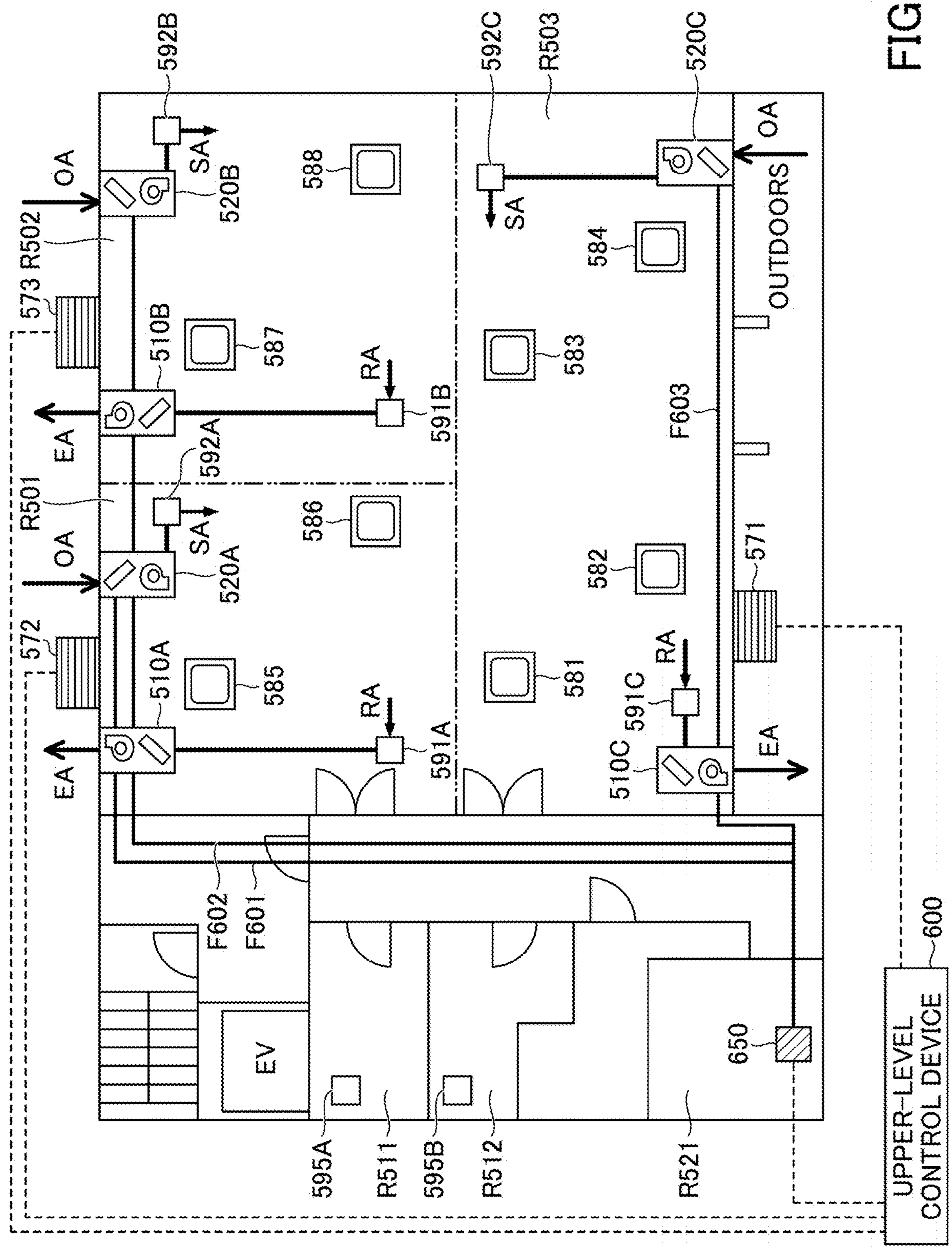

592B
592C
R503
520C
OA
SA
520B
588
SA
OA
R502
573
510B
587
584
OUTDOORS
583
591B
RA
EA
592A
F503
R501
586
SA
OA
520A
582
571
572
510A
585
591A
RA
581
591C
RA
EA
510C
EA
F502
F501
EV
550A
550B
550C
R521
1D_1
1D_2
1D_3
500
595A
R511
595B
R512
UPPER-LEVEL CONTROL DEVICE

FIG.9



592B
592C
R503
520C
OA
SA
588
520B
SA
OA
R502
573
584
OUTDOORS
510B
587
583
RA
591B
EA
F603
592A
R501
586
SA
OA
520A
582
571
572
510A
585
581
RA
591C
RA
591A
EA
510C
EA
F602
F601
EV
650
600
UPPER-LEVEL CONTROL DEVICE
595A
R511
595B
R512
R521

FIG.10

FIG.11

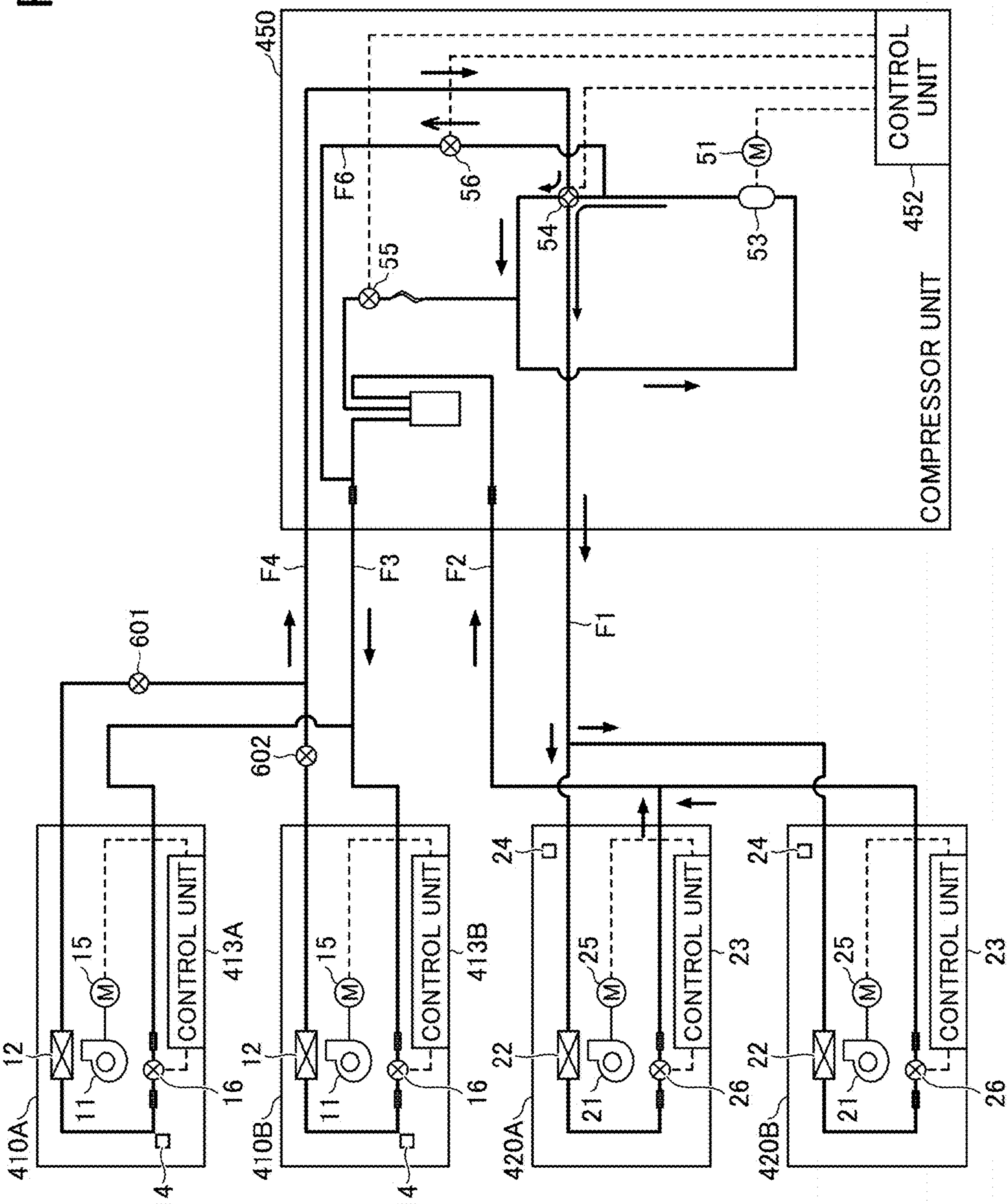
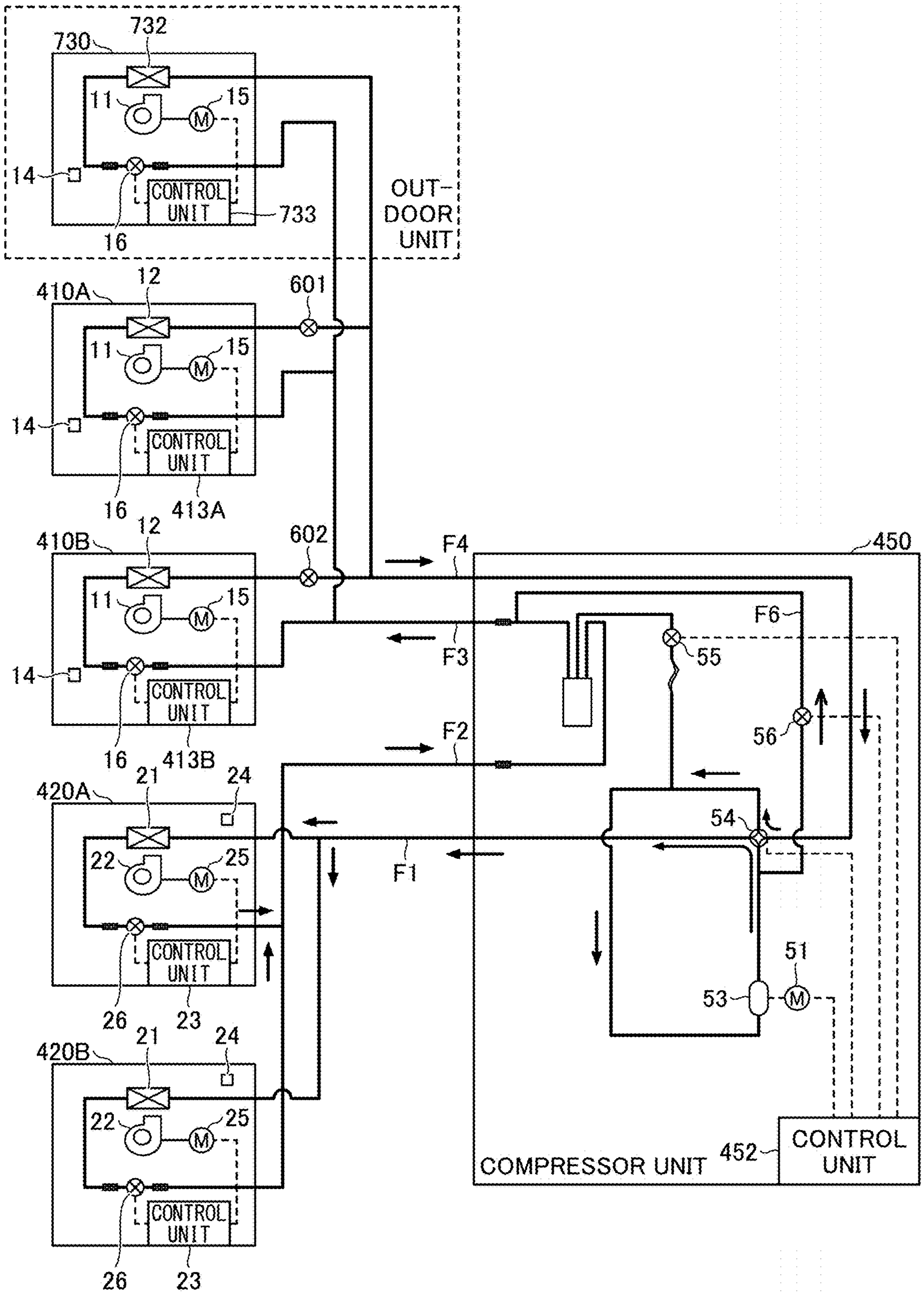

450
CONTROL UNIT
452
COMPRESSOR UNIT
51
53
54
55
56
F6
F1
F2
F3
F4
601
602
410A
410B
420A
420B
11
12
14
15
16
CONTROL UNIT
413A
413B
21
22
23
24
25
26
M

FIG.12



730
732
11
15
14
16
CONTROL UNIT
733
OUT-DOOR UNIT
410A
12
601
413A
410B
602
413B
F4
F3
F2
F1
F6
450
55
56
54
53
51
420A
21
22
24
25
26
23
420B
COMPRESSOR UNIT
452

FIG.13

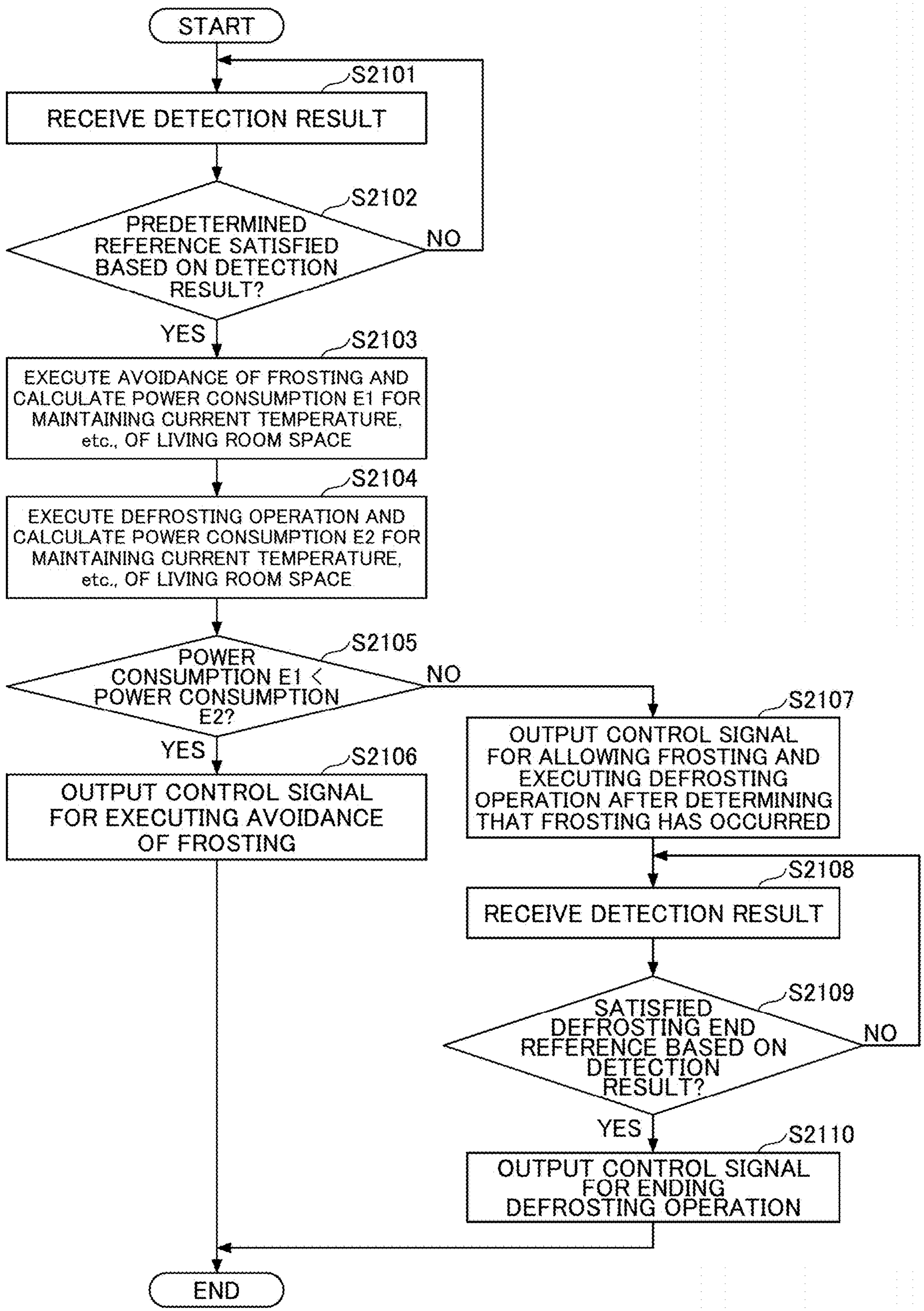
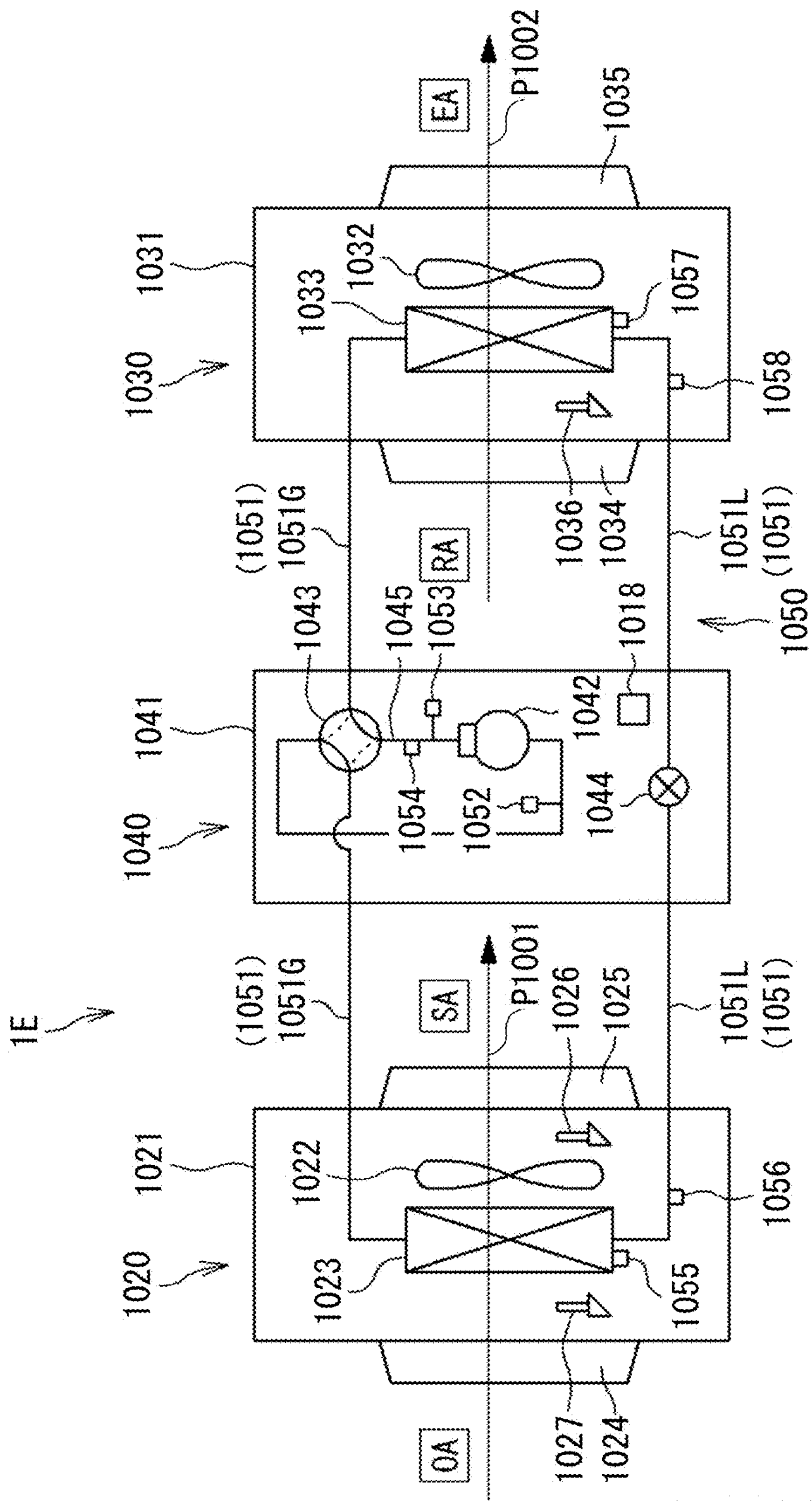

START
S2101
RECEIVE DETECTION RESULT
S2102
PREDETERMINED REFERENCE SATISFIED BASED ON DETECTION RESULT?
NO
YES
S2103
EXECUTE AVOIDANCE OF FROSTING AND CALCULATE POWER CONSUMPTION E1 FOR MAINTAINING CURRENT TEMPERATURE, etc., OF LIVING ROOM SPACE
S2104
EXECUTE DEFROSTING OPERATION AND CALCULATE POWER CONSUMPTION E2 FOR MAINTAINING CURRENT TEMPERATURE, etc., OF LIVING ROOM SPACE
S2105
POWER CONSUMPTION E1 < POWER CONSUMPTION E2?
NO
YES
S2106
OUTPUT CONTROL SIGNAL FOR EXECUTING AVOIDANCE OF FROSTING
S2107
OUTPUT CONTROL SIGNAL FOR ALLOWING FROSTING AND EXECUTING DEFROSTING OPERATION AFTER DETERMINING THAT FROSTING HAS OCCURRED
S2108
RECEIVE DETECTION RESULT
S2109
SATISFIED DEFROSTING END REFERENCE BASED ON DETECTION RESULT?
NO
YES
S2110
OUTPUT CONTROL SIGNAL FOR ENDING DEFROSTING OPERATION
END

FIG.14


1E
1020
1021
1022
1023
1024
1025
1026
1027
OA
SA
P1001
(1051)
1051G
1051L
(1051)
1040
1041
1042
1043
1044
1045
1052
1053
1054
1018
1050
RA
(1051)
1051G
1051L
(1051)
1030
1031
1032
1033
1034
1035
1036
1055
1056
1057
1058
EA
P1002

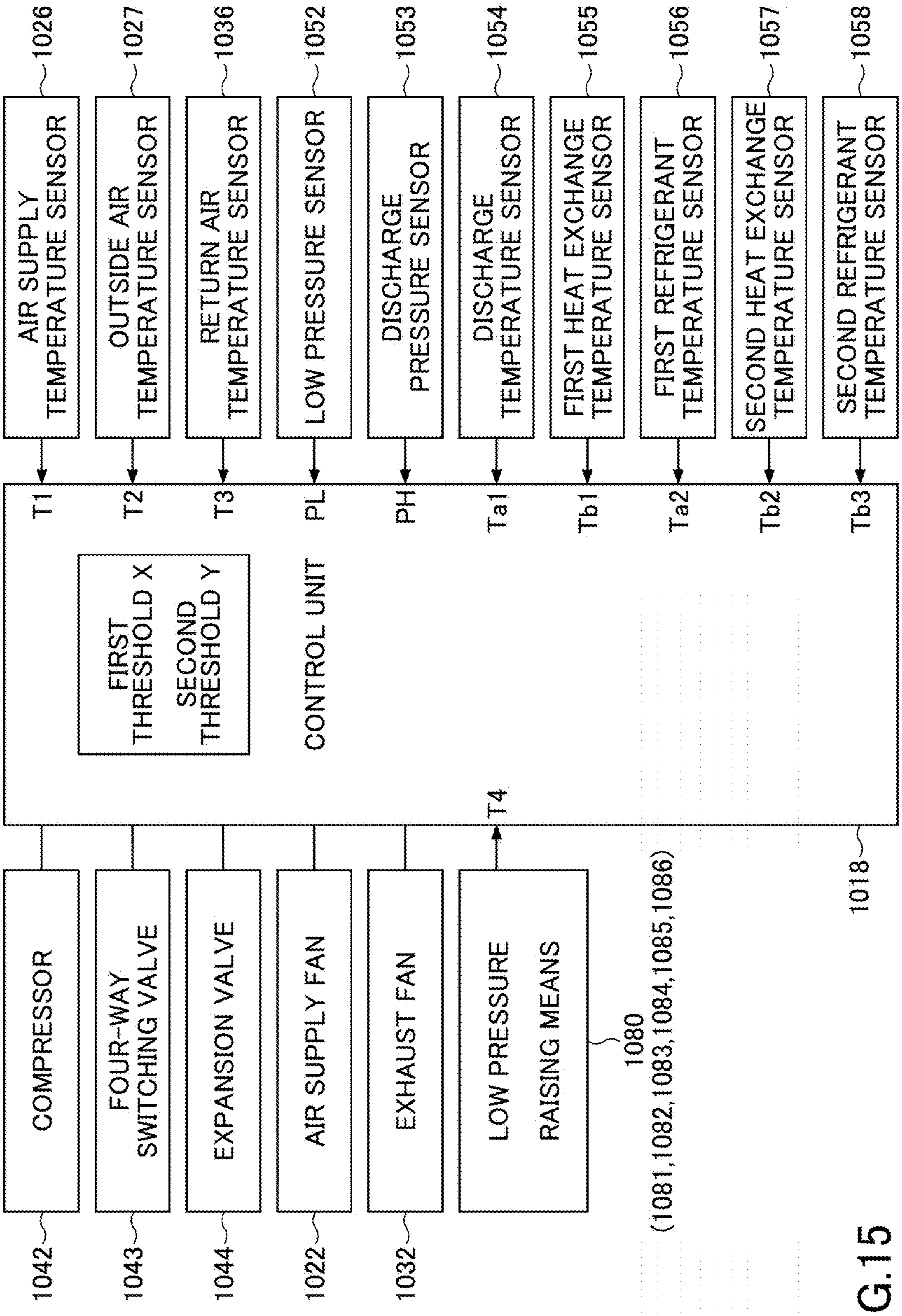

AIR SUPPLY TEMPERATURE SENSOR
1026
OUTSIDE AIR TEMPERATURE SENSOR
1027
RETURN AIR TEMPERATURE SENSOR
1036
LOW PRESSURE SENSOR
1052
DISCHARGE PRESSURE SENSOR
1053
DISCHARGE TEMPERATURE SENSOR
1054
FIRST HEAT EXCHANGE TEMPERATURE SENSOR
1055
FIRST REFRIGERANT TEMPERATURE SENSOR
1056
SECOND HEAT EXCHANGE TEMPERATURE SENSOR
1057
SECOND REFRIGERANT TEMPERATURE SENSOR
1058
T1
T2
T3
PL
PH
Ta1
Tb1
Ta2
Tb2
Tb3
FIRST THRESHOLD X
SECOND THRESHOLD Y
CONTROL UNIT
T4
1018
COMPRESSOR
1042
FOUR-WAY SWITCHING VALVE
1043
EXPANSION VALVE
1044
AIR SUPPLY FAN
1022
EXHAUST FAN
1032
LOW PRESSURE RAISING MEANS
1080
(1081,1082,1083,1084,1085,1086)

FIG.15

FIG.16

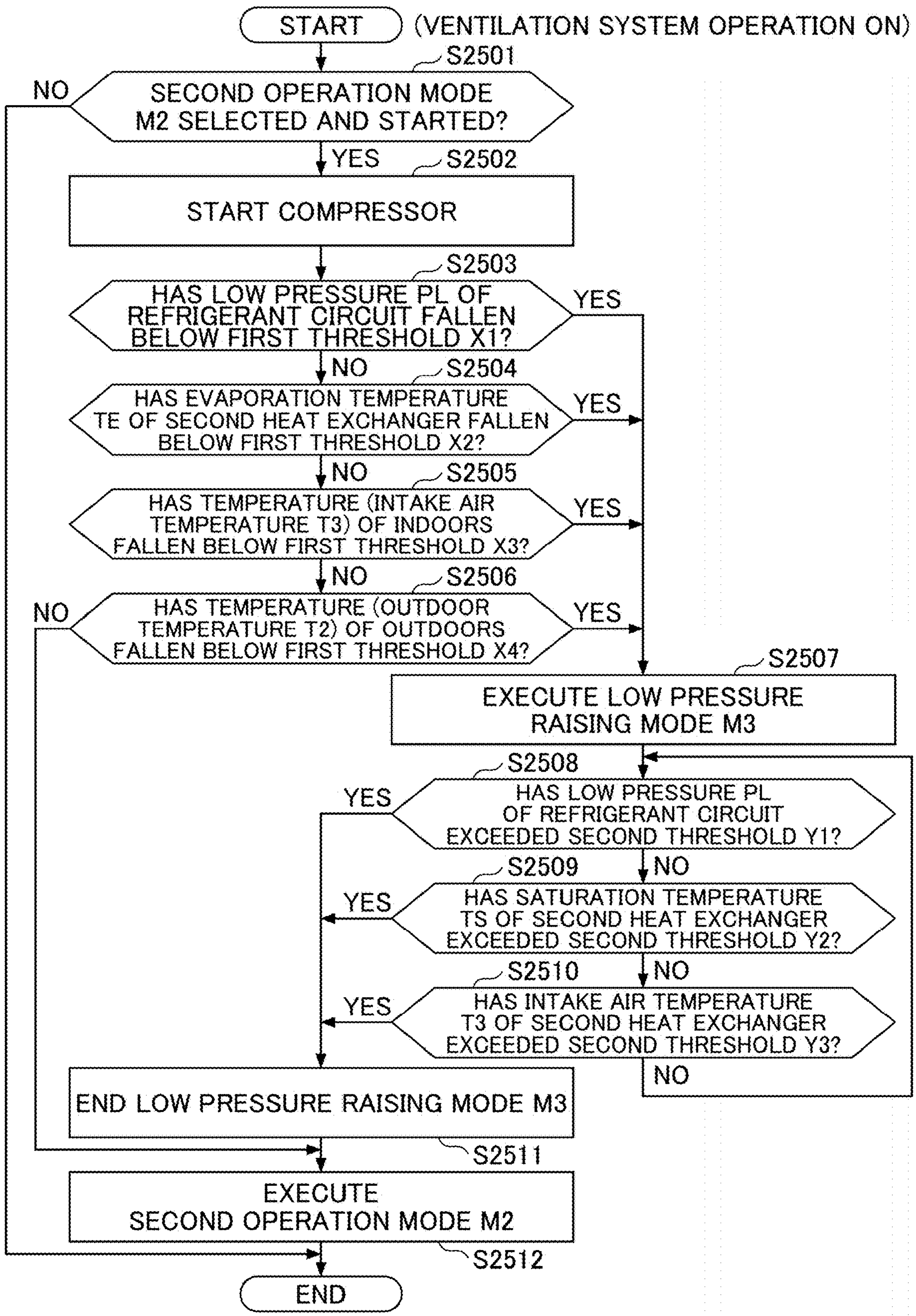

START
(VENTILATION SYSTEM OPERATION ON)
S2501
SECOND OPERATION MODE M2 SELECTED AND STARTED?
NO
YES
S2502
START COMPRESSOR
S2503
HAS LOW PRESSURE PL OF REFRIGERANT CIRCUIT FALLEN BELOW FIRST THRESHOLD X1?
YES
NO
S2504
HAS EVAPORATION TEMPERATURE TE OF SECOND HEAT EXCHANGER FALLEN BELOW FIRST THRESHOLD X2?
YES
NO
S2505
HAS TEMPERATURE (INTAKE AIR TEMPERATURE T3) OF INDOORS FALLEN BELOW FIRST THRESHOLD X3?
YES
NO
S2506
HAS TEMPERATURE (OUTDOOR TEMPERATURE T2) OF OUTDOORS FALLEN BELOW FIRST THRESHOLD X4?
NO
YES
S2507
EXECUTE LOW PRESSURE RAISING MODE M3
S2508
HAS LOW PRESSURE PL OF REFRIGERANT CIRCUIT EXCEEDED SECOND THRESHOLD Y1?
YES
NO
S2509
HAS SATURATION TEMPERATURE TS OF SECOND HEAT EXCHANGER EXCEEDED SECOND THRESHOLD Y2?
YES
NO
S2510
HAS INTAKE AIR TEMPERATURE T3 OF SECOND HEAT EXCHANGER EXCEEDED SECOND THRESHOLD Y3?
YES
NO
END LOW PRESSURE RAISING MODE M3
S2511
EXECUTE SECOND OPERATION MODE M2
S2512
END

FIG.17

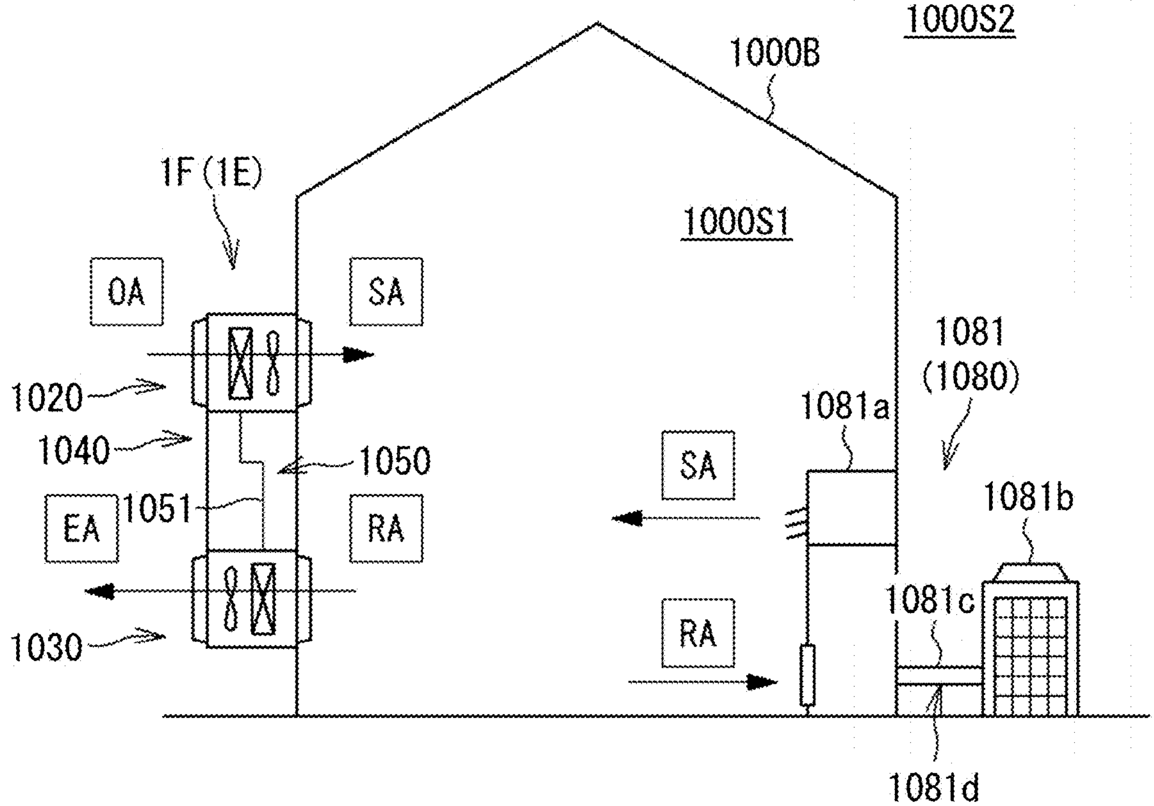

1000S2
1000B
1F (1E)
1000S1
OA
SA
1081
(1080)
1020
1081a
1040
1050
SA
1081b
1051
EA
RA
1081c
RA
1030
1081d

FIG.18

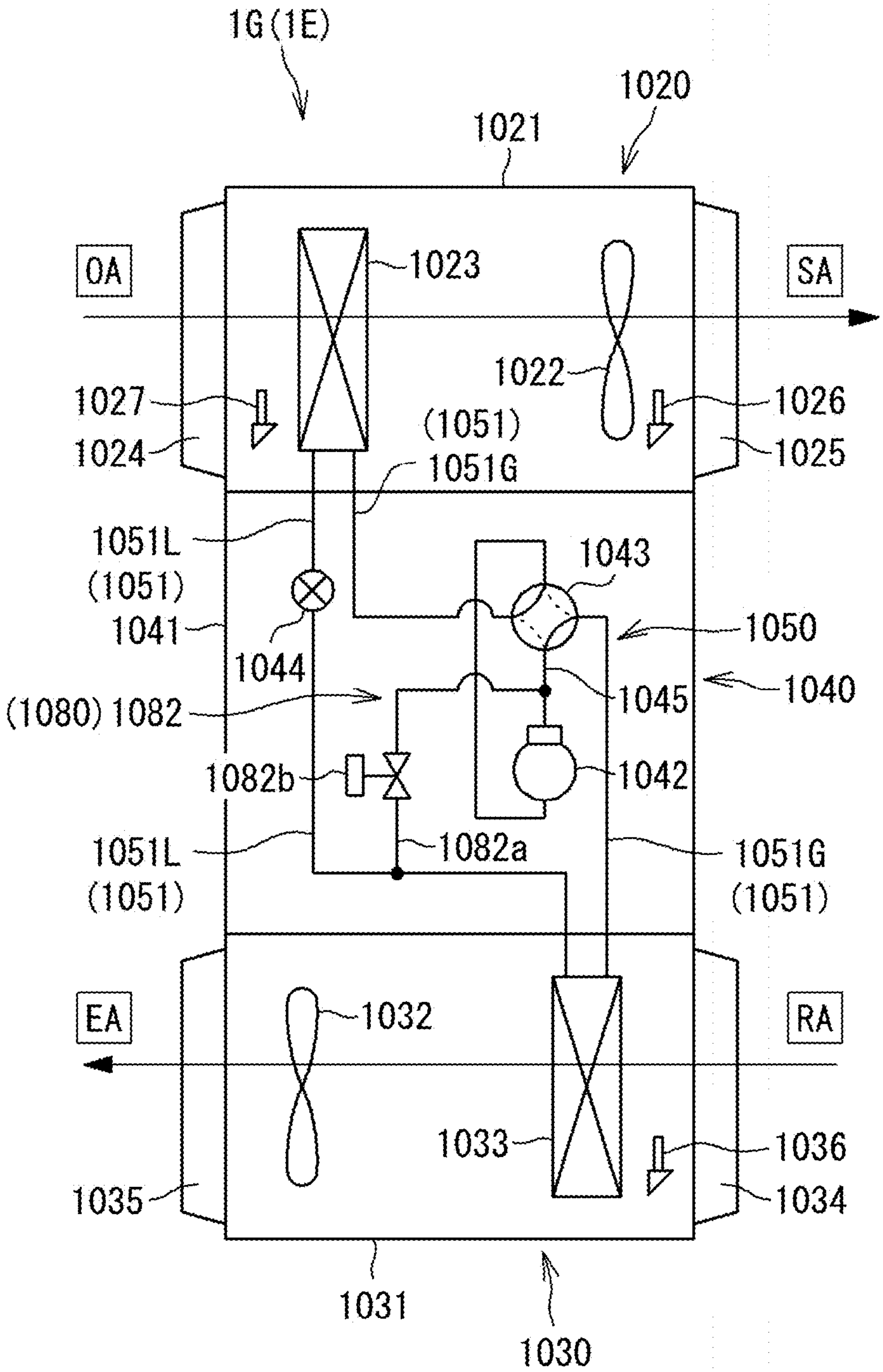

1G(1E)
1020
1021
OA
SA
1023
1022
1027
1026
(1051)
1024
1025
1051G
1051L
(1051)
1043
1041
1050
1044
1045
1040
(1080) 1082
1082b
1042
1082a
1051L
(1051)
1051G
(1051)
EA
RA
1032
1033
1036
1035
1034
1031
1030

FIG.19

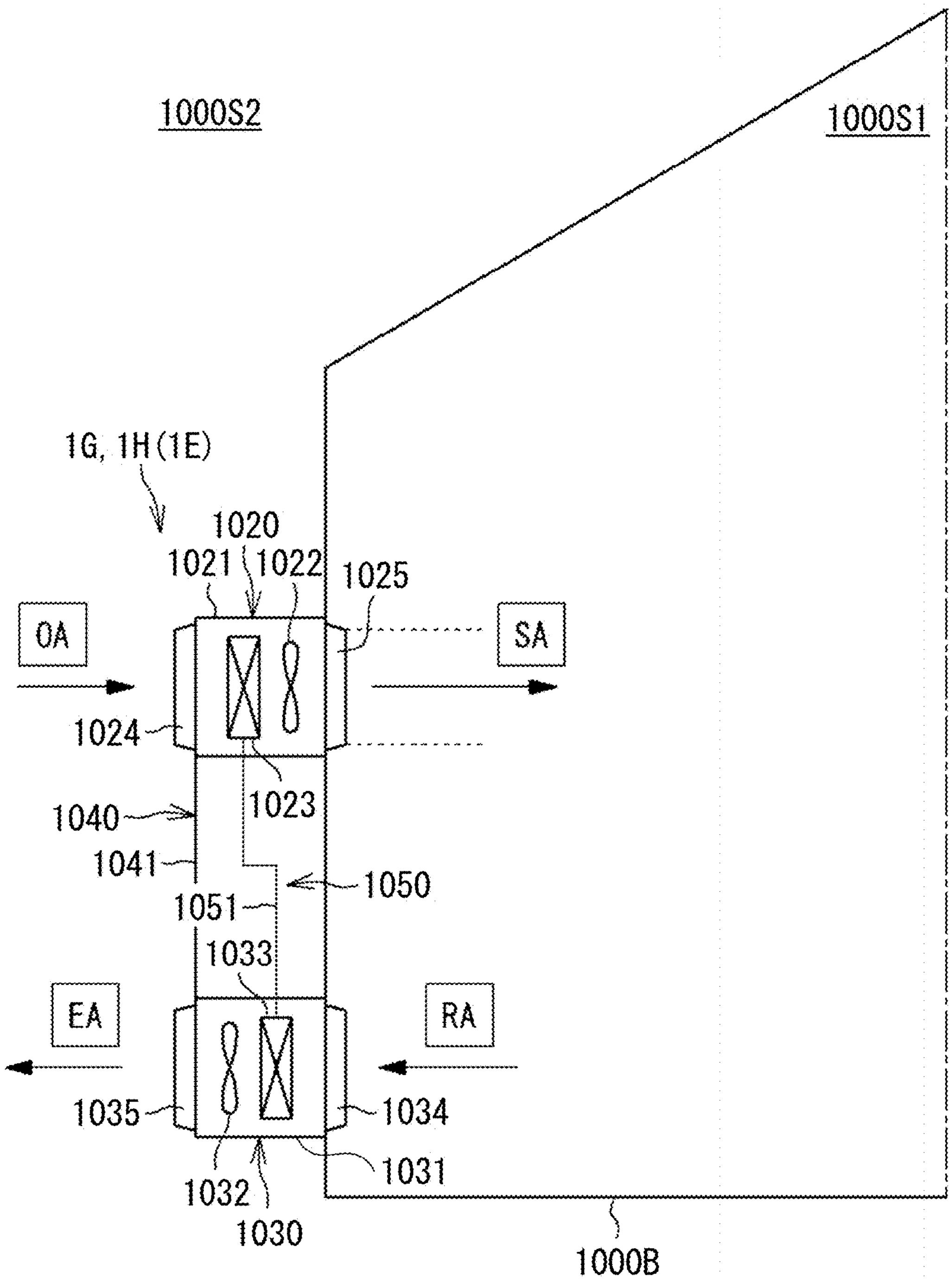
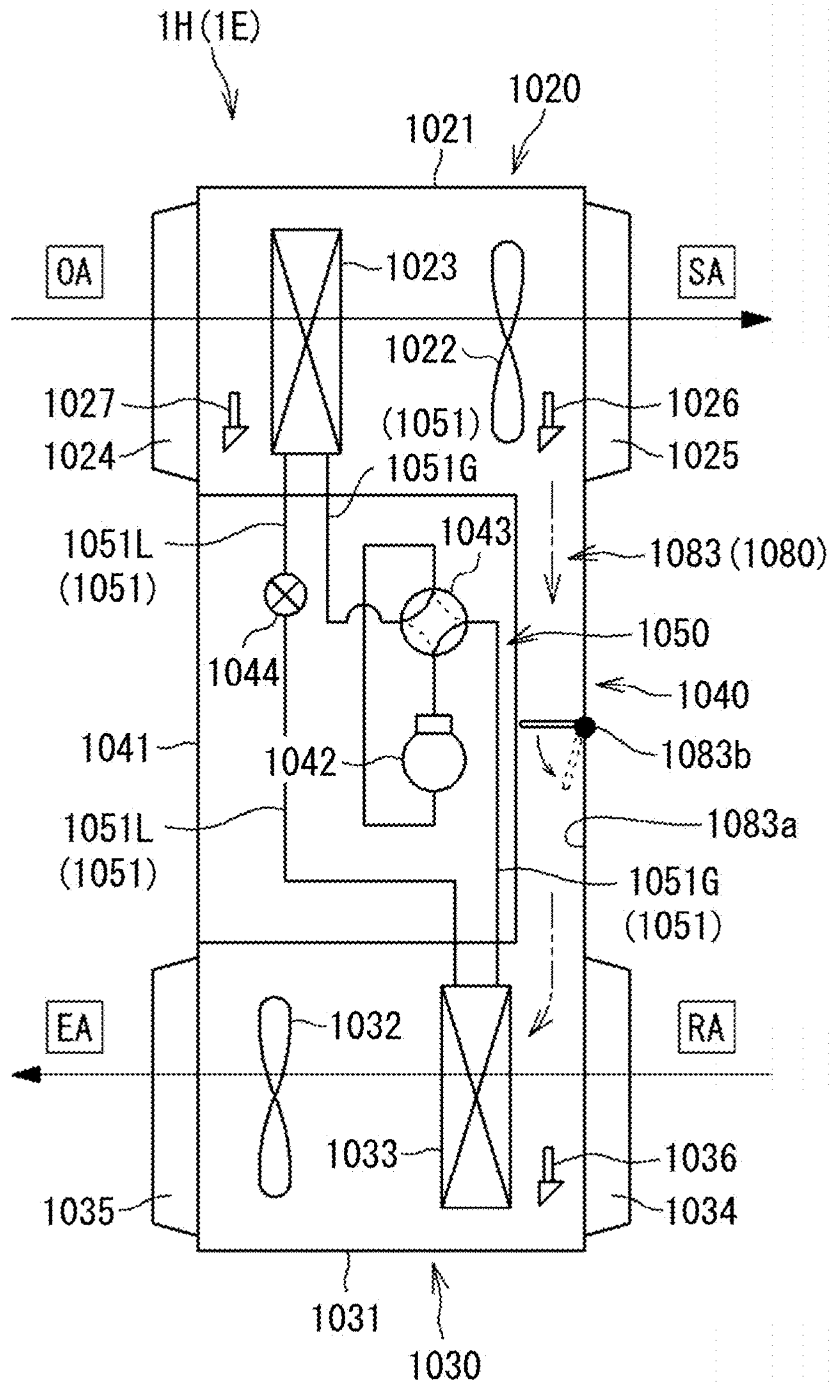

1000S2
1000S1
1G, 1H (1E)
1020
1021
1022
1025
OA
SA
1024
1023
1040
1041
1050
1051
1033
EA
RA
1035
1034
1032
1031
1030
1000B

FIG.20



1H(1E)
1020
1021
OA
SA
1023
1022
1027
1026
(1051)
1024
1025
1051G
1051L
(1051)
1043
1083(1080)
1050
1044
1040
1041
1042
1083b
1083a
1051L
(1051)
1051G
(1051)
EA
RA
1032
1033
1036
1035
1034
1031
1030

FIG.21

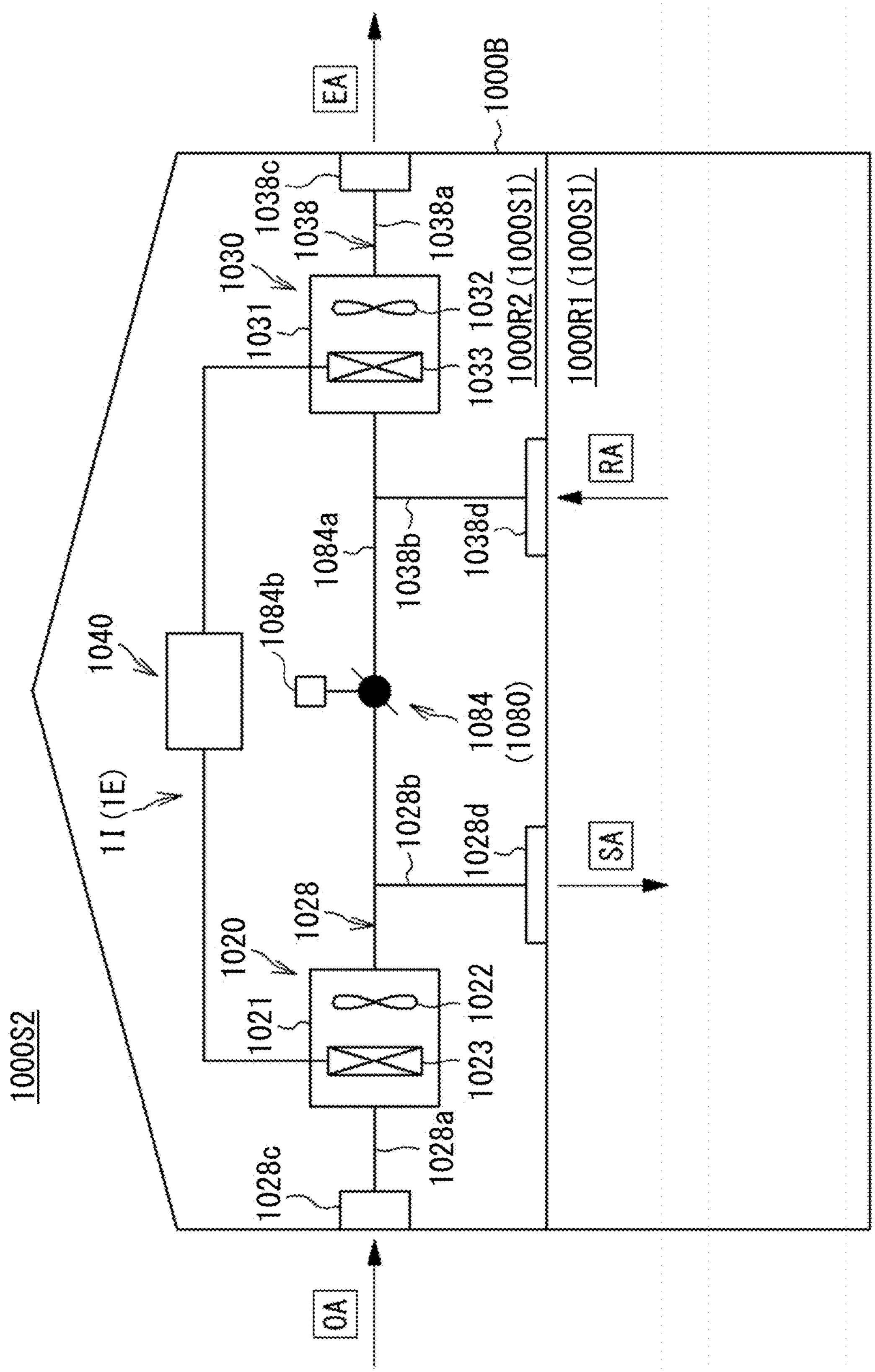

1000S2
OA
1028c
1028a
1021
1023
1022
1020
1028
1028b
1028d
SA
11 (1E)
1040
1084b
1084
(1080)
1084a
1038b
1038d
RA
1031
1033
1032
1030
1038
1038a
1038c
EA
1000B
1000R2 (1000S1)
1000R1 (1000S1)

FIG.22

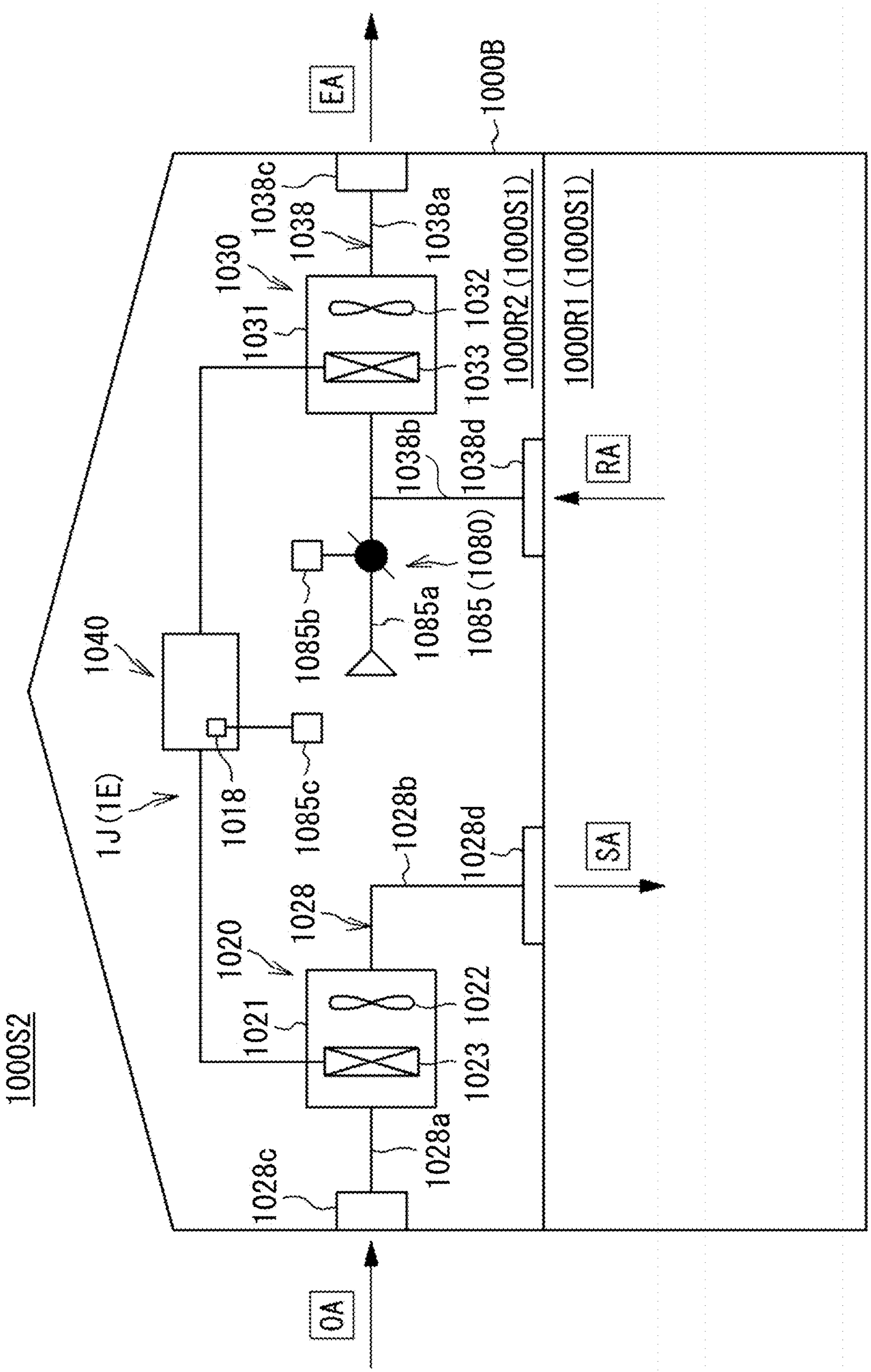
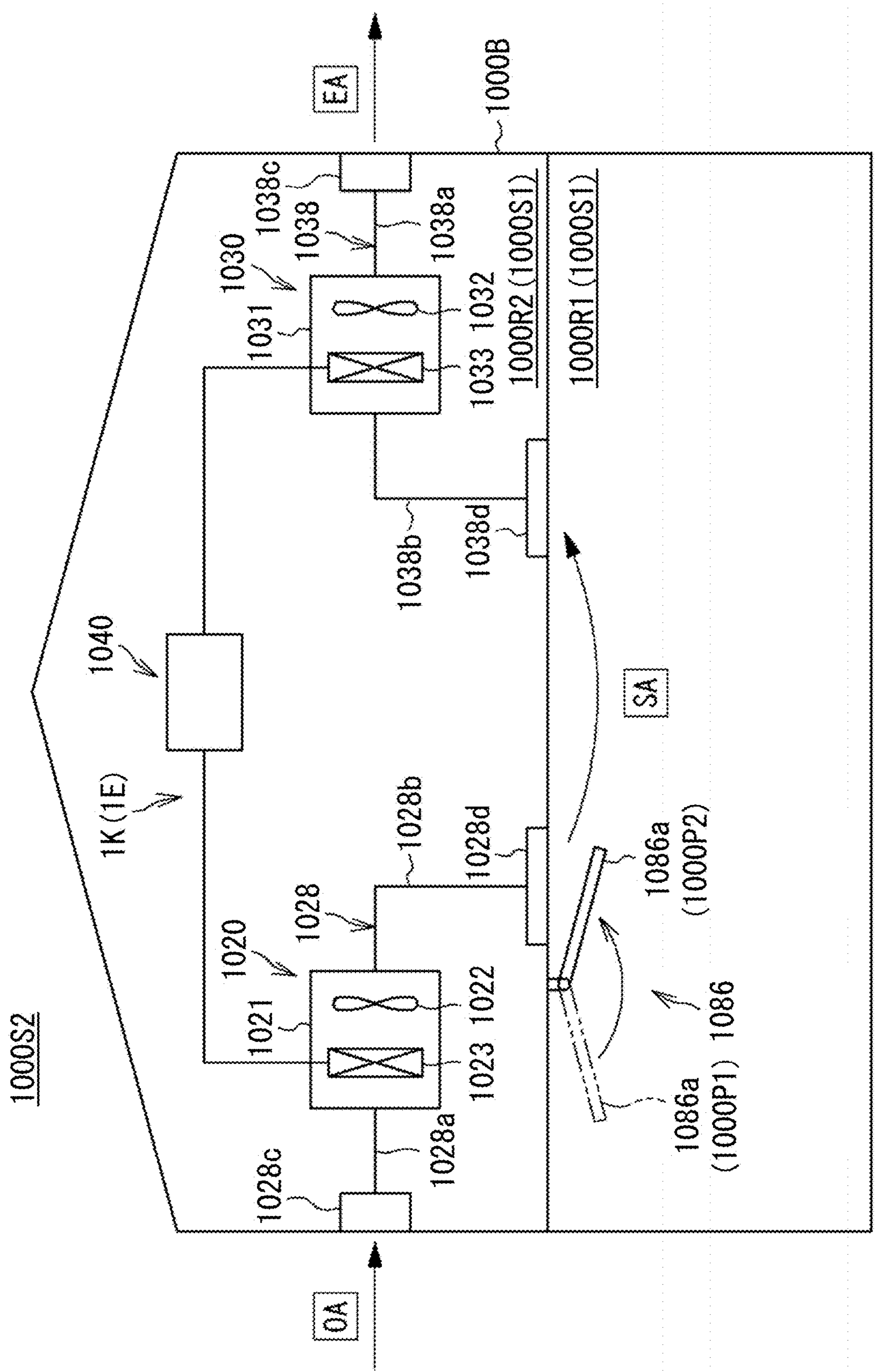

EA
1000B
1038c
1038
1038a
1030
1031
1032
1033
1000R2 (1000S1)
1000R1 (1000S1)
1038b
1038d
RA
1085 (1080)
1085a
1085b
1040
1018
1085c
1J (1E)
1028b
1028d
SA
1028
1020
1021
1022
1023
1028a
1028c
1000S2
OA

FIG.23


1000S2
1K (1E)
1040
1020
1021
1022
1023
1028
1028a
1028b
1028c
1028d
1030
1031
1032
1033
1038
1038a
1038b
1038c
1038d
1000B
1000R2 (1000S1)
1000R1 (1000S1)
OA
EA
SA
1086
1086a (1000P1)
1086a (1000P2)

VENTILATION APPARATUS, AIR CONDITIONING SYSTEM, AND VENTILATION SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application is a continuation application of International Application No. PCT/JP2022/036876 filed on Sep. 30, 2022, which is based on and claims priority to Japanese Patent Application No. 2021-204798 filed on Dec. 17, 2021 and Japanese Patent Application No. 2021-205609 filed on Dec. 17, 2021. The contents of these applications are incorporated herein by reference in their entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to a ventilation apparatus, an air conditioning system, a ventilation method, and a ventilation system.

BACKGROUND ART

[0003] 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

[0004] [Patent Document 1] Japanese Patent No. 5076745

[0005] [Patent Document 2] Japanese Unexamined Patent Application Publication No. H3-20573

SUMMARY

[0006] The present disclosure provides a ventilation apparatus including

[0007] a processor;

[0008] a compressor;

[0009] a first heat exchanger configured to function as a condenser or an evaporator;

[0010] a first air flow path configured to supply air taken in from outdoors to an indoor space after passing through the first heat exchanger;

[0011] a second heat exchanger configured to function as a condenser or an evaporator;

[0012] 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;

[0013] 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

[0014] a memory storing one or more programs, which when executed, cause the processor to:

[0015] 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 processor detects that the predetermined reference is satisfied.

BRIEF DESCRIPTION OF DRAWINGS

[0016] FIG. **1** is a diagram illustrating a configuration example of a ventilation apparatus and an air conditioner according to the first embodiment;

[0017] 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;

[0018] 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;

[0019] FIG. **4** is a diagram illustrating a configuration example of the ventilation apparatus and the air conditioner according to the second embodiment;

[0020] FIG. **5** is a diagram illustrating a refrigerant circuit according to the modified example 1 of the second embodiment;

[0021] 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;

[0022] 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;

[0023] 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;

[0024] FIG. **9** is a diagram illustrating an arrangement of the device group including the upper-level control device according to the seventh embodiment;

[0025] FIG. **10** is a diagram illustrating an arrangement of a device group including an upper-level control device according to an eighth embodiment;

[0026] FIG. **11** illustrates a refrigerant circuit according to the eleventh embodiment;

[0027] FIG. **12** illustrates a refrigerant circuit according to a modified example of the eleventh embodiment;

[0028] FIG. **13** is a flowchart illustrating a processing procedure of the upper-level control device according to the twelfth embodiment;

[0029] FIG. **14** illustrates a schematic configuration of a ventilation system according to an embodiment;

[0030] FIG. **15** is a control block diagram of a ventilation system according to an embodiment of the present invention;

[0031] FIG. **16** is a flow diagram illustrating the operation of a ventilation system according to an embodiment;

[0032] FIG. **17** is a schematic configuration diagram of a ventilation system according to a thirteenth embodiment;

[0033] FIG. **18** is a schematic configuration diagram of a ventilation system according to a fourteenth embodiment;

[0034] 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;

[0035] FIG. **20** is a schematic configuration diagram of a ventilation system according to a fifteenth embodiment;

[0036] FIG. **21** is a schematic configuration diagram of a ventilation system according to a sixteenth embodiment;

[0037] FIG. **22** is a schematic configuration diagram of a ventilation system according to a seventeenth embodiment; and

[0038] FIG. **23** is a schematic configuration diagram of a ventilation system according to a eighteenth embodiment.

DESCRIPTION OF EMBODIMENTS

[0039] 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

[0040] 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.

[0041] In the present embodiment, as an example of an indoor space, an example having a living room space R**11** and a ceiling space R**12** will be described. However, the indoor space is not limited to the living room space R**11** and the ceiling space R**12**, and may be a space inside a building, for example, a space under the floor.

[0042] The living room space R**11** is, for example, a living room inside an office or a house. The ceiling space R**12** is an adjacent space above the living room space R**11**. The ceiling space R**12** exists above the living room space R**11**, and, therefore, warm air tends to be collected in the ceiling space R**12**.

[0043] The air conditioner **2** includes an outdoor unit **70** and two air conditioning indoor units **81** and **82** (air conditioning indoor devices). 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.

[0044] The air conditioner **2** performs a vapor compression type refrigeration cycle to cool and heat the living room space R**11**. The air conditioner **2** according to the present embodiment can both cool and heat the living room space R**11**. 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.

[0045] The space between the outdoor unit **70** and the two air conditioning indoor units **81** and **82** is connected by a connection pipe F**5**. The connection pipe F**5** 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**.

[0046] 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.

[0047] 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 R**11**. 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 R**11**. 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 **93**A and **93**B. Although an example in which the ventilation ports **93**A and **93**B are provided on the ceiling will be described in the present embodiment, the positions at which the ventilation ports **93**A and **93**B 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.

[0048] The ventilation apparatus **1** includes the exhaust unit **10**, the air supply unit **20**, a compressor unit **50**, refrigerant circuits F**1**, F**2**, F**3**, and F**4**, an air supply flow path P**1**, and a return air flow path P**2**.

[0049] The ventilation apparatus **1** supplies the air taken in from outdoors to the living room space R**11** and exhausts the air taken in from the indoor space (including the living room space R**11**) to the outside. Thus, the ventilation apparatus **1** implements the replacement of the air in the living room space R**11**.

[0050] 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 R**11**.

[0051] The air supply flow path P**1** (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 R**11** 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.

[0052] The return air flow path P**2** (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 R**11** 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.

[0053] In the return air flow path P**2** 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 P**2**A (an example of a second air flow path) and a second return air branch path P2B (an example of the third air flow path).

[0054] 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.

[0055] 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.

[0056] 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) 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.

[0057] 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.

[0058] 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.

[0059] 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.

[0060] The driving motor **51** is a motor for rotating (driving) the compressor for compressing the refrigerant.

[0061] 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**.

[0062] 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.

[0063] The fan **21** functions to supply air (SA) to the living room space R11 from the outside air (OA) that is taken in.

[0064] The first heat exchanger **22** functions as a condenser or an evaporator.

[0065] 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**.

[0066] 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**.

[0067] 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.

[0068] The fan **11** functions to exhaust (EA) the return air (RA) taken in from the living room space R11 to the outside.

[0069] The second heat exchanger **12** functions as a condenser or an evaporator.

[0070] 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).

[0071] 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**.

[0072] 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**.

[0073] 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 **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.

[0074] 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**.

[0075] 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 F**1**, F**2**, F**3**, and F**4** has fallen below the predetermined pressure threshold.

[0076] 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 satisfies 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.

[0077] 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 R**12** is guided to the second heat exchanger **12** through the second return air branch path P**2**B as a control to prevent frosting in the second heat exchanger **12**. That is, warm air is gathered in the ceiling space R**12** because the ceiling space R**12** exists above the living room space R**11**. 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 R**12** and the air existing in the living room space R**11** is guided to the second heat exchanger **12**.

[0078] 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 R**12** to flow to the second heat exchanger **12**. Thus, frosting in the second heat exchanger **12** can be prevented.

[0079] 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.

[0080] The control unit **13** of the exhaust unit **10** acquires the temperature of the outside air from the temperature detecting unit **14** (S**1201**).

[0081] 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 (S**1202**).

[0082] When the control unit **13** of the exhaust unit **10** determines that the predetermined reference is not satisfied (S**1202**: NO), the control unit **13** ends the process without performing any particular processing.

[0083] On the other hand, when the control unit **13** of the exhaust unit **10** determines that the predetermined reference is satisfied (S**1202**: YES), the control unit **13** acquires, from the temperature detecting unit **14**, the temperature of the air in the ceiling space R**12** and the temperature of the air taken in from the living room space R**11** (S**1203**).

[0084] The control unit **13** of the exhaust unit **10** determines whether the temperature of the air in the ceiling space R**12** is higher than the temperature of the air in the living room space R**11** (S**1204**). When the control unit **13** determines that the temperature of the air in the ceiling space R**12** is lower than the temperature of the air in the living room space R**11** (S**1204**: 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.

[0085] On the other hand, when the control unit **13** determines that the temperature of the air in the ceiling space R**12** is higher than the temperature of the air in the living room space R**11** (S**1204**: YES), the control unit performs control to open the opening/closing damper **40** (S**1205**).

[0086] 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 R**12** where the air is warmer than the living room space R**11** is guided to the second heat exchanger **12**.

[0087] 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

[0088] 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 R**12** 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 R**12** 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 R**11**.

[0089] 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**.

[0090] 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.

[0091] 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.

[0092] 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 R**11**. 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 R**11**, and, therefore, the temperature of the refrigerant flowing through the second heat exchanger **12** can be raised.

[0093] 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 R**11**. Accordingly, the room temperature of the living room space R**11** 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**.

[0094] In the present modified example, an example of outputting a control signal for raising the temperature currently set in the living room space R**11** 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 R**11**, 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 R**11**.

Modified Example 2 of the First Embodiment

[0095] 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.

[0096] 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.

[0097] The control unit **13** controls the fan **11** (an example of a second ventilation device) 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.

[0098] 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 device) 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**.

[0099] 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 R**11**. 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

[0100] 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.

[0101] 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 **1**A 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.

[0102] As illustrated in FIG. **3**, a bypass flow path P**102** is provided between the air supply unit **20** and the exhaust unit **110**. The bypass flow path P**102** includes a first bypass partial flow path P**102**A further towards the air supply unit **20** than the air supply flow path P**101**, a third bypass partial flow path P**102**C further towards the exhaust unit **110** than the return flow path P**103**, and a second bypass partial flow path P**102**B connecting the first bypass partial flow path P**102**A and the third bypass partial flow path P**102**C.

[0103] An opening/closing damper **140** is provided on the second bypass partial flow path P**102**B. The opening/closing damper **140** is usually closed. The opening/closing damper **140** (an example of the second guide) 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 S**2**.

[0104] After taking in outside air (OA), the air supply unit **20** usually supplies air (SA) to the living room space R**11** through the first bypass partial flow path P**102**A and the air supply flow path P**101**.

[0105] 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 R**11** through the return flow path P**103** and the third bypass partial flow path P**102**C, and exhausts (EA) the air to the outside.

[0106] 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.

[0107] 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**.

[0108] 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 P**102** 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

[0109] 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.

[0110] 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 **1**B 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.

[0111] The control unit **52** of the compressor unit **50**, the control unit **23** of the first air supply unit **220**A, the control unit **23** of the second air supply unit **220**B, and the control unit **213** of the exhaust unit **210** are connected by a signal line S**201** 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 **220**A, the control unit **23** of the second air supply unit **220**B, and the control unit **213** of the exhaust unit **210**.

[0112] The ventilation apparatus **1**B includes an exhaust unit **210**, a first air supply unit **220**A, a second air supply unit **220**B, a compressor unit **50**, refrigerant circuits F**1**, F**2**, F**3**, and F**4**, a first air supply flow path P**201**, a second air supply flow path P**202**, and a return air flow path P**203**.

[0113] The first air supply flow path P**201** (an example of the first air flow path) supplies air taken in from the outdoors to the living room space R**11** from the ventilation port **92**A after passing through the first air supply unit **220**A having the first heat exchanger **22**.

[0114] The second air supply flow path P**202** (an example of the first air flow path) supplies air taken in from the outside to the living room space R**11** from the ventilation port **92**B after passing through the second air supply unit **220**B having the first heat exchanger **22**.

[0115] The return air flow path P**203** (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**.

[0116] The first air supply unit **220**A and the second air supply unit **220**B 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 R**11**.

[0117] 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 R**11** and exhausts air (EA) to the outside.

[0118] 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**.

[0119] The processing performed by the ventilation apparatus **1**B 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 **220**A and the second air supply unit **220**B 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**.

[0120] 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.

[0121] 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**.

[0122] 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.

[0123] 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 F**1**, F**2**, F**3**, and F**4** is reduced, and, therefore, the temperature (evaporation temperature) of the refrigerant flowing through the second heat exchanger **12** can be increased.

[0124] 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

[0125] 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.

[0126] 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.

[0127] In the example illustrated in FIG. **5**, the air supply units **320**A and **320**B, the exhaust unit **310**, and the compressor unit **350** are provided.

[0128] The air supply units **320**A and **320**B 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**.

[0129] The driving motor **25** controls the air volume of the fan **21** by the control unit **23**.

[0130] 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.

[0131] 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**.

[0132] 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.

[0133] 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 F**6**, as a control for preventing frosting in the second heat exchanger **12**.

[0134] The driving motor **15** controls the air volume of the fan **11** by the control unit **313**.

[0135] 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.

[0136] 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**.

[0137] The compressor **53** compresses the refrigerant flowing through the refrigerant circuit.

[0138] 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**.

[0139] 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**.

[0140] 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 F**1**

and the refrigerant circuit F**4**. 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 F**1** based on the control of the control unit **352**.

[0141] 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.

[0142] In the present modified example, when the second heat exchanger **12** functions as an evaporator, a bypass flow path F**6** 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**.

[0143] The bypass flow path F**6** 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 F**3**. That is, while the second heat exchanger **12** functions as an evaporator, the bypass flow path F**6** functions as a pipe for passing the refrigerant to the second heat exchanger **12** without going through the first heat exchanger **22**.

[0144] The bypass electric valve **56** functions as a valve for switching whether the refrigerant flows to the bypass flow path F**6** according to the control from the control unit **352**.

[0145] Specifically, the control unit **313** of the exhaust unit **310** first outputs a control signal for passing the refrigerant to the bypass flow path F**6**, 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.

[0146] When the control signal for passing the refrigerant to the bypass flow path F**6** 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.

[0147] 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 F**3** through the bypass flow path F**6**. Accordingly, the temperature of the refrigerant flowing through the refrigerant circuit F**3** rises. Then, the refrigerant whose temperature has risen flows into the second heat exchanger **12**.

[0148] 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 F**6** into the second heat exchanger **12**. Thus, frosting in the second heat exchanger **12** can be prevented.

Modified Example 2 of the Second Embodiment

[0149] 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 F**6**.

[0150] 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.

[0151] 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.

[0152] 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**.

[0153] 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

[0154] 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.

[0155] 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.

[0156] In the example illustrated in FIG. **6**, an upper-level control device **400** is provided for performing the cooperation between the ventilation apparatus **1**C and the air conditioner **2**C.

[0157] The air conditioner **2**C 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.

[0158] The outdoor unit **470** includes a control unit **471** together with a heat exchanger (not illustrated).

[0159] The control unit **471** controls the entire air conditioner **2**C. 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**.

[0160] The ventilation apparatus **1**C includes a first exhaust unit **410**A, a second exhaust unit **410**B, a first air supply unit **420**A, a second air supply unit **420**B, a compressor unit **450**, refrigerant circuits F**401**, F**402**, F**403**, and F**404**, a first air supply flow path P**401**, a second air supply flow path P**402**, a first return air flow path P**403**, and a second return air flow path P**404**.

[0161] The first air supply flow path P**401** supplies air taken in from outside to the living room space R**11** from the ventilation port **92**A after passing through the first air supply unit **420**A having the first heat exchanger **22**.

[0162] The second air supply flow path P**402** supplies air taken in from outside to the living room space R**11** from the ventilation port **92**B after passing through the second air supply unit **420**B having the first heat exchanger **22**.

[0163] The first return air flow path P**403** exhausts air (return air) taken in from the ventilation port **91**A of the indoor space to the outside after passing through the first exhaust unit **410**A having the second heat exchanger **12**.

[0164] The second return air flow path P**404** exhausts air (return air) taken in from the ventilation port **91**B of the indoor space to the outside after passing through the second exhaust unit **410**B having the second heat exchanger **12**.

[0165] The refrigerant circuits F**401**, F**402**, F**403**, and F**404** are circuits that connect the compressor unit **450**, the first heat exchanger **22** of the first air supply unit **420**A and the second air supply unit **420**B, and the second heat exchanger **12** of the first exhaust unit **410** and the second exhaust unit **410**B by a refrigerant pipe, and allow the refrigerant to flow inside.

[0166] The control unit **452** of the compressor unit **450**, the control unit **423**A of the first air supply unit **420**A, the control unit **423**B of the second air supply unit **420**B, the control unit **413**A of the first exhaust unit **410**A, and the control unit **413**B of the second exhaust unit **410**B are connected by a signal line S**401** indicated by a dotted line. Thus, information can be transmitted and received between the control unit **452**, the control unit **423**A, the control unit **423**B, the control unit **413**A, and the control unit **413**B.

[0167] The control unit **452** of the compressor unit **450** transmits the status of the ventilation apparatus **1**C received from the control unit **423**A, the control unit **423**B, the control unit **413**A, and the control unit **413**B 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 **1**C.

[0168] The first air supply unit **420**A is provided with the fan **21**, the first heat exchanger **22**, the control unit **423**A, and the temperature detecting unit **24**, takes in outside air (OA), and supplies air (SA) from the ventilation port **92**A to the living room space R**11**.

[0169] The second air supply unit **420**B is provided with the fan **21**, the first heat exchanger **22**, the control unit **423**B, and the temperature detecting unit **24**, takes in outside air (OA), and supplies air (SA) from the ventilation port **92**B to the living room space R**11**.

[0170] The control unit **423**A and the control unit **423**B control the configuration in each air supply unit. Further, the control unit **423**A and the control unit **423**B 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 **420**A and the second air supply unit **420**B.

[0171] The first exhaust unit **410**A is provided with the fan **11** (an example of a second ventilation device), the second heat exchanger **12**, a control unit **413**A, and the temperature detecting unit **14**, and takes in return air (RA) from a ventilation port **91**B of the living room space R**11** and exhausts (EA) the air to the outside.

[0172] The second exhaust unit **410**B is provided with the fan **11** (an example of a second ventilation device), the second heat exchanger **12**, a control unit **413**B, and the temperature detecting unit **14**, and takes in return air (RA) from a ventilation port **91**A of the living room space R**11** and exhausts (EA) the air to the outside.

[0173] The control unit **413**A and the control unit **413**B control the configuration in each exhaust unit. Further, the control unit **413**A and the control unit **413**B 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 **410**A and the second exhaust unit **410**B.

[0174] The upper-level control device **400** performs various kinds of control to coordinate the operation of the ventilation apparatus **1**C with the operation of the air conditioner **2**C.

[0175] The upper-level control device **400** receives the status of the air conditioner **2**C from the control unit **471** of the outdoor unit **470** and receives the status of the ventilation apparatus **1**C 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 **2**C and the status of the ventilation apparatus **1**C.

[0176] For example, when the upper-level control device **400** recognizes that the air conditioner **2**C 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 **1**C.

[0177] That is, when the air conditioner **2**C performs a defrosting operation, the air conditioner **2**C does not function as a heater, and, therefore, the temperature in the living room space R**11** may decrease. On the other hand, when the air supply temperature of the first air supply unit **420**A and the second air supply unit **420**B is increased to compensate for the decrease in the function of the air conditioner **2**C when the air conditioner **2**C performs a defrosting operation, the temperature of the refrigerant flowing to the second heat exchanger **12** of the first exhaust unit **410**A and the second exhaust unit **410**B connected by the refrigerant circuits F**401**, F**402**, F**403**, and F**404** decreases. In this case, the possibility of frosting in the second heat exchanger **12** of the first exhaust unit **410**A and the second exhaust unit **410**B is increased.

[0178] Therefore, when the upper-level control device **400** recognizes that the air conditioner **2**C 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 **1**C, thereby improving the heating performance and preventing a decrease in temperature in the living room space R**11**.

[0179] FIG. **7** is a sequence diagram illustrating the flow of processing performed between the upper-level control device **400**, the ventilation apparatus **1**C, and the air conditioner **2**C when the defrosting operation of the air conditioner **2**C according to the present embodiment is started.

[0180] First, when the defrosting operation is started, the control unit **471** in the outdoor unit **470** of the air conditioner **2**C transmits a signal indicating that the defrosting operation is to be performed to the upper-level control device **400** (S**1701**).

[0181] Then, when the upper-level control device **400** recognizes that the defrosting operation has started in the air conditioner **2**C based on the received signal, the upper-level control device **400** determines that the air volume of the ventilation apparatus **1**C is to be controlled to rise in order to compensate for the decrease of function caused by the defrosting operation (S**1702**).

[0182] 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 **410**A and the second exhaust unit **410**B) to the control unit **452** of the compressor unit **450** (S**1703**).

[0183] 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 **413**A and **413**B of the exhaust unit group (the first exhaust unit **410**A and the second exhaust unit **410**B) (S**1704**).

[0184] Based on the received control signal, the control units **413**A and **413**B of the exhaust unit group control the fan **11** (an example of the second ventilation device) to increase the air volume flowing to the second heat exchanger **12** (increase in air volume) as compared with before the air conditioner **2**C performs defrosting operation (S**1705**).

[0185] 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 **420**A and the second air supply unit **420**B), to the control unit **452** of the compressor unit **450** (S**1706**).

[0186] The control unit **452** of the compressor unit **450** transmits a control signal to instruct the air volume increase to the control units **423**A and **423**B of the air supply unit group (the first air supply unit **420**A and the second air supply unit **420**B) (S**1707**).

[0187] Based on the received control signal, the control units **423**A and **423**B of the air supply unit group control the fan **21** (an example of the first ventilation device) to increase the air volume flowing to the first heat exchanger **22** (air volume increase) compared with before the air conditioner **2**C performs defrosting operation (S**1708**).

[0188] In the present embodiment, the heating performance of the ventilation apparatus **1**C is increased by increasing the air supply/exhaust volume without increasing the air supply temperature of the ventilation apparatus **1**C, thereby preventing a decrease in the room temperature of the living room space R**11**. 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 **1**C.

[0189] 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 **1**C in order to compensate for the decrease in performance caused by the frosting operation of the air conditioner **2**C.

[0190] The upper-level control device **400** according to the present embodiment can perform various kinds of control other than the above-mentioned cooperative control.

[0191] 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 **413**A or the control unit **413**B 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**.

[0192] 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

[0193] In the third embodiment, coordination control in the case where defrosting operation is performed on the air conditioner **2**C 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.

[0194] 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**.

[0195] In the present embodiment, the control of preventing frosting in the ventilation apparatus **1**C 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 **410**A and **410**B, the pressure in the living room space R**11** may become negative pressure.

[0196] Therefore, in the present embodiment, the defrosting control is performed by increasing the air volume in one of the plurality of exhaust units **410**A and **410**B, and the air volume is decreased in the other one of the plurality of exhaust units **410**A and **410**B. That is, in the present embodiment, the defrosting control operation is performed preferentially in one of the plurality of exhaust units **410**A and **410**B. Furthermore, the upper-level control device **400** prevents the negative pressure of the living room space R**11** by adjusting to maintain the total air volume to be discharged.

[0197] 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.

[0198] First, the control unit **413**A of the first exhaust unit **410**A acquires the temperature of the outside air from the temperature detecting unit **14** (S**1801**).

[0199] Then, the control unit **413**A reports the detected temperature of the outside air to the control unit **452** of the compressor unit **450** (S**1802**).

[0200] The control unit **413**B of the second exhaust unit **410**B acquires the temperature of the outside air from the temperature detecting unit **14** (S**1811**).

[0201] The control unit **413**B reports the detected temperature of the outside air to the control unit **452** of the compressor unit **450** (S**1812**).

[0202] The control unit **452** of the compressor unit **450** determines, based on the detected outside air temperatures received from the control unit **413**A of the first exhaust unit **410**A and the control unit **413**B of the second exhaust unit **410**B, whether the second heat exchanger **12** of the first exhaust unit **410**A and the second exhaust unit **410**B satisfies a predetermined reference indicating the possibility of frosting (S**1821**). In the example illustrated in FIG. **8**, it is determined that each of the second heat exchangers **12** of the first exhaust unit **410**A and the second exhaust unit **410**B satisfies the predetermined reference. The predetermined reference is the same as in the above-described embodiment, and, therefore, the description thereof will be omitted.

[0203] 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 (S**1822**).

[0204] The upper-level control device **400** determines the order in which frost prevention is controlled for the first exhaust unit **410**A and the second exhaust unit **410**B based on the received determination result (S**1831**). 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 **410**A and the second exhaust unit **410**B. 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 **410**A and the second exhaust unit **410**B.

[0205] The upper-level control device **400** transmits a signal indicating an instruction to increase the air volume of the first exhaust unit **410**A to the control unit **452** of the compressor unit **450** (S**1832**).

[0206] The control unit **452** of the compressor unit **450** transmits a signal indicating an instruction to increase the air volume to the control unit **413**A of the first exhaust unit **410**A (S**1823**).

[0207] Accordingly, the control unit **413**A of the first exhaust unit **410**A 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 S**1801** (S**1803**).

[0208] 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 **410**B to the control unit **452** of the compressor unit **450** after a predetermined time (a predetermined time for preventing frosting) has elapsed (S**1833**).

[0209] Then, the control unit **452** of the compressor unit **450** transmits a signal indicating an instruction of air volume reduction to the control unit **413**B of the second exhaust unit **410**B (S**1824**).

[0210] Accordingly, the control unit **413**B of the second exhaust unit **410**B 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 S**1811** (S**1813**).

[0211] In the present embodiment, the air volume of the first exhaust unit **410**A is increased and the air volume of the second exhaust unit **410**B 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.

[0212] The upper-level control device **400** transmits a signal indicating an instruction for reducing the air volume of the first exhaust unit **410**A to the control unit **452** of the compressor unit **450** (S**1834**).

[0213] The control unit **452** of the compressor unit **450** transmits a signal indicating an instruction for reducing the air volume to the control unit **413**A of the first exhaust unit **410**A (S**1825**).

[0214] Accordingly, the control unit **413**A of the first exhaust unit **410**A 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 S**1801** (S**1804**).

[0215] The upper-level control device **400** transmits a signal indicating an instruction to increase the air volume of the second exhaust unit **410**B to the control unit **452** of the compressor unit **450** (S**1835**).

[0216] The control unit **452** of the compressor unit **450** transmits a signal indicating an instruction to increase the air volume to the control unit **413**B of the second exhaust unit **410**B (S**1826**).

[0217] Accordingly, the control unit **413**B of the second exhaust unit **410**B 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 S**1811** (S**1814**).

[0218] 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.

[0219] 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 R**11** becomes negative pressure.

[0220] 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

[0221] 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.

[0222] 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 **410**A and the second exhaust unit **410**B satisfies the predetermined reference indicating the possibility of frosting based on the received outside air temperature.

[0223] When the control unit **452** of the compressor unit **450** determines that any one of the first exhaust unit **410**A and the second exhaust unit **410**B 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.

[0224] When the upper-level control device **400** determines that each of the first exhaust unit **410**A and the second exhaust unit **410**B 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 **410**A and the second exhaust unit **410**B. The upper-level control device **400** then instructs each of the first exhaust unit **410**A and the second exhaust unit **410**B to increase the air volume according to the order.

[0225] The upper-level control device **400** according to the present embodiment instructs one or more of the first air supply unit **420**A and the second air supply unit **420**B 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 **423**A of the first air supply unit **420**A and the control unit **423**B of the second air supply unit **420**B to increase the air volume through the control unit **452** of the compressor unit **450**.

[0226] The target for instructing the increase of the air volume may be any one of the first air supply unit **420**A and the second air supply unit **420**B, or may be each of the first air supply unit **420**A and the second air supply unit **420**B. However, the upper-level control device **400** makes an adjustment such that the air volume discharged by the first exhaust unit **410**A and the second exhaust unit **410**B and the air volume taken in by the first air supply unit **420**A and the second air supply unit **420**B are the same.

[0227] 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 R**11** from becoming negative pressure.

Sixth Embodiment

[0228] 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**.

[0229] 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.

[0230] While the second heat exchanger **12** functions as an evaporator, the control unit **413**A of the first exhaust unit **410**A and the control unit **413**B of the second exhaust unit **410**B obtain the surface temperature of the second heat exchanger **12** from the temperature detecting unit **14**. The control unit **413**A and the control unit **413**B of the second exhaust unit **410**B transmit the detected surface temperature of the second heat exchanger **12** to the control unit **452** of the compressor unit **450**.

[0231] 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.

[0232] 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**.

[0233] 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.

[0234] 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 **413**A of the first exhaust unit **410**A and the control unit **413**B of the second exhaust unit **410**B. Further, the upper-level control device **400** may perform control of increasing the air volume of the fan **11** as in the fourth embodiment.

[0235] In the present embodiment, by stopping the compressor in the compressor unit **450** and passing air in the living room space R**11** 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

[0236] 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.

[0237] 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 R**501**, R**502**, R**503**, lavatory rooms R**511**, R**512**, and a pipe shaft R**521**.

[0238] The lavatory rooms R**511**, R**512** are provided with ventilation ports **595**A, **595**B, respectively.

[0239] The air conditioner **2**D 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).

[0240] 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**.

[0241] The first ventilation apparatus **1**D**_1** is a ventilation apparatus provided in the living room space R**501** and includes a first compressor unit **550**A, a first air supply unit **520**A, and a first exhaust unit **510**A.

[0242] The first air supply unit **520**A supplies air (SA) from the ventilation port **592**A. The first exhaust unit **510**A returns air (RA) from the ventilation port **591**A. The first compressor unit **550**A, the first air supply unit **520**A, and the first exhaust unit **510**A are connected by a connection pipe F**501**. The connection pipe F**501** includes a plurality of refrigerant connection pipes. Thereby, the refrigerant can be circulated between the first compressor unit **550**A, the first air supply unit **520**A, and the first exhaust unit **510**A.

[0243] The first compressor unit **550**A, the first air supply unit **520**A, 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 **550**A, the first air supply unit **520**A, and the first exhaust unit **510**A is the same as that of the compressor unit **450**A, the first air supply unit **420**A, and the first exhaust unit **410**A illustrated in FIG. **6**, and the description thereof will be omitted.

[0244] The second ventilation apparatus **1**D **2** is a ventilation apparatus provided in the living room space R**502** and includes a second compressor unit **550**B, a second air supply unit **520**B, and a second exhaust unit **510**B.

[0245] The second air supply unit **520**B supplies air (SA) from the ventilation port **592**B. The second exhaust unit **510**B returns air (RA) from the ventilation port **591**B. The second compressor unit **550**B, the second air supply unit **520**B, and the second exhaust unit **510**B are connected by a connection pipe F**502**. The connection pipe F**502** includes a plurality of refrigerant connection pipes. Thus, the refrigerant can be circulated between the second compressor unit **550**B, the second air supply unit **520**B, and the second exhaust unit **510**B.

[0246] The second compressor unit **550**B, the second air supply unit **520**B, and the second exhaust unit **510**B 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 **550**B, the second air supply unit **520**B, and the second exhaust unit **510**B is the same as that of the compressor unit **450**A, the first air supply unit **420**A, and the first exhaust unit **410**A illustrated in FIG. **6**, and descriptions thereof will be omitted.

[0247] The third ventilation apparatus **1**D**_3** is a ventilation apparatus provided in the living room space R**503** and includes a third compressor unit **550**C, a third air supply unit **520**C, and a third exhaust unit **510**C.

[0248] The third air supply unit **520**C supplies air (SA) from the ventilation port **592**C. The third exhaust unit **510**C returns air (RA) from the ventilation port **591**C. The third compressor unit **550**C, the third air supply unit **520**C, and the third exhaust unit **510**C are connected by a connection pipe F**503**. The connection pipe F**503** includes a plurality of refrigerant connection pipes. Thus, the refrigerant can be circulated between the third compressor unit **550**C, the third air supply unit **520**C, and the third exhaust unit **510**C.

[0249] The third compressor unit **550**C, the third air supply unit **520**C, and the third exhaust unit **510**C 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 **550**C, the third air supply unit **520**C, and the third exhaust unit **510**C is the same as that of the compressor unit **450**A, the first air supply unit **420**A, and the first exhaust unit **410**A illustrated in FIG. **6**, and the description thereof will be omitted.

[0250] 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 **550**A, the second compressor unit **550**B, and the third compressor unit **550**C are arranged on the pipe shaft R**521**.

[0251] The upper-level control device **500** is connected to the first compressor unit **550**A, the second compressor unit **550**B, and the third compressor unit **550**C 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.

[0252] According to the above configuration, while the second heat exchanger **12** of each of the first exhaust units **510**A to the third exhaust unit **510**C functions as an evaporator, the control unit (not illustrated) of the first compressor unit **550**A to the third compressor unit **550**C receives the surface temperature of the second heat exchanger **12** from each of the first exhaust units **510**A to the third exhaust unit **510**C.

[0253] Then, while the second heat exchanger **12** functions as an evaporator, the control unit of the first compressor unit **550**A to the third compressor unit **550**C 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.

[0254] The control units of the first compressor unit **550**A to the third compressor unit **550**C report, to the upper-level control device **500**, the determination result indicating whether the predetermined reference is satisfied.

[0255] 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 **550**A to the third compressor unit **550**C) 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 **550**A to the third compressor unit **550**C) 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.

[0256] 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 R**501** to R**503** to the second heat exchanger **12**. Accordingly, the temperature of the refrigerant flowing through the second heat exchanger **12** can be increased.

[0257] 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

[0258] 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.

[0259] 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.

[0260] As illustrated in FIG. **10**, the compressor unit **650** is connected to the first air supply unit **520**A and the first exhaust unit **510**A through the connection pipe F**601**, connected to the second air supply unit **520**B and the second exhaust unit **510**B through the connection pipe F**602**, and connected to the third air supply unit **520**C and the third exhaust unit **510**C through the connection pipe F**603**. Accordingly, the refrigerant circulates through the units connected by the connection pipes F**601**, F**602**, and F**603**.

[0261] The compressor unit **650**, the first air supply unit **520**A to the third air supply unit **520**C, and the first exhaust unit **510**A to the third exhaust unit **510**C are connected by a signal line (not illustrated), and, therefore, information can be transmitted and received between the units. The upper-level control device **600** and the compressor unit **650** are also connected by a signal line, and, therefore, information can be transmitted and received therebetween.

[0262] The first air supply unit **520**A, the second air supply unit **520**B, and the third air supply unit **520**C are provided with the electric valve **26** (an example of the first valve part) as illustrated in FIG. **5**. Similarly, the first exhaust unit **510**A, the second exhaust unit **510**B, and the third exhaust unit **510**C are provided with the electric valve **16** (an example of the first valve part) as illustrated in FIG. **5**.

[0263] When the second heat exchanger **12** of the first exhaust unit **510**A, the second exhaust unit **510**B, and the third exhaust unit **510**C 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)

[0264] Thus, with respect to each of the first exhaust unit **510**A, the second exhaust unit **510**B, and the third exhaust unit **510**C, 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.

[0265] 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.

[0266] 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 **510**A to the third exhaust unit **510**C) 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.

[0267] 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 R**501** to R**503** to the second heat exchanger **12**.

[0268] 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

[0269] 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.

[0270] 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.

[0271] 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.

[0272] 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 device) of the exhaust unit group (for example, the first exhaust unit **410**A and the second exhaust unit **410**B) is greater than the total air volume exhausted by the fan **21** (an example of the first ventilation device) of the air supply unit group (for example, the first supply air unit **420**A and the second supply air unit **420**B), as a control for preventing frosting in the second heat exchanger **12**.

[0273] 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

[0274] 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.

[0275] The configuration of the tenth embodiment may be any configuration of the above-described embodiment, 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.

[0276] 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.

[0277] 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 **2**C provided in the living room space R**11**, to the first heat exchanger of the air supply unit group (for example, the first supply air unit **420**A and the second supply air unit **420**B), as the control for preventing frosting in the second heat exchangers **12**. The temperature set in the air conditioner **2**C is acquired from the control unit **471** of the outdoor unit **470**.

[0278] 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

[0279] 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.

[0280] 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.

[0281] 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 **410**A and **410**B 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.

[0282] In the example illustrated in FIG. **11**, when the second heat exchanger **12** of the exhaust units **410**A and **410**B functions as an evaporator, electric valves **601** and **602** are provided downstream from the second heat exchanger **12** of each of the exhaust units **410**A and **410**B.

[0283] 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.

[0284] 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 **413**A or the control unit **413**B) of the exhaust unit (for example, the first exhaust unit **410**A or the second exhaust unit **410**B) that includes the second heat exchanger **12**.

[0285] 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.

[0286] Although the bypass flow path F**6** is illustrated in FIG. **11**, in the present embodiment, the bypass flow path F**6** may or may not be combined with the control using the bypass flow path F**6** illustrated in the above embodiment.

Modified Example of Eleventh Embodiment

[0287] 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.

[0288] 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.

[0289] 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**.

[0290] 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**.

[0291] 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.

[0292] 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**.

[0293] 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 **410**A and **410**B. 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.

[0294] 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 perform processing of the above-described embodiment on a server for centralized management or in the cloud.

Twelfth Embodiment

[0295] 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.

[0296] 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.

[0297] 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.

[0298] 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.

[0299] 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 **410**A and the second exhaust unit **410**B) controls the frosting prevention or allows the frosting and performs defrosting operation after the frosting.

[0300] FIG. **13** is a flowchart illustrating the processing procedure of the upper-level control device **400** according to the present embodiment.

[0301] 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 (S**2101**). The detection result is the temperature or the pressure of the refrigerant flowing through the second heat exchanger **12**.

[0302] The control unit **452** of the compressor unit **450** determines whether the predetermined reference is satisfied based on the detection result (S**2102**). 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 S**2102**), the process is performed again from S**2101**. 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).

[0303] When the control unit **452** of the compressor unit **450** determines that the predetermined reference is satisfied (YES in S**2102**), the control unit **452** reports, to the upper-level control device **400**, the determination result.

[0304] 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 E**1** for maintaining the current temperature of the living room space R**11** and the like (S**2103**).

[0305] Further, the upper-level control device **400** performs a defrosting operation, and calculates the power consumption E**2** for maintaining the current temperature of the living room space R**11** and the like (S**2104**).

[0306] 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 E**1** and the power consumption E**2**. 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.

[0307] Thereafter, the upper-level control device **400** determines whether the power consumption E**1** is lower than the power consumption E**2** (S**2105**). When the upper-level control device **400** determines that the power consumption E**1** is lower than the power consumption E**2** (YES in S**2105**), the upper-level control device **400** outputs a control signal to prevent frosting to the exhaust unit group (S**2106**). 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 S**2101** again.

[0308] Thereafter, when it is determined that the power consumption E**1** is equal to or greater than the power consumption E**2** (not less) (NO in S**2105**), 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 occurred according to the detection result (S**2107**). The defrosting operation method may be any method, regardless of whether the method is known, and the description thereof will be omitted.

[0309] 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** (S**2108**). The detection result is the temperature or the pressure of the refrigerant flowing through the second heat exchanger **12**.

[0310] Based on the detection result, the upper-level control device **400** determines whether a defrosting end reference is satisfied (S**2109**). 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 a and B are positive numbers determined according to the embodiment, and descriptions thereof are omitted. It is determined whether the defrosting end reference is satisfied (S**2109**). If it is determined that the defrosting end reference is not satisfied (NO in S**2109**), the process is performed again from S**2108**. It is considered that the determination is made every predetermined time (for example, y minutes).

[0311] 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 S**2109**), the upper-level control device outputs a control signal for ending the defrosting operation to the exhaust unit group (S**2110**) and ends the process. Thereafter, the upper-level control device **400** performs processing from step S**2101** again.

[0312] By implementing the above control, the upper-level control device **400** 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**.

[0313] Thus, in the present embodiment, power consumption can be prevented when preventing frosting in the exhaust unit group or when performing defrosting.

[0314] 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.

[0315] 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.

[0316] 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)

[0317] 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.

[0318] 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.

[0319] 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 ventilation system **1**E according to the thirteenth embodiment (see FIG. **17**) is referred to as the thirteenth ventilation system **1**F, a ventilation system **1**E according to the fourteenth embodiment (see FIG. **18** and FIG. **19**) is referred to as the fourteenth ventilation system **1**G, a ventilation system **1**E according to the fifteenth embodiment (see FIG. **20**) is referred to as the fifteenth ventilation system **1**H, a ventilation system **1**E according to the sixteenth embodiment (see FIG. **21**) is referred to as the sixteenth ventilation system **1**I, a ventilation system **1**E according to the seventeenth embodiment (see FIG. **22**) is referred to as the seventeenth ventilation system **1**J, and a ventilation system **1**E according to the eighteenth embodiment (see FIG. **23**) is referred to as the eighteenth ventilation system **1**K. In the following description, when the term "ventilation system **1**E" is simply used, the common configuration among the thirteenth to eighteenth ventilation systems **1**F to **1**K is described.

[0320] The ventilation system **1**E 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 **1**E includes an air supply unit **1020**, an exhaust unit **1030**, a compressor unit **1040**, and a refrigerant circuit **1050**.

[0321] 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 **1**E has an air supply flow path P**1001** (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**.

[0322] 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**.

[0323] 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 T**1** (hereinafter referred to as the blowout air temperature T**1**) 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 T**2** (hereinafter referred to as the outside air temperature T**2**) of the outside air OA.

[0324] 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 Tb**1** 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 Ta**2** 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.

[0325] 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 **1**E has a return air flow path P**1002** (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**.

[0326] 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**.

[0327] 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 T**3** of the air flowing into the second heat exchanger **1033**. In the following description, this temperature T**3** is referred to as the intake air temperature T**3**. In the present disclosure, the intake air temperature T**3** 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**.

[0328] 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 Tb**2** (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 Tb**3** 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.

[0329] 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 **1**E 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**.

[0330] 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 Ta**1** of the refrigerant discharged from the compressor **1042**.

[0331] 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 **1**E of the present disclosure may be configured by connecting two or more compressors in parallel.

[0332] 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 **1**E can switch between a cooling operation mode (hereinafter also referred to as the first operation mode M**1**) for cooling the outside air OA and a heating operation mode (hereinafter also referred to as the second operation mode M**2**) 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 **1**E, 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**.

[0333] 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 **1051**L and a gas pipe **1051**G) connecting these elements. The refrigerant circuit **1050** circulates the refrigerant between the first heat exchanger **1023** and the second heat exchanger **1033**.

[0334] In the ventilation system **1**E 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 M**1**), 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 **1051**G) and is taken into the compressor **1042** through the four-way switch valve **1043**.

[0335] In the ventilation system **1**E 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 M**2**), 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 **1051**L) 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)

[0336] FIG. **15** is a control block diagram of the ventilation system **1**E. As illustrated in FIG. **15**, the ventilation system **1**E has a control unit **1018**. The control unit **1018** is a device for controlling the operation of the ventilation system **1**E, and is composed of, for example, a microcomputer 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.

[0337] 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.

[0338] During operation in the second operation mode M**2**, 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 Tb**2**) 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.

[0339] As described above, the ventilation system **1**E of the present disclosure has a first operation mode M**1** and a second operation mode M**2** as operation modes selectable by the user. When the user selects the first operation mode M**1** and starts the operation of the ventilation system **1**E, 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 M**2** and starts the operation of the ventilation system **1**E, 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 M**2** and starts the operation of the ventilation system **1**E" 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.

[0340] When the ventilation system **1**E of the present disclosure is started upon selecting the second operation mode M**2**, the control unit **1018** may execute low pressure raising control (first control). In the following description, the operation mode of the ventilation system **1**E when the control unit **1018** executes low pressure raising control is referred to as low pressure raising mode M**3**. When the user selects the second operation mode M**2** and the operation of the ventilation system **1**E 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).

[0341] 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.

[0342] 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.

[0343] 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)

[0344] 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.

[0345] 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).

[0346] 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.

[0347] 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.

[0348] 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.

[0349] 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.

[0350] 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.

[0351] 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.

[0352] 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.

[0353] 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.

[0354] 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**).

[0355] 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 control (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)

[0356] As illustrated in FIG. **15**, the ventilation system 1E of the present disclosure includes a low pressure raising means **1080**. The thirteenth to eighteenth 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 thirteenth to eighteenth 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)

[0357] 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.

[0358] 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 **1000**B. 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**.

[0359] 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 **1081**d including an indoor unit **1081**a, an outdoor unit **1081**b, and a refrigerant pipe **1081**c.

(Air Conditioner)

[0360] The air conditioner **1081** is installed in a building **1000**B 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.

[0361] In the air conditioner **1081**, the indoor unit **1081**a is arranged indoors **1000S1** and the outdoor unit **1081**b is arranged outdoors **1000S2**. The indoor unit **1081**a and the outdoor unit **1081**b are connected by a refrigerant pipe **1081**c. The air conditioner **1081** has a refrigerant circuit **1081**d for air conditioning. The refrigerant circuit **1081**d 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 **1081**d for air conditioning circulates the refrigerant between the indoor unit **1081**a and the outdoor unit **1081**b through the refrigerant pipe **1081**c. The refrigerant circuit **1081**d for air conditioning is separated from the refrigerant circuit **1050** of the thirteenth ventilation system **1**F and constitutes an independent circuit. The air conditioner **1081** detects the temperature of the indoors **1000S1**.

[0362] In the thirteenth ventilation system **1**F, 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 **1**F, when the control unit **1018** determines that the temperature of the air in the indoors **1000S1** detected by the air conditioner **1081** exceeds the second threshold Y (air temperature threshold Y**3** for intake air temperature T**3**) (see FIG. **15**), the operation of the exhaust fan **1032** is started. In the thirteenth ventilation system **1**F, this causes the second heat exchanger **1033** to take in air having a temperature higher than the air temperature threshold Y**3** for the intake air temperature T**3**. In the thirteenth ventilation system **1**F, the frosting in the second heat exchanger **1033** is prevented by operating the air conditioner **1081**. In the thirteenth ventilation system **1**F, the intake air temperature T**3** 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**.

[0363] In the thirteenth ventilation system **1**F, when the second operation mode M**2** 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 **1**F, when the second operation mode M**2** 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 **1**F 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 T**3** 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 **1**F, 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 M**2** is selected and the air conditioner **1081** is started, the control unit **1018** may execute low pressure raising control.

[0364] In the thirteenth ventilation system **1**F, 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 **1**G)

[0365] 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 the fourteenth embodiment of the present disclosure in a building. The fourteenth ventilation system **1**G illustrated in FIGS. **18** and **19** is a fourteenth embodiment of the ventilation system **1**E of the present disclosure. The fourteenth ventilation system **1**G differs from the thirteenth ventilation system **1**F in that the fourteenth ventilation system **1**G includes a second low pressure raising means **1082** which is a second low pressure raising means **1080**.

[0366] As illustrated in FIG. **18**, the fourteenth ventilation system **1**G includes a second low pressure raising means **1082**. The second low pressure raising means **1082** includes a bypass pipe **1082**a and a valve **1082**b. The valve **1082**b is, for example, a motor-driven valve, a solenoid valve, or the like. The bypass pipe **1082**a bypasses the discharge pipe **1045** of the compressor **1042** and the liquid pipe **1051**L. The bypass pipe **1082**a can supply high temperature and high pressure gaseous refrigerant discharged from the compressor **1042** to the second heat exchanger **1033** through the liquid pipe **1051**L. The valve **1082**b can switch the flow of refrigerant in the bypass pipe **1082**a. When the valve **1082**b is opened, the gaseous refrigerant can flow into the bypass pipe **1082**a, and when the valve **1082**b is closed, the flow of the gaseous refrigerant in the bypass pipe **1082**a can be stopped.

[0367] The fourteenth ventilation system **1**G 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 **1082**a with the valve **1082**b open, thereby preventing frosting in the second heat exchanger **1033**. In the fourteenth ventilation system **1**G, 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**.

[0368] In the fourteenth ventilation system **1**G, the control unit **1018** closes the valve **1082**b to end the low pressure raising control.

(Fifteenth Ventilation System **1**H)

[0369] FIG. **20** is a schematic configuration diagram of a ventilation system according to a fifteenth embodiment of the present disclosure. The fifteenth ventilation system **1**H illustrated in FIGS. **19** and **20** is a fifteenth embodiment of the ventilation system **1**E of the present disclosure. As illustrated in FIG. **20**, the fifteenth ventilation system **1**H differs from the thirteenth and fourteenth ventilation systems **1**F and **1**G in that the fifteenth ventilation system **1**H includes a third low pressure raising means **1083**, which is a third low pressure raising means **1080**.

[0370] The fifteenth ventilation system **1**H includes a third low pressure raising means **1083**. The third low pressure raising means **1083** includes a bypass duct **1083***a* and a damper **1083***b*. The bypass duct **1083***a* 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 **1083***a* 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 **1083***b* includes a valve and an opening/closing mechanism for opening/closing the flow of the air supply SA in the bypass duct **1083***a*. When the damper **1083***b* is opened, the supply air SA can flow in the bypass duct **1083***a*, and when the damper **1083***b* is closed, the flow of the supply air SA in the bypass duct **1083***a* can be stopped.

[0371] In the fifteenth ventilation system **1**H, when the control unit **1018** determines that the blowout air temperature T**1** detected by the supply air temperature sensor **1026** exceeds the second threshold Y (air temperature threshold Y**3** for the intake air temperature T**3**) (see FIG. **15**), the damper **1083***b* is opened. The fifteenth ventilation system **1**H can raise the intake air temperature T**3** 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 **1083***a* while the damper **1083***b* is opened. In the fifteenth ventilation system **1**H, the third low pressure raising means **1083** can raise the intake air temperature T**3** 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**.

[0372] In the fifteenth ventilation system **1**H, the control unit **1018** closes the damper **1083***b* to end the low pressure raising control.

(Sixteenth Ventilation System **1**I)

[0373] FIG. **21** is a schematic configuration diagram of a ventilation system according to the sixteenth embodiment of the present disclosure. The sixteenth ventilation system **1**I illustrated in FIG. **21** is a sixteenth embodiment of the ventilation system **1**E of the present disclosure. As illustrated in FIG. **21**, the configuration of the low pressure raising means **1080** of the sixteenth ventilation system **1**I differs from that of the thirteenth to fifteenth ventilation systems **1**F to **1**H. The sixteenth ventilation system **1**I differs from the thirteenth to fifteenth ventilation systems **1**F to **1**H 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 **1**I, 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 R**2**) behind the ceiling of the room R**1**, which is the space to be ventilated in the indoors **1000S1**. Although the present embodiment illustrates the case where the sixteenth ventilation system **1**I is arranged in the indoors **1000S1**, the sixteenth ventilation system **1**I may be arranged entirely or partially in the outdoors **1000S2**.

[0374] In the sixteenth ventilation system **1**I, 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 **1028***a*, a second air supply duct **1028***b*, and an air supply unit **1020**. The first air supply duct **1028***a* connects the outdoors **1000S2** and the air supply unit **1020**. Specifically, the first air supply duct **1028***a* has an intake port **1028***c* at one end, and the intake port **1028***c* is connected to an opening in the outer wall of the building **1000**B and communicates with the outdoors **1000S2**. The other end of the first air supply duct **1028***a* is connected to the air supply unit **1020**. The second air supply duct **1028***b* connects the air supply unit **1020** to the indoors **1000S1**. Specifically, the second air supply duct **1028***b* has a blowout port **1028***d* as one end, and the blowout port **1028***d* 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 **1028***b* is connected to the air supply unit **1020**.

[0375] In the sixteenth ventilation system **1**I, 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 **1038***a*, a second exhaust duct **1038***b*, and an exhaust unit **1030**. The first exhaust duct **1038***a* connects the outdoors **1000S2** and the exhaust unit **1030**. Specifically, the first exhaust duct **1038***a* has an exhaust port **1038***c* at one end, and the exhaust port **1038***c* is connected to an opening in the outer wall of the building **1000**B and communicates with the outdoors **1000S2**. The other end of the first exhaust duct **1038***a* is connected to the exhaust unit **1030**. The second exhaust duct **1038***b* connects the exhaust unit **1030** to the indoors **1000S1**. Specifically, the second exhaust duct **1038***b* has an intake port **1038***d* at one end, and the intake port **1038***d* 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 **1038***b* is connected to the exhaust unit **1030**.

[0376] The sixteenth ventilation system **1**I includes a fourth low pressure raising means **1084**. The fourth low pressure raising means **1084** includes a bypass duct **1084***a* and a damper **1084***b*. The bypass duct **1084***a* communicates with the second air supply duct **1028***b* connected to the blowout side of the air supply unit **1020** and the second exhaust duct **1038***b* connected to the intake side of the exhaust unit **1030**. The bypass duct **1084***a* 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 **1084***b* includes a valve and an opening/closing mechanism for opening/closing the flow of the supply air SA in the bypass duct **1084***a*. When the damper **1084***b* is opened, the supply air SA can flow in the bypass duct **1084***a*, and when the damper **1084***b* is closed, the flow of the supply air SA in the bypass duct **1084***a* can be stopped.

[0377] In the sixteenth ventilation system **1**I, when the control unit **1018** determines that the blowout air temperature T**1** 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 **1084***b* is opened. The sixteenth ventilation system **1**I can raise the intake air temperature T**3** 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 **1084***a* while the damper **1084***b* is opened. In the sixteenth ventilation system **1**I, the intake air temperature T**3** 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**.

[0378] In the sixteenth ventilation system **1**I, the control unit **1018** closes the damper **1084***b* to end the low pressure raising control.

(Seventeenth Ventilation System **1**J)

[0379] FIG. **22** is a schematic configuration diagram of a ventilation system according to a seventeenth embodiment of the present disclosure. The seventeenth ventilation system **1**J illustrated in FIG. **22** is a seventeenth embodiment of the ventilation system **1**E of the present disclosure. As illustrated in FIG. **22**, the configuration of the low pressure raising means **1080** of the seventeenth ventilation system **1**J is different from that of the sixteenth ventilation system **1**I. The seventeenth ventilation system **1**J includes a fifth low pressure raising means **1085** which is a fifth low pressure raising means **1080**.

[0380] The fifth low pressure raising means **1085** includes an intake duct **1085***a*, a damper **1085***b*, and a ceiling space temperature sensor **1085***c*. The intake duct **1085***a* is connected to the second exhaust duct **1038***b* and is opened in the ceiling space R**2** so that air in the ceiling space R**2** can be taken into the exhaust unit **1030** by driving the exhaust fan **1032**. In the seventeenth ventilation system **1**J, air in the ceiling space R**2** taken into the exhaust unit **1030** can be passed into the second heat exchanger **1033**. The damper **1085***b* is a valve for opening and closing the air flow in the intake duct **1085***a*. When the damper **1085***b* is opened, the air in the ceiling space R**2** can be taken into the intake duct **1085***a*, and when the damper **1085***b* is closed, the air flow in the intake duct **1085***a* can be stopped.

[0381] In the seventeenth ventilation system **1**J, the ceiling space temperature sensor **1085***c* is connected to the control unit **1018**. The ceiling space temperature sensor **1085***c* can detect the temperature of the air in the ceiling space R**2**. In the seventeenth ventilation system **1**J, when the control unit **1018** determines that the temperature T**4** of the air in the ceiling space R**2** has exceeded the second threshold Y (the air temperature threshold Y3 for the intake air temperature T**3**), the damper **1085***b* is opened and the air in the ceiling space R**2** is passed to the second heat exchanger **1033** through the intake duct **1085***a*.

[0382] The seventeenth ventilation system **1**J can raise the intake air temperature T**3** of the second heat exchanger **1033** by supplying the air in the ceiling space R**2** to the intake side of the second heat exchanger **1033** through the intake duct **1085***a* while the damper **1085***b* is opened. In the seventeenth ventilation system **1**J, the intake air temperature T**3** 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**.

[0383] In the seventeenth ventilation system **1**J, the control unit **1018** closes the damper **1085***b*, thereby ending the low pressure raising control.

(Eighteenth Ventilation System **1**K)

[0384] FIG. **23** is a schematic configuration diagram of a ventilation system according to an eighteenth embodiment of the present disclosure. The eighteenth ventilation system **1**K illustrated in FIG. **23** is a eighteenth embodiment of the ventilation system **1**E of the present disclosure. As illustrated in FIG. **23**, the configuration of the low pressure raising means **1080** of the eighteenth ventilation system **1**K is different from those of the sixteenth and seventeenth ventilation systems **1**I and **1**J.

[0385] The eighteenth ventilation system **1**K 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 **1086***a* which is turnably arranged around a rotation axis and a mechanism (not illustrated) for turning the louver **1086***a*. The louver **1086***a* is arranged in the vicinity of the blowout port **1028***d* in the indoors **1000S1**. The louver **1086***a* 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 **1028***d*, and an operating position **1000P2** which changes the blowout direction of the supply air SA blown out from the blowout port **1028***d*.

[0386] In the eighteenth ventilation system **1**K, 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 **1086***a* is rotated from the housing position **1000P1** to the operating position **1000P2**. In the eighteenth ventilation system **1**K, the blowout direction of the air supply SA blown out from the blowout port **1028***d* is changed by hitting the louver **1086***a* and flows toward the intake port **1038***d*. In the eighteenth ventilation system **1**K, the intake air temperature T**3** 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 **1038***d*. In the eighteenth ventilation system **1**K, the intake air temperature T**3** 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.

[0387] In the eighteenth ventilation system **1**K, the control unit **1018** changes the turning position of the louver **1086***a* from the operating position **1000P2** to the housing position **1000P1**, thereby ending the low pressure raising control.

Effects of the Embodiments

[0388] (1) The ventilation system **1**E 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 T**3**), or the temperature of the outdoors **1000S2** (outside air temperature T**2**) 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 T**3**, or the outside air temperature T**2**, the control unit performs low pressure raising control to raise the low pressure PL of the refrigerant circuit **1050**.

[0389] According to the ventilation system **1**E 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.

[0390] (2) In the fourteenth ventilation system **1**G illustrated in the above embodiment, the refrigerant circuit **1050** has the bypass pipe **1082***a* connecting the discharge pipe **1045** of the compressor **1042** and the second heat exchanger **1033** or the liquid pipe **1051**L connected to the second heat exchanger **1033**, and the valve **1082***b* provided in the bypass pipe **1082***a*. In the fourteenth ventilation system **1**G, the control unit **1018** opens the valve **1082***b* in the low pressure raising control (first control).

[0391] 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.

[0392] (3) In the fourteenth ventilation system **1**G illustrated in the above embodiment, when the valve **1082***b* is opened, the control unit **1018** closes the valve **1082***b* 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 T**3** 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 T**3** of the second heat exchanger **1033**.

[0393] 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.

[0394] (4) In each ventilation system **1**F, **1**H to **1**K 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 Y**3**) for the intake air temperature T**3** in the low pressure raising mode M**3** for performing the low pressure raising control.

[0395] In this case, air at a temperature higher than the second threshold Y (air temperature threshold Y**3**) 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.

[0396] (5) In the eighteenth ventilation system **1**K 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 M**3** for performing the low pressure raising control.

[0397] In this case, air having a temperature higher than the second threshold Y (air temperature threshold Y**3**) for the intake air temperature T**3** can flow into the second heat exchanger **1033** during the execution of the low pressure raising control.

[0398] (6) In the thirteenth ventilation system **1**F 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 Y**3**) by the air conditioner **1081** in the low pressure raising mode M**3** for performing the low pressure raising control.

[0399] In this case, air having a higher temperature than the second threshold Y (air temperature threshold Y**3**) for the intake air temperature T**3** can flow into the second heat exchanger **1033** during the execution of the low pressure raising control.

[0400] 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.

[0401] 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.

[0402] 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.

[0403] 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.

What is claimed is:

1. A ventilation apparatus comprising:

a processor;

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 memory storing one or more programs, which when executed, cause the processor 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 processor detects that the predetermined reference is satisfied.

2. The ventilation apparatus according to claim 1, wherein the processor detects whether the predetermined 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 processor detects that the predetermined reference is satisfied.

3. The ventilation apparatus according to claim 2, wherein the processor 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 processor detects that the predetermined reference is satisfied.

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

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

the processor drives the second ventilation device 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 processor 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 1, further 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 configured to switch between whether or not to guide air to the second heat exchanger through the third air flow path, wherein

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

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

a first ventilation device configured to adjust an air volume flowing to the first heat exchanger upon flowing through the first air flow path; and

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

the processor controls the first ventilation device to increase the air volume flowing to the first heat exchanger and controls the second ventilation device 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.

8. 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 configured to switch between whether or not to guide air to the second heat exchanger through the bypass flow path, wherein

the processor controls the second guide to guide air to the second heat exchanger through the bypass flow path when the predetermined reference is satisfied.

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

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

the processor implements control to stop the compressor and to control the second ventilation device 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.

10. The ventilation apparatus according to claim 1, wherein the processor 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.

11. 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 processor 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.

12. The ventilation apparatus according to claim **11**, 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.

13. An air conditioning system comprising:

a processor;

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 device 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 memory storing one or more programs, which when executed, cause the processor 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 processor 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.

14. A ventilation system comprising:

a processor;

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 memory storing one or more programs, which when executed, cause the processor to:

start the compressor when the second heat exchanger functions as an evaporator, and when the processor 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 processor performs first control to raise the low pressure of the refrigerant circuit.

15. The ventilation system according to claim **14**, 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 processor opens the valve in the first control.

16. The ventilation system according to claim **14**, wherein the processor 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.

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