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(54) **AIR CONDITIONER**

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(57) **ABSTRACT**

An air conditioner may include a controller; a compressor that compresses a refrigerant; an outdoor heat exchanger through which the refrigerant discharged from the compressor flows; a plurality of expansion valves that expands the refrigerant passed through the outdoor heat exchanger; a plurality of indoor heat exchangers through which the refrigerant passed through the plurality of expansion valves flows; a plurality of connection pipes that connects the plurality of indoor heat exchangers and the compressor; and a plurality of variable valves installed in the plurality of connection pipes. An opening degree of each of the plurality of variable valves may be adjustable via the controller.

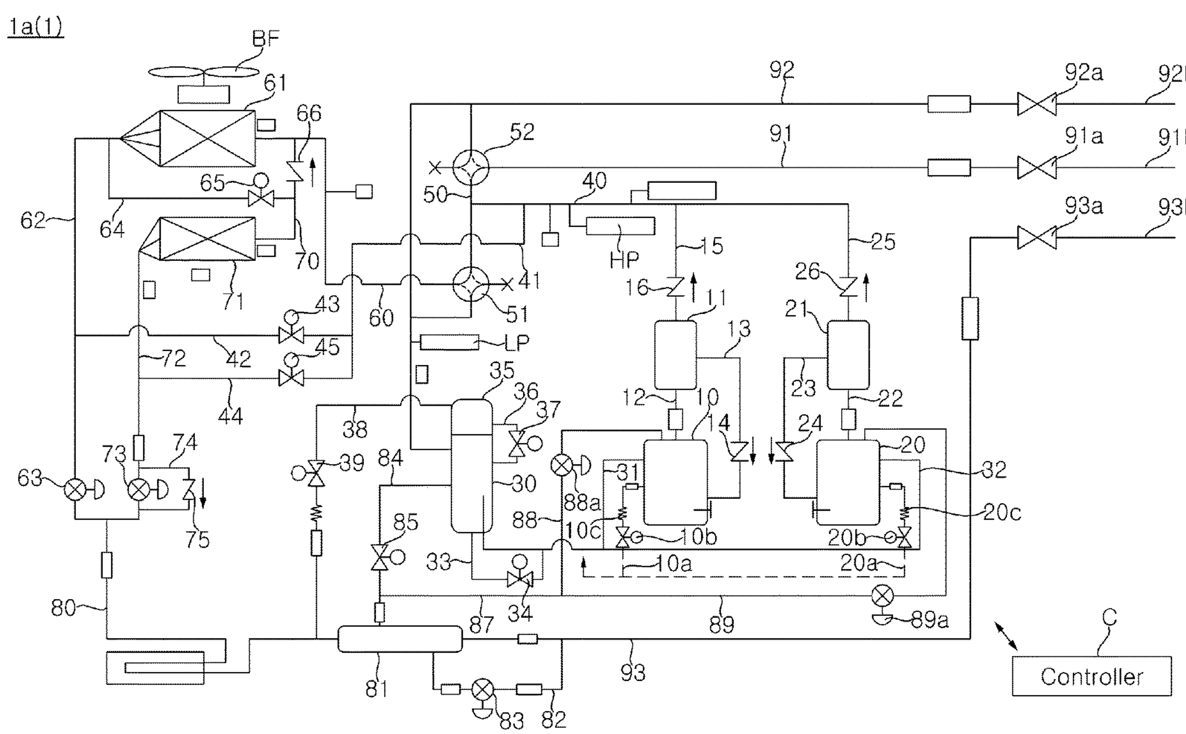


FIG. 1

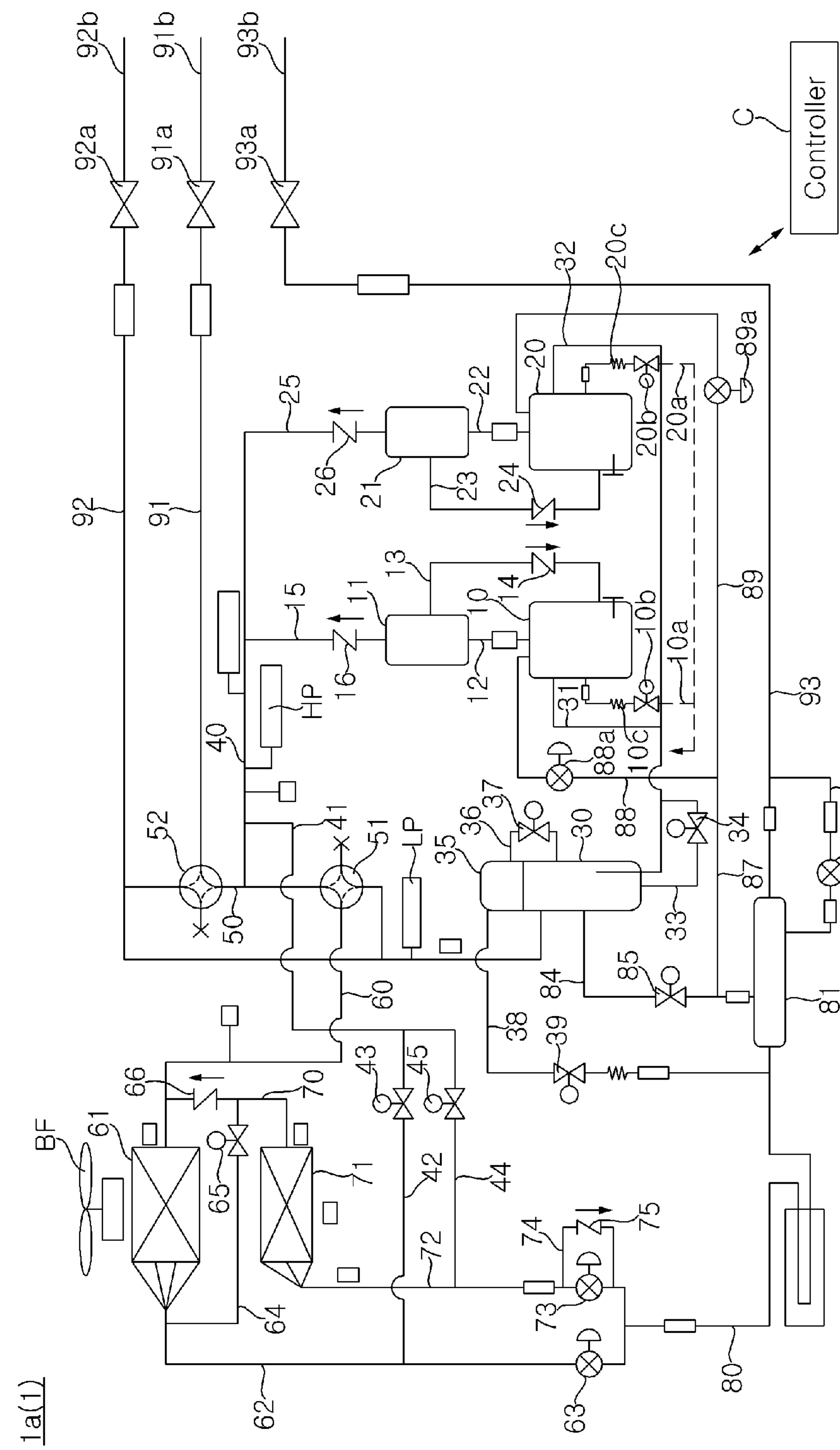
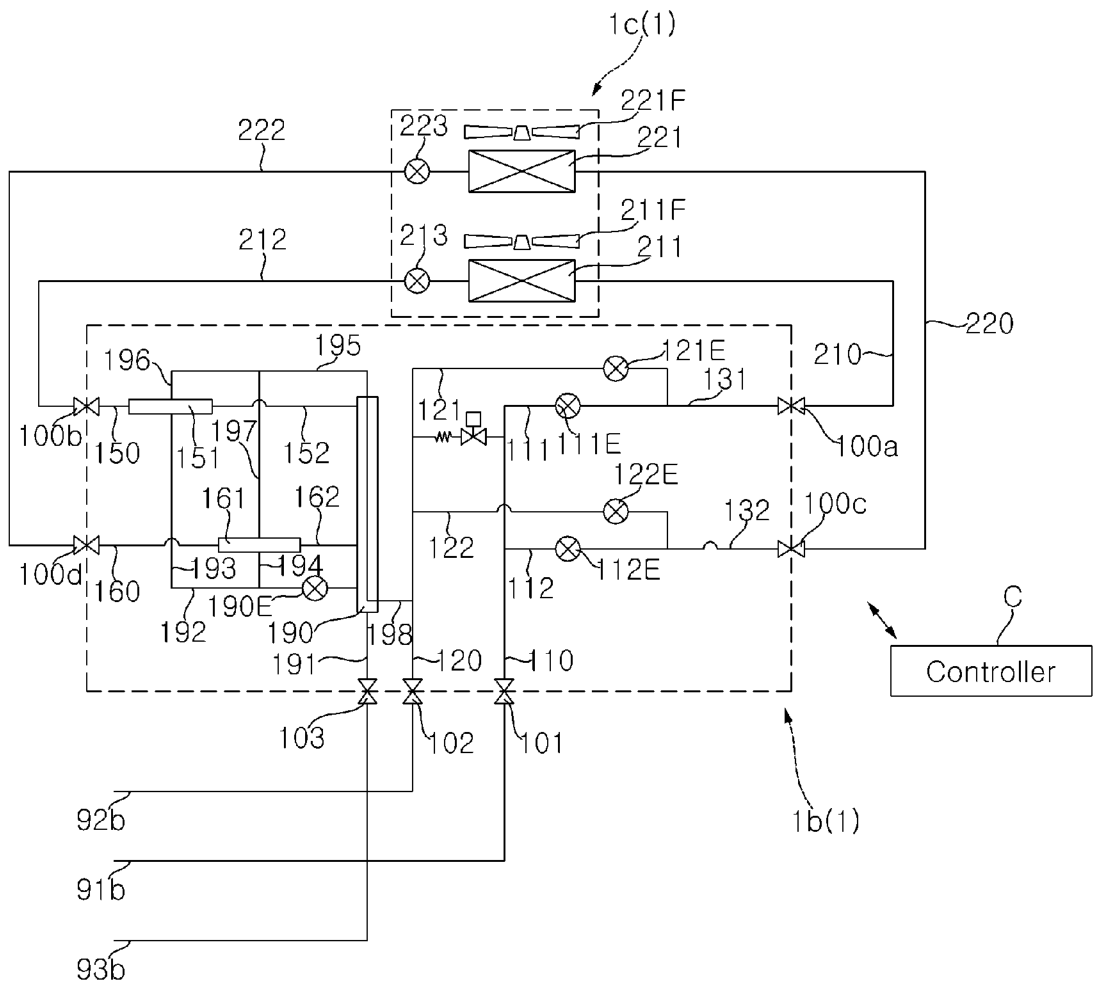
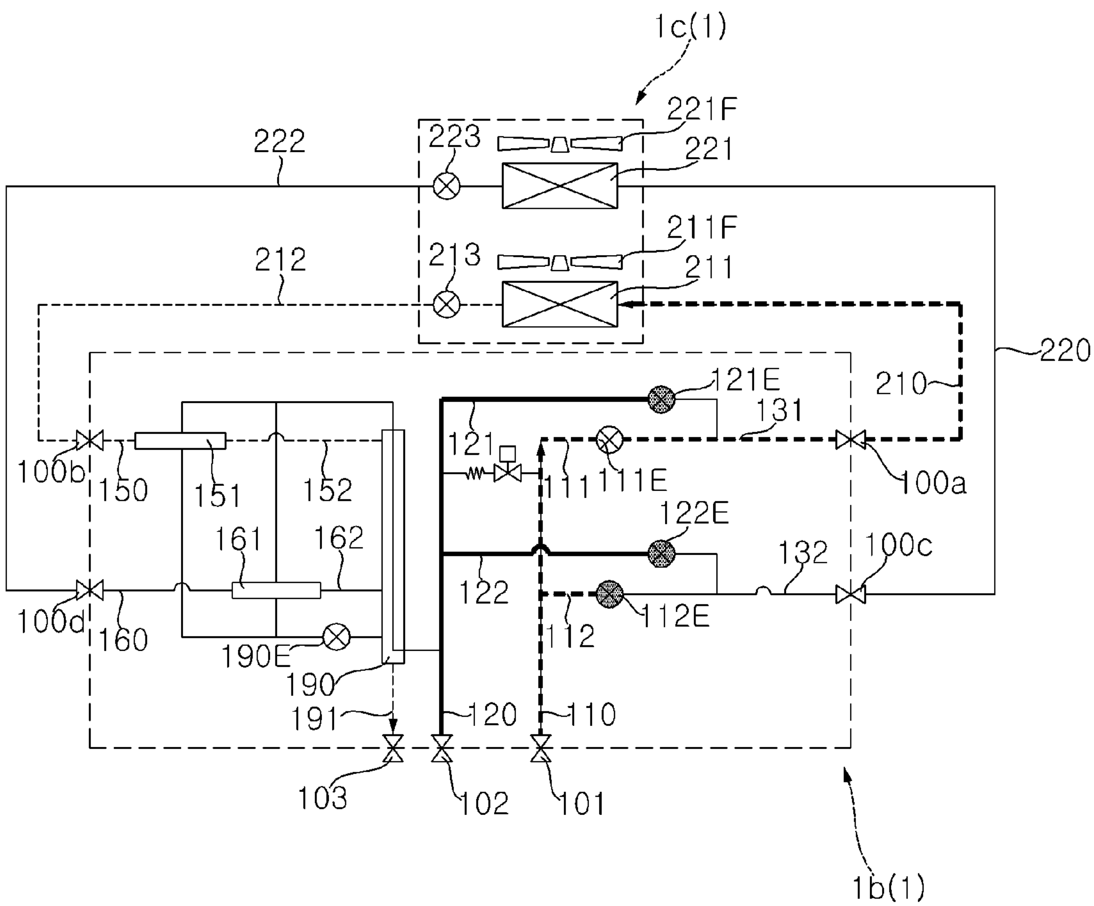

1a(1)
Controller
C
HP
LP
BF
92b
91b
93b
92a
91a
93a
92
91
93
10
10a
10b
10c
11
12
13
14
15
16
20
20a
20b
20c
21
22
23
24
25
26
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
50
51
52
60
61
62
63
64
65
66
70
71
72
73
74
75
80
81
82
83
84
85
87
88
88a
89
89a

FIG. 2



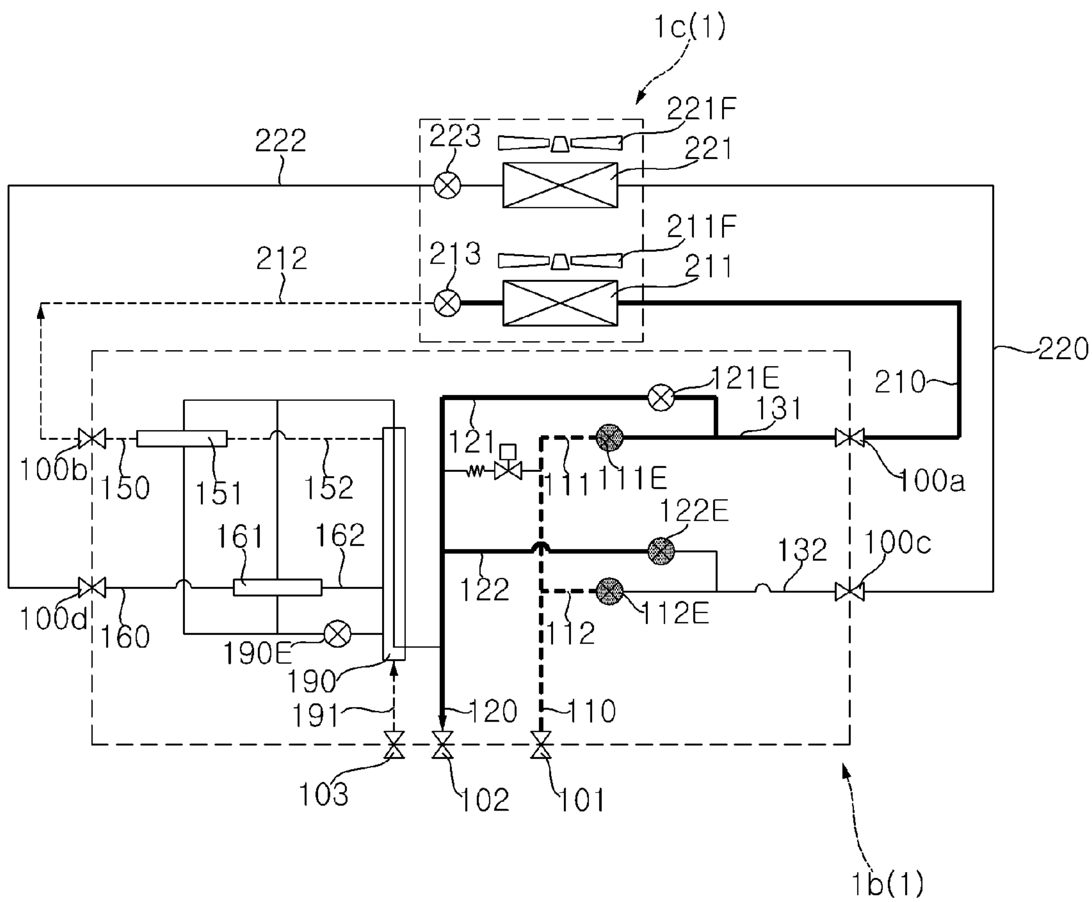
1c(1)
221F
223
221
222
211F
213
211
212
220
195
196
121E
210
131
100b
121
100a
197
152
111
111E
150
151
122E
161
162
132
100c
122
193
194
100d
112
112E
160
190E
C
192
190
198
191
120
110
Controller
103
102
101
92b
1b(1)
91b
93b

FIG. 3A



1c(1)
221F
223
221
222
211F
212
213
211
220
121E
210
131
100a
121
111
111E
100b
150
151
152
122E
161
162
100c
132
100d
160
122
112E
112
190E
190
191
120
110
103
102
101
1b(1)

FIG. 3B



1c(1)
221F
222
223
221
211F
212
213
211
220
121E
131
210
121
100b
150
151
152
111
111E
100a
122E
161
162
132
100c
122
112E
100d
160
112
190E
190
191
120
110
103
102
101
1b(1)

FIG. 4

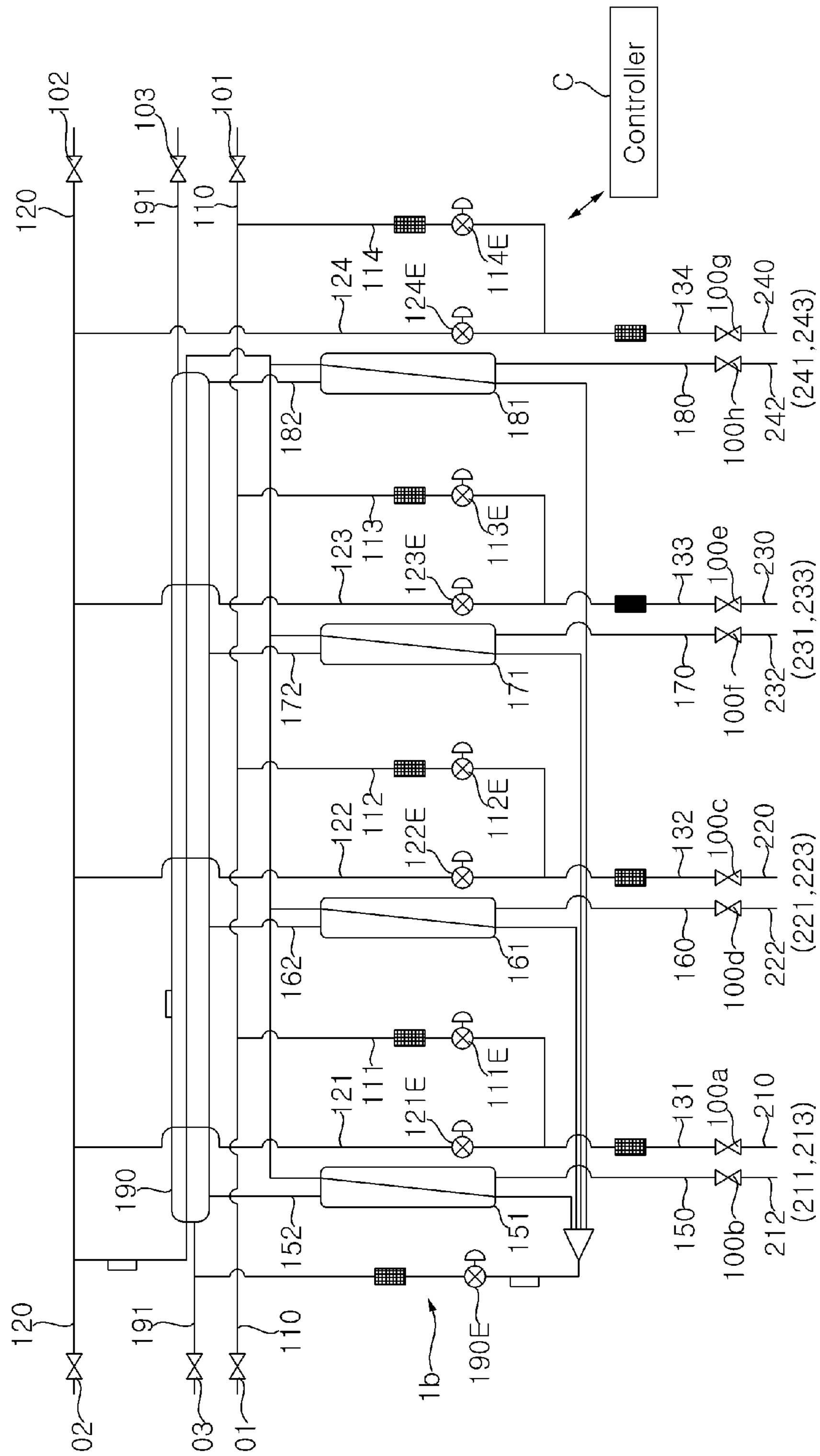
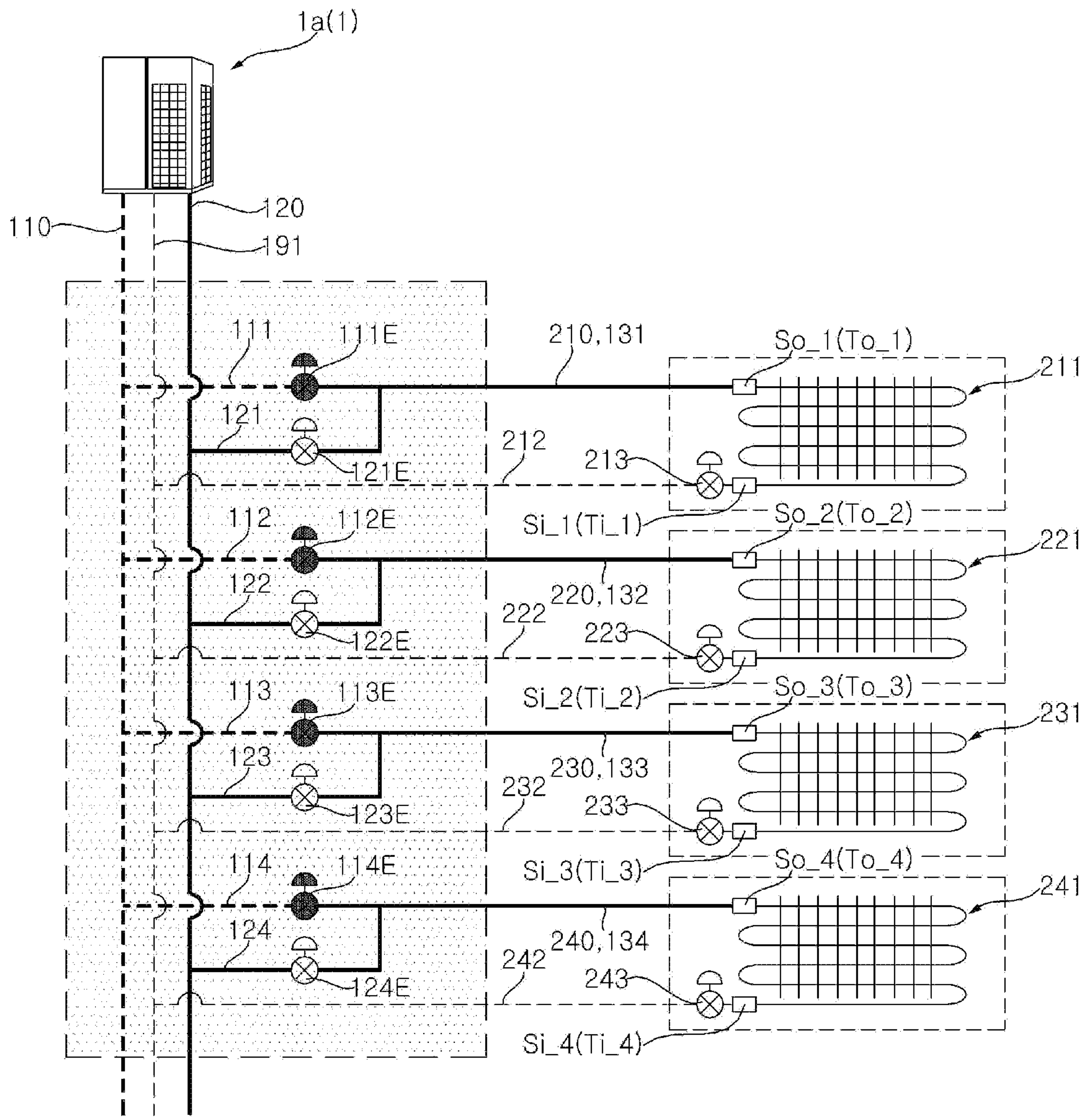

Controller
C
102
103
101
120
191
110
124
114
124E
114E
134
100g
240
(241,243)
182
181
180
100h
242
123
113
123E
113E
133
100e
230
(231,233)
172
171
170
100f
232
122
112
122E
112E
132
100c
220
(221,223)
162
161
160
100d
222
121
111
121E
111E
131
100a
210
(211,213)
190
152
151
150
100b
212
1b
190E

FIG. 5



1a(1)
110
120
191
111
111E
121
121E
212
213
210,131
So_1(To_1)
211
Si_1(Ti_1)
112
112E
122
122E
222
223
220,132
So_2(To_2)
221
Si_2(Ti_2)
113
113E
123
123E
232
233
230,133
So_3(To_3)
231
Si_3(Ti_3)
114
114E
124
124E
242
243
240,134
So_4(To_4)
241
Si_4(Ti_4)

FIG. 6

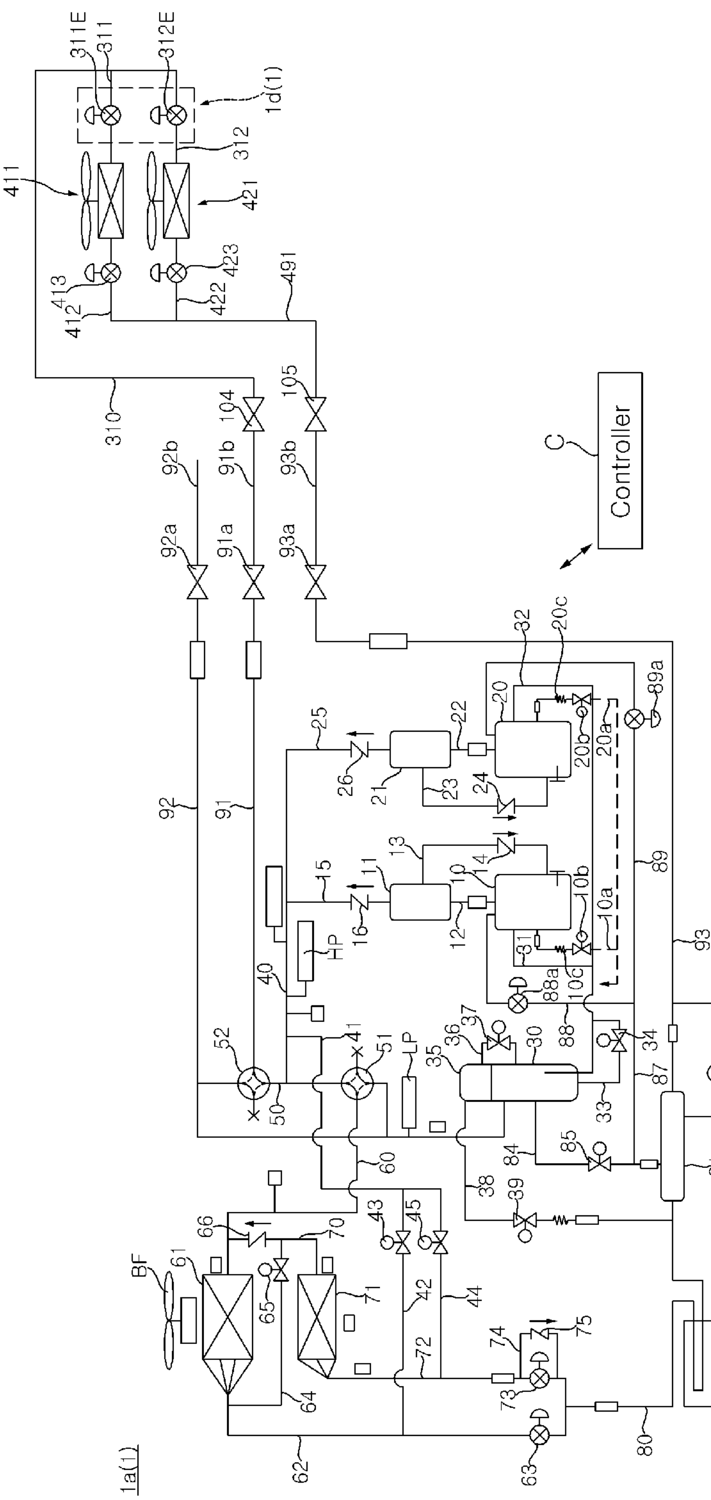

311E
311
312E
1d(1)
312
411
421
413
412
422
423
491
310
104
105
92b
91b
93b
92a
91a
93a
C
Controller
32
20c
20
22
25
89a
20b
20a
26
21
23
24
92
91
13
14
11
10
15
10b
10a
89
16
12
HP
40
31
88a
10C
93
52
41
51
LP
37
36
35
30
88
34
82
83
87
33
50
85
84
81
60
38
39
66
70
43
45
61
BF
65
71
42
44
74
75
72
64
73
80
62
63
1a(1)

FIG. 7

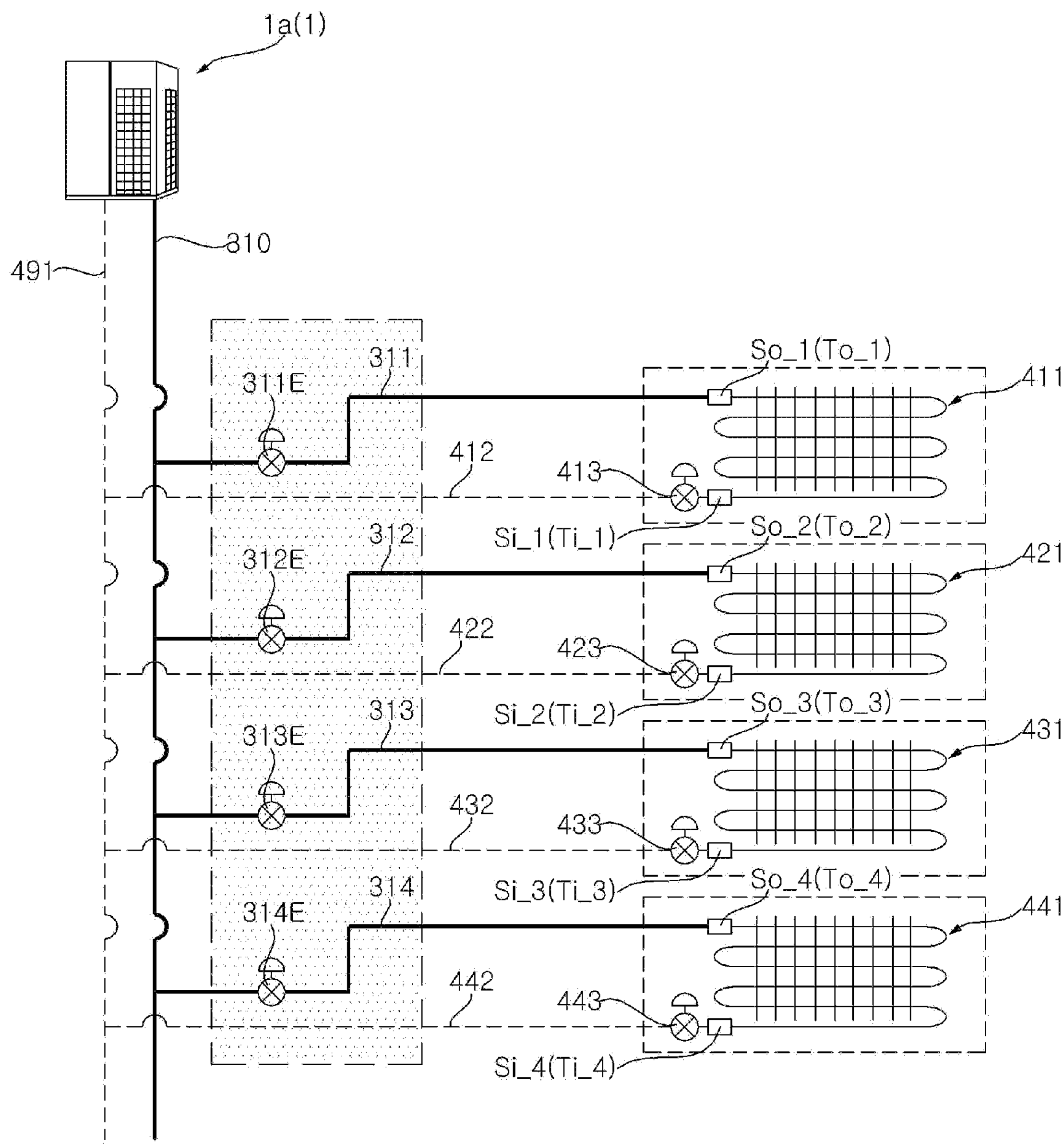
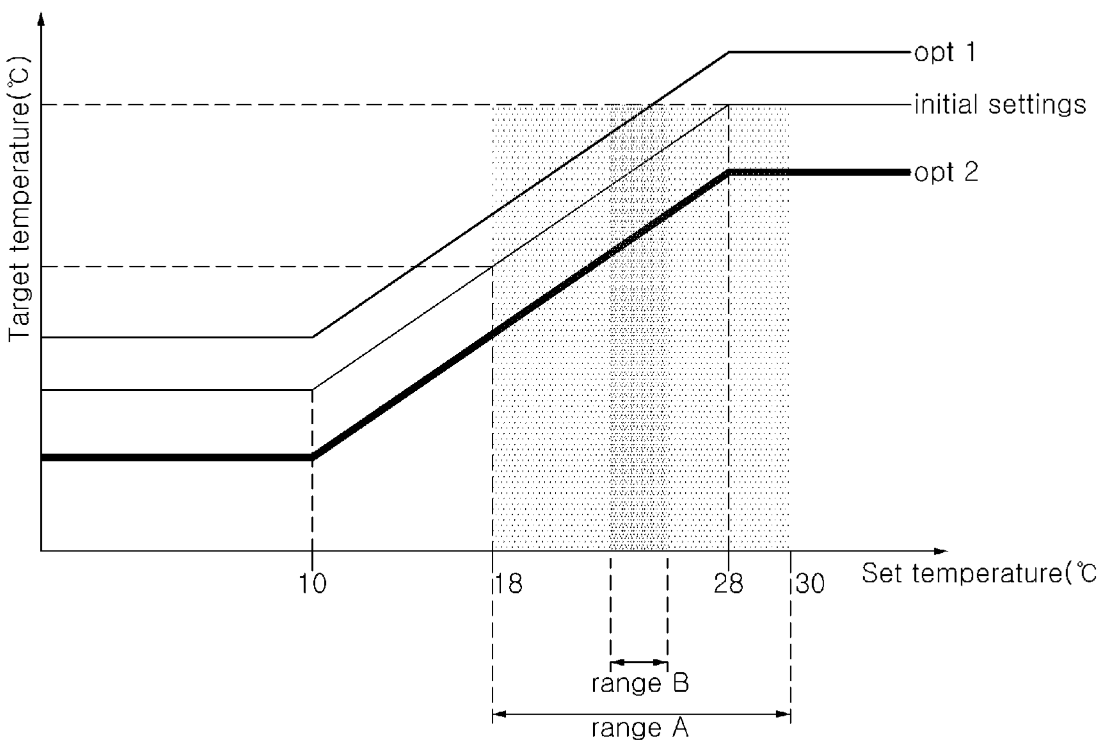

1a(1)
310
491
311
311E
So_1(To_1)
411
412
413
Si_1(Ti_1)
312
312E
So_2(To_2)
421
422
423
Si_2(Ti_2)
313
313E
So_3(To_3)
431
432
433
Si_3(Ti_3)
314
314E
So_4(To_4)
441
442
443
Si_4(Ti_4)

FIG. 8



Target temperature(℃)
opt 1
initial settings
opt 2
10
18
28
30
Set temperature(℃)
range B
range A

FIG. 9

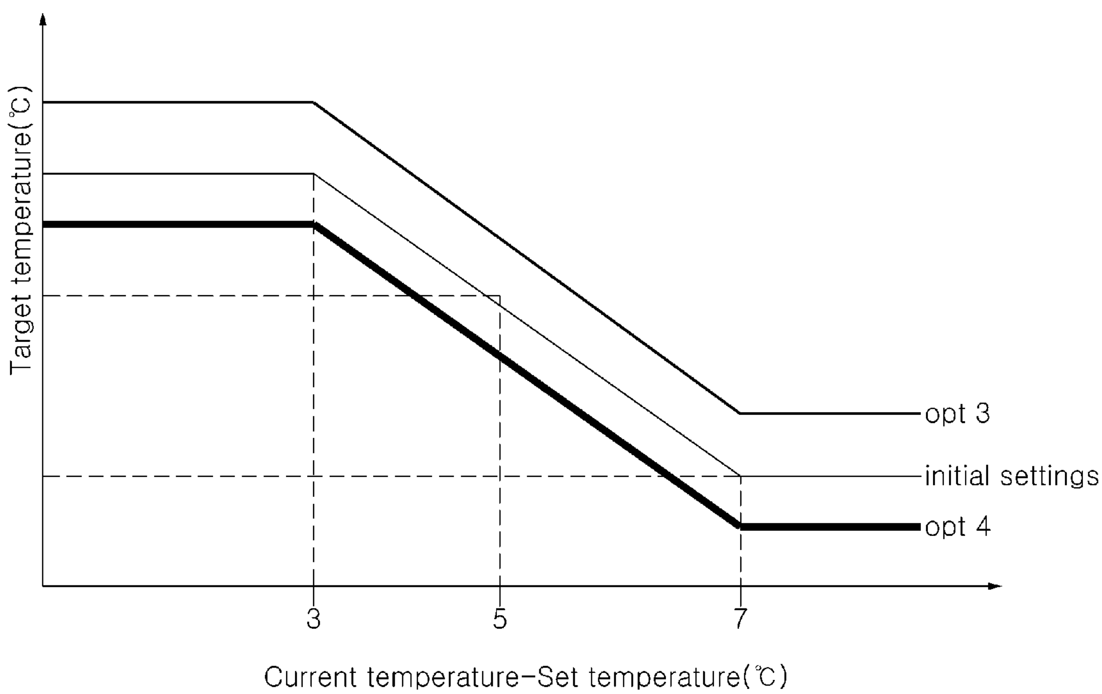

Target temperature(℃)
opt 3
initial settings
opt 4
3
5
7
Current temperature-Set temperature(℃)

FIG. 10

Error													
	−8	−8	−8	−8	−8	−8	−8	−5	−3	−3	−3	−2	−1
	−8	−8	−8	−6	−5	−5	−5	−3	−2	−2	−2	−1	−1
	−8	−8	−8	−5	−3	−3	−3	−2	−1	−1	−1	−1	0
(+)	−5	−5	−5	−3	−2	−2	−2	−1	−1	−1	−1	0	1
	−3	−3	−3	−2	−1	−1	−1	−1	0	0	0	1	1
	−3	−2	−2	−1	−1	−1	−1	0	0	0	1	1	2
0	−3	−2	−1	−1	0	0	0	0	0	1	1	2	3
	−2	−1	−1	0	0	0	1	1	1	1	2	2	3
	−1	−1	0	0	0	1	1	1	1	2	3	3	3
(−)	−1	0	1	1	1	1	2	2	2	3	5	5	5
	0	1	1	1	1	2	3	3	3	5	8	8	8
	1	1	2	2	2	3	5	5	5	6	8	8	8
	1	2	3	3	3	5	8	8	8	8	8	8	8
			(−)				0				(+)		Error slope

FIG. 11

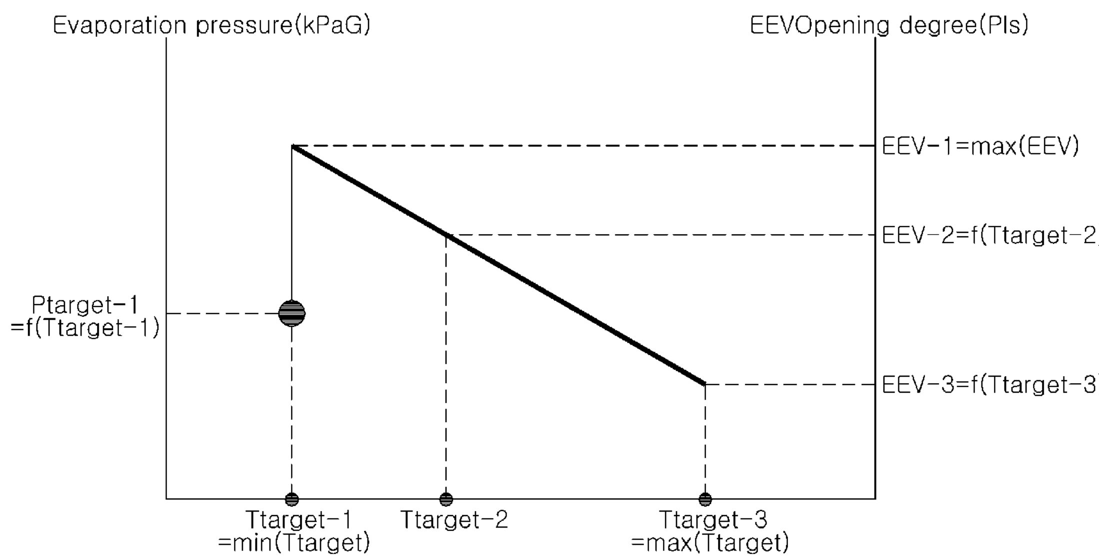

Evaporation pressure(kPaG)
EEVOpening degree(Pls)
EEV-1=max(EEV)
EEV-2=f(Ttarget-2)
Ptarget-1
=f(Ttarget-1)
EEV-3=f(Ttarget-3)
Ttarget-1
=min(Ttarget)
Ttarget-2
Ttarget-3
=max(Ttarget)

FIG. 12

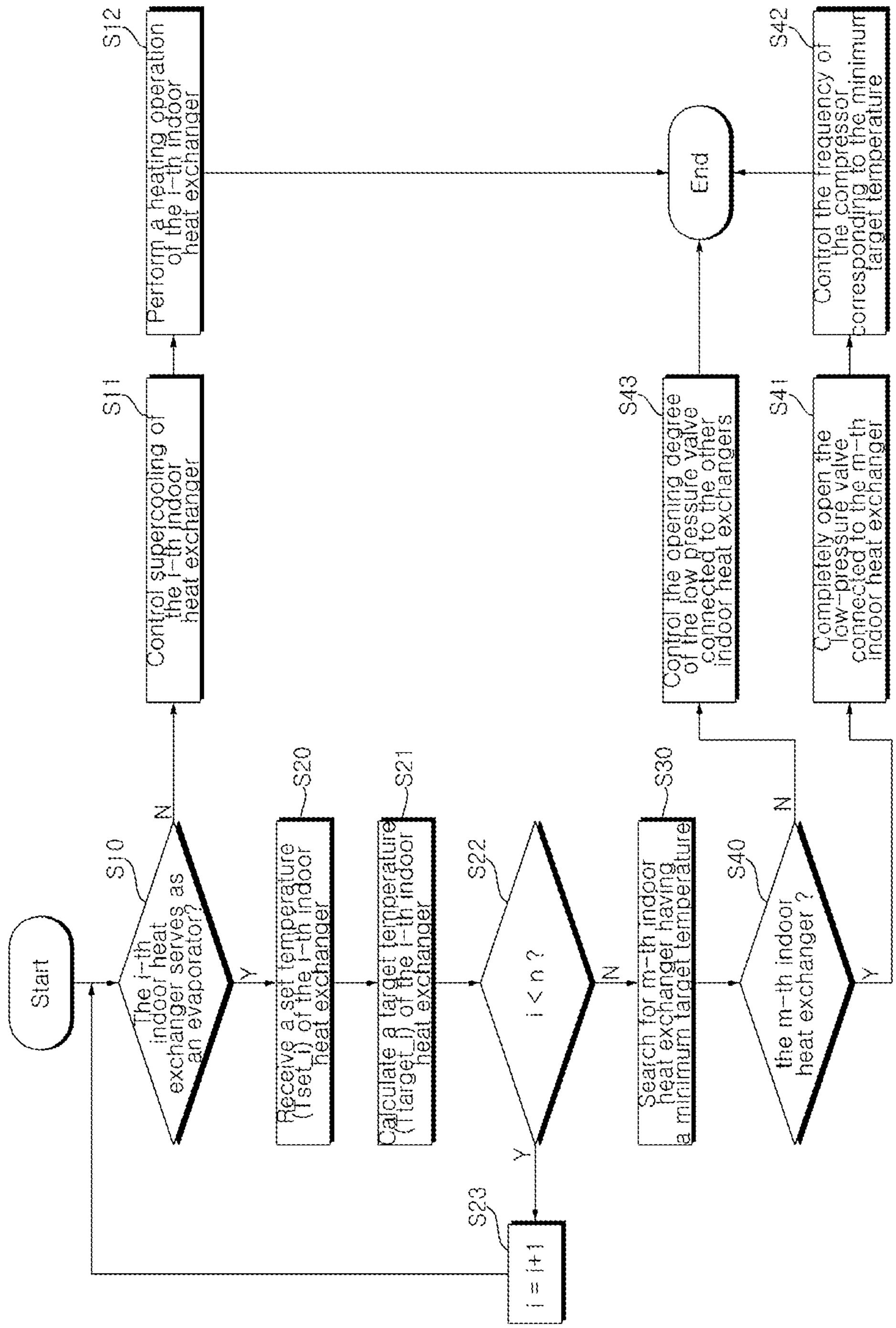
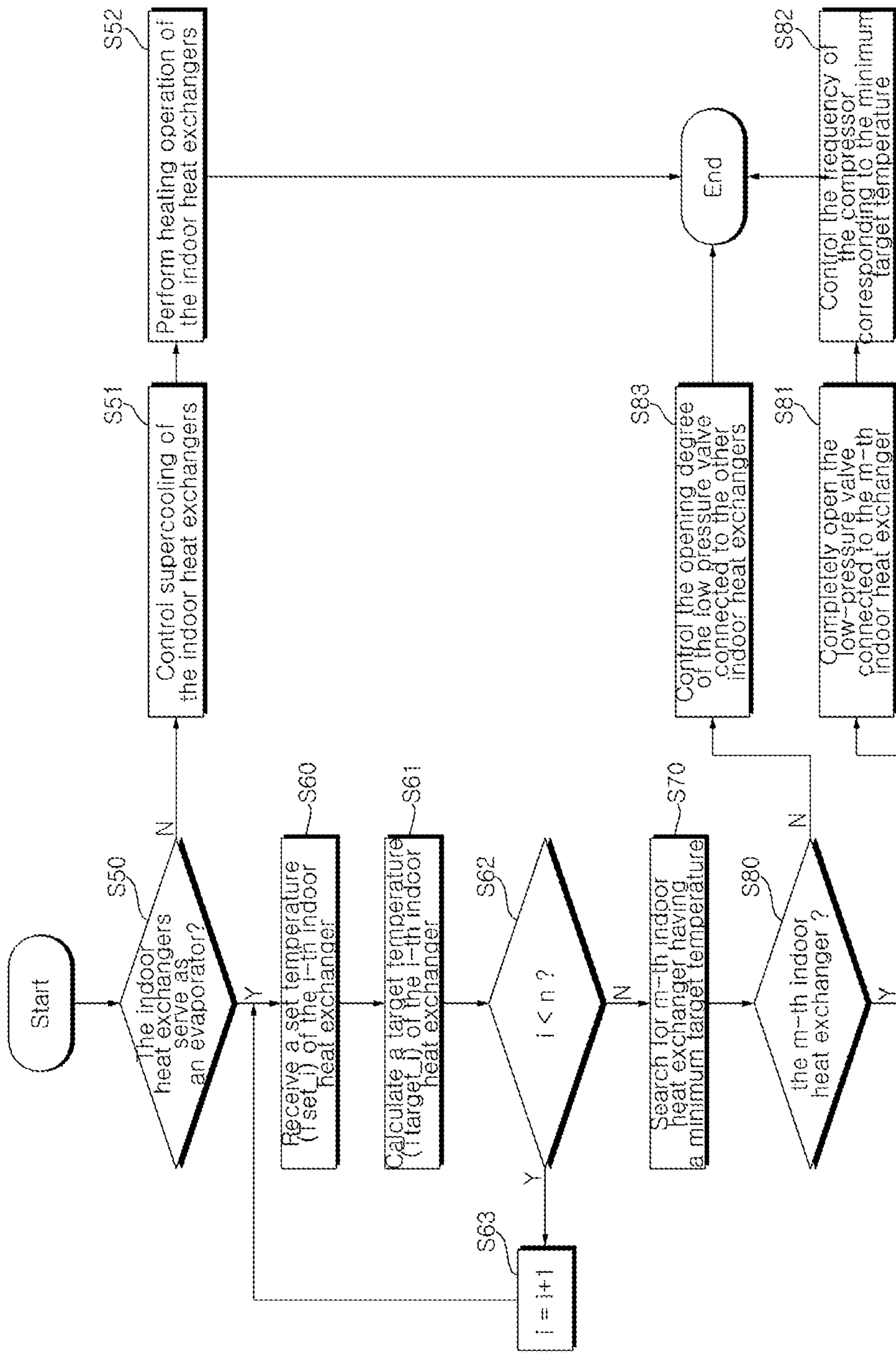

Start
S10
The i-th indoor heat exchanger serves as an evaporator?
Y
N
S11
Control supercooling of the i-th indoor heat exchanger
S12
Perform a heating operation of the i-th indoor heat exchanger
S20
Receive a set temperature (Tset_i) of the i-th indoor heat exchanger
S21
Calculate a target temperature (Ttarget_i) of the i-th indoor heat exchanger
S22
i < n ?
Y
N
S23
i = i+1
S30
Search for m-th indoor heat exchanger having a minimum target temperature
S40
the m-th indoor heat exchanger ?
Y
N
S41
Completely open the low-pressure valve connected to the m-th indoor heat exchanger
S42
Control the frequency of the compressor corresponding to the minimum target temperature
S43
Control the opening degree of the low pressure valve connected to the other indoor heat exchangers
End

FIG. 13



Start
S50
The indoor heat exchangers serve as an evaporator?
Y
N
S51
Control supercooling of the indoor heat exchangers
S52
Perform heating operation of the indoor heat exchangers
S60
Receive a set temperature (T set_i) of the i-th indoor heat exchanger
S61
Calculate a target temperature (T target_i) of the i-th indoor heat exchanger
S62
i < n ?
Y
N
S63
i = i+1
S70
Search for m-th indoor heat exchanger having a minimum target temperature
S80
the m-th indoor heat exchanger ?
Y
N
S81
Completely open the low-pressure valve connected to the m-th indoor heat exchanger
S82
Control the frequency of the compressor corresponding to the minimum target temperature
S83
Control the opening degree of the low pressure valve connected to the other indoor heat exchangers
End

AIR CONDITIONER

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims priority from Korean Patent Application No. 10-2022-0138146, filed in Korea on Oct. 25, 2022, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

1. Field

[0002] An air conditioner is disclosed herein.

2. Background

[0003] In general, an air conditioner refers to a device that heats or cools a room through processes of compression, condensation, expansion, and evaporation of a refrigerant. When an air conditioner includes a plurality of indoor heat exchangers, respective indoor spaces may be simultaneously heated and cooled. In addition, it is possible to switch an operation mode of the air conditioner. That is, a heating operation may be switched to a cooling operation, or the cooling operation may be switched to the heating operation.

[0004] However, in a conventional air conditioner, evaporation pressures of a plurality of indoor heat exchangers performing the cooling operation are identical to each other, such that the plurality of indoor heat exchangers cannot but have the same blowdown temperature. For this reason, there is a problem in that it is difficult to adjust the blowdown temperature for each indoor space to meet the needs of occupants.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Embodiments will be described in detail with reference to the following drawings in which like reference numerals refer to like elements, and wherein:

[0006] FIG. **1** is a schematic diagram of an outdoor unit of an air conditioner according to an embodiment;

[0007] FIG. **2** is a schematic diagram of an indoor unit of the air conditioner according to the embodiment of FIG. **1**;

[0008] FIGS. **3**A and **3**B are schematic diagrams for explaining a heating operation and a cooling operation of the air conditioner according to the embodiment of FIG. **1**;

[0009] FIGS. **4** and **5** are schematic diagrams of the air conditioner of FIG. **1** for explaining a configuration in which evaporation pressure is differently adjusted for each indoor heat exchanger by adjusting an opening degree of a variable valve;

[0010] FIGS. **6** and **7** are schematic diagrams of an air conditioner according to another embodiment for explaining a configuration in which evaporation pressure is differently adjusted for each indoor heat exchanger by adjusting an opening degree of a variable valve;

[0011] FIGS. **8** and **9** are graphs for explaining a method for determining a target temperature of refrigerant in an inlet side of the indoor heat exchanger;

[0012] FIG. **10** is a graph for explaining a method for adjusting the opening degree of a variable valve to adjust a temperature of refrigerant in an inlet side of the indoor heat exchanger to a target temperature;

[0013] FIG. **11** is a graph for explaining a method for adjusting the opening degrees of variable valves connected to indoor heat exchangers having different target temperatures;

[0014] FIG. **12** is a flowchart of a method for controlling an air conditioner according to an embodiment; and

[0015] FIG. **13** is a flowchart of a method for controlling an air conditioner according to another embodiment.

DETAILED DESCRIPTION

[0016] Description will now be given according to exemplary embodiments disclosed herein, with reference to the accompanying drawings. For the sake of brief description with reference to the drawings, the same or equivalent components may be denoted by the same reference numbers, and description thereof will not be repeated.

[0017] In general, suffixes such as "module" and "unit" may be used to refer to elements or components. Use of such suffixes herein is merely intended to facilitate description of the specification, and the suffixes do not have any special meaning or function.

[0018] Hereinafter, that which is well known to one of ordinary skill in the relevant art has generally been omitted for the sake of brevity. The accompanying drawings are used to assist in easy understanding of various technical features and it should be understood that the embodiments presented herein are not limited by the accompanying drawings. As such, embodiments should be construed to extend to any alterations, equivalents and substitutes in addition to those which are particularly set out in the accompanying drawings.

[0019] It will be understood that although the terms first, second, etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another.

[0020] It will be understood that when an element is referred to as being "connected with" another element, there may be intervening elements present. In contrast, it will be understood that when an element is referred to as being "directly connected with" another element, there are no intervening elements present.

[0021] A singular representation may include a plural representation unless context clearly indicates otherwise.

[0022] Herein, it should be understood that the terms "comprises, includes," "has," etc. specify the presence of features, numbers, steps, operations, elements, components, or combinations thereof described in the specification, but do not preclude the presence or addition of one or more other features, numbers, steps, operations, elements, components, or combinations thereof.

[0023] Referring to FIGS. **1** and **2**, an air conditioner **1** may include an outdoor unit **1***a*, a heat recovery unit **1***b*, and an indoor unit **1***c*. The outdoor unit **1***a* may include a compressor **10**, **20**, an oil separator **11**, **21**, an accumulator **30**, a switching valve **51**, **52**, an outdoor heat exchanger **61**, **71**, and an outdoor expansion valve **63**, **73**.

[0024] The compressor **10**, **20** may compress and discharge refrigerant at a high temperature and high pressure. The compressor **10**, **20** may be an inverter compressor capable of controlling an amount of refrigerant and a discharge pressure of the refrigerant by adjusting an operating frequency. For example, the compressor **10**, **20** may include first compressor **10** and second compressor **20**. Alternatively, the number of compressors **10**, **20** may be one, three, or more.

[0025] The oil separator **11**, **21** may be connected to the compressor **10**, **20** through a refrigerant pipe **12**, **22** and an oil recovery pipe **13**, **23**. The refrigerant discharged from the first compressor **10** may flow into first oil separator **11** through first refrigerant pipe **12**, and the oil flowing into the first oil separator **11** may be returned to the first compressor **10** through first oil recovery pipe **13**. A first check valve **14** may be installed in the first oil recovery pipe **13**, and fluid in the first oil recovery pipe **13** may flow from the first oil separator **11** to the first compressor **10**. The refrigerant discharged from the second compressor **20** may flow into second oil separator **21** through second refrigerant pipe **22**, and the oil flowing into the second oil separator **21** may be returned to the second compressor **20** through second oil recovery pipe **23**. A second check valve **24** may be installed in the second oil recovery pipe **23**, and fluid in the second oil recovery pipe **23** may flow from the second oil separator **21** to the second compressor **20**.

[0026] The refrigerant passing through the first oil separator **11** may flow through a first refrigerant pipe **15** in which a first check valve **16** is installed, and the refrigerant passing through the second oil separator **21** may flow through a second refrigerant pipe **25** in which a second check valve **16** is installed. The refrigerant passing through the first refrigerant pipe **15** and the second refrigerant pipe **25** may flow through a discharge pipe **40**, **50**.

[0027] The accumulator **30** may provide gaseous refrigerant to the compressor **10**, **20** through a refrigerant pipe **31**, **32**. One or a first end of the oil recovery pipe **33** may be connected to the accumulator **30**, and the other or a second end of the oil recovery pipe **33** may be connected to the refrigerant pipe **31**, **32**. A control valve **34** may be installed in the oil recovery pipe **33** and may control a flow of oil in the oil recovery pipe **33**.

[0028] The switching valve **51**, **52** may switch a flow path of the refrigerant according to an operation mode of the air conditioner. The switching valve **51**, **52** may be a four-way valve.

[0029] First switching valve **51** may be connected to the discharge pipe **40**, **50**, a first connection pipe **60**, a low pressure pipe **92**, and a closed pipe (see "X" near the first switching valve **51** in FIG. **1**). The first connection pipe **60** may connect the first switching valve **51** and first outdoor heat exchanger **61**, and the low pressure pipe **92** may provide low pressure refrigerant which has passed through the evaporator to the accumulator **30**. The first switching valve **51** in a first state may guide the refrigerant in the discharge pipe **40**, **50** to the first connection pipe **60** (see the solid line of the first switching valve **51** in FIG. **1**). The first switching valve **51** in a second state switched from the first state may guide the refrigerant in the first connection pipe **60** to the low pressure pipe **92** (see the dotted line of first switching valve **51** in FIG. **1**). The first connection pipe **60** may be referred to as connection pipe **60**.

[0030] Second switching valve **52** may be connected to the discharge pipe **40**, **50**, a high pressure pipe **91**, the low pressure pipe **92**, and the closed pipe (see "X" near the second switching valve **52** in FIG. **1**). The second switching valve **52** may guide the refrigerant in the discharge pipe **40**, **50** to the high pressure pipe **91**.

[0031] The outdoor heat exchanger **61**, **71** may include a pipe through which refrigerant flows, and may exchange heat between a refrigerant and a heat transfer medium. A heat transfer direction between the refrigerant and the heat transfer medium in the outdoor heat exchanger **61**, **71** may be different depending on the operation mode of the air conditioner. When the outdoor heat exchanger **61**, **71** serves as a condenser, heat may be transferred from the refrigerant passing through the outdoor heat exchanger **61**, **71** to the heat transfer medium, and the refrigerant may be condensed. When the outdoor heat exchanger **61**, **71** serves as an evaporator, heat may be transferred from the heat transfer medium to the refrigerant passing through the outdoor heat exchanger **61**, **71**, and the refrigerant may be evaporated. For example, the heat transfer medium may be outdoor air. In this case, an outdoor fan BF may cause air to flow through the outdoor heat exchanger **61**, **71**. The number of outdoor heat exchanger **61**, **71** may be one or two or more.

[0032] One or a first end of the first outdoor heat exchanger **61** may be connected to the first connection pipe **60**, and the other or a second end of the first outdoor heat exchanger **61** may be connected to a first outdoor pipe **62**. One or a first end of a variable bypass pipe **64** may be connected to the first outdoor pipe **62**, and the other or a second end of the variable bypass pipe **64** may be connected to the first connection pipe **60**. A variable valve **65** may be installed in the variable bypass pipe **64**. A check valve **66** may be installed in the variable bypass pipe **64** at a location between the variable valve **65** and the other end of the variable bypass pipe **64**, and may block the refrigerant in the first connection pipe **60** from passing through the variable bypass pipe **64**.

[0033] One or a first end of the second outdoor heat exchanger **71** may be connected to the variable bypass pipe **64** at a position between the variable valve **65** and the check valve **66** through a second connection pipe **70**. The other or a second end of the second outdoor heat exchanger **71** may be connected to the second outdoor pipe **72**. One or a first end and the other or a second end of a bypass pipe **74** may be connected to the second outdoor pipe **72**, and the check valve **75** may be installed in the bypass pipe **74**. The second connection pipe **70** may be referred to as a connection pipe **70**.

[0034] The outdoor expansion valve **63**, **73** may include first outdoor expansion valve **63** and second outdoor expansion valve **73**. The first outdoor expansion valve **63** may be installed in the first outdoor pipe **62** and may expand the refrigerant flowing through the first outdoor pipe **62**. The second outdoor expansion valve **73** may be installed in the second outdoor pipe **72** and expand the refrigerant flowing through the second outdoor pipe **72**. The outdoor expansion valves **63**, **73** may each be an Electronic Expansion Valve (EEV).

[0035] A supercooling pipe **80** may connect the outdoor expansion valve **63**, **73** and a supercooler **81**. A liquid pipe **93** may be opposite to the supercooling pipe **80** with respect to the supercooler **81**, and may be connected to the supercooler **81**. One or a first end of a supercooling bypass pipe **82** may be connected to the liquid pipe **93**, and the other or a second end of the supercooling bypass pipe **82** may be connected to the supercooler **81**.

[0036] A part or portion of the refrigerant in the liquid pipe **93** may be expanded by a supercooling expansion valve **83** installed in the bypass pipe **82** and may pass through the supercooler **81**. The refrigerant evaporated while passing through the supercooler **81** may be supplied to the compressor **10**, **20** through a refrigerant pipe **87**, **88**, **89**. An expansion valve **88***a*, **89***a* may be installed in the refrigerant pipe **88**, **89** to expand the refrigerant passing through the refrigerant pipe **88**, **89**. A bypass pipe **84** in which a bypass valve **85** is installed may have one or a first end connected to the accumulator **30** and the other or a second end connected to the refrigerant pipe **87**. When the bypass valve **85** is opened, liquid refrigerant in the accumulator **30** may be expanded by the expansion valve **88***a*, **89***a* in the refrigerant pipe **87**, **88**, **89** and flow into the compressor **10**, **20**. The supercooling expansion valve **83** and the expansion valve **88***a*, **89***a* may each be an electronic expansion valve (EEV).

[0037] The rest of the refrigerant in the liquid pipe **93** may be supercooled while passing through the supercooler **81**. The supercooled refrigerant may pass through the supercooling pipe **80**.

[0038] A receiver **35** may store refrigerant. A first receiver connection pipe **36** may connect the receiver **35** and the accumulator **30**, and a first valve **37** may be installed in the first receiver connection pipe **36** and be opened or closed. A second receiver connection pipe **38** may connect the receiver **35** and the supercooling pipe **80**, and a second valve **39** may be installed in the second receiver connection pipe **38** and be opened or closed. The first and second valves **37** and **39** may adjust an amount of refrigerant circulated through the refrigerant pipe.

[0039] The indoor unit **1***c* may include an indoor heat exchanger **211**, **221** and an indoor expansion valve **213**, **223**. The indoor heat exchanger **211**, **221** may include a pipe through which the refrigerant flows, and may exchange heat between the refrigerant and the heat transfer medium. The direction of heat transfer between the refrigerant and the heat transfer medium in the indoor heat exchanger **211**, **221** may vary depending on the operation mode of the air conditioner. When the indoor heat exchanger **211**, **221** serves as an evaporator, heat may be transferred from the heat transfer medium to the refrigerant passing through the indoor heat exchanger **211**, **221**, and the refrigerant may be evaporated. When the indoor heat exchanger **211**, **221** serves as an a condenser, heat may be transferred from the refrigerant passing through the indoor heat exchanger **211**, **221** to the heat transfer medium, and the refrigerant may be condensed. For example, the heat transfer medium may be indoor air. In this case, an indoor fan **211**F, **221**F may cause air to flow through the indoor heat exchanger **211**, **221**. For another example, the heat transfer medium may be water. In this case, the water passing through the indoor heat exchanger **211**, **221** may be supplied to a radiator or pipe installed in a room to cool or heat the room, or may be supplied to a water tank to provide cold or hot water to the room. The number of indoor heat exchanger **211**, **221** may be one, or two or more.

[0040] One or a first end of a first indoor heat exchanger **211** may be connected to a first connection pipe **210**, and the other or a second end of the first indoor heat exchanger **211** may be connected to a first indoor pipe **212**. One or a first end of a second indoor heat exchanger **221** may be connected to a second connection pipe **220**, and the other or a second end of the second indoor heat exchanger **221** may be connected to a second indoor pipe **222**.

[0041] The indoor expansion valve **213**, **223** may include first indoor expansion valve **213** and second indoor expansion valve **223**. The first indoor expansion valve **213** may be installed in the first indoor pipe **212** and expand the refrigerant flowing through the first indoor pipe **212**. The second indoor expansion valve **223** may be installed in the second indoor pipe **222**, and may expand the refrigerant flowing through the second indoor pipe **222**. The indoor expansion valve **213**, **223** may be an electronic expansion valve (EEV).

[0042] The heat recovery unit **1***b* may connect the outdoor unit **1***a* and the indoor unit **1***c* through a refrigerant pipe. The heat recovery unit **1***b* may include a distributor and a supercooler.

[0043] A high pressure connection pipe **91***b* may be connected to the high pressure pipe **91** of the outdoor unit **1***a* through a first connection valve **91***a*, and may be connected to a high pressure pipe **110** of the heat recovery unit **1***b* through a second connection valve **101**. The high pressure pipe **91**, the high pressure connection pipe **91***b*, and the high pressure pipe **110** may be a gas pipe through which high pressure gaseous refrigerant flows. A first high pressure valve **111**E may be installed in a first high pressure pipe **111** of the high pressure pipe **110**, and an opening degree of the first high pressure valve **111**E may be adjusted. A second high pressure valve **112**E may be installed in the second high pressure pipe **112** of the high pressure pipe **110**, and an opening degree of the second high pressure valve **112**E may be adjusted. The first and second high pressure valves **111**E and **112**E may each be an electronic expansion valve (EEV). The first and second high pressure valves **111**E and **112**E may each be a large-capacity EEV having a large flow coefficient. The first and second high pressure pipes **111** and **112** may be referred to as first and second refrigerant pipes **111** and **112**. The first and second high pressure valves **111**E and **112**E may be referred to as first and second control valves **111**E and **112**E.

[0044] A low pressure connection pipe **92***b* may be connected to the low pressure pipe **92** of the outdoor unit **1***a* through a first connection valve **92***a*, and may be connected to a low pressure pipe **120** of the heat recovery unit **1***b* through a second connection valve **102**. The low pressure pipe **92**, the low pressure connection pipe **92***b*, and the low pressure pipe **120** may be a gas pipe through which low pressure gaseous refrigerant flows. A first low pressure valve **121**E may be installed in a first low pressure pipe **121** of the low pressure pipe **120**, and an opening degree of the first low pressure valve **121**E may be adjusted. A second low pressure valve **122**E may be installed in a second low pressure pipe **122** of the low pressure pipe **120**, and an opening degree of the second low pressure valve **122**E may be adjusted. The first and second low pressure valves **121**E and **122**E may each be an electronic expansion valve (EEV). The first and second low pressure valves **121**E and **122**E may each be a large-capacity EEV having a large flow coefficient. The first and second low pressure pipes **121** and **122** may be referred to as first and second connection pipes **121** and **122**. The first and second low pressure valves **121**E and **122**E may be referred to as first and second variable valves **121**E and **122**E. The number of each of the high pressure valve **111**E, **112**E and the low pressure valve **121**E, **122**E may be the same as the number of indoor heat exchanger **211**, **221**. The number of indoor heat exchanger **211**, **221** may be one, or two or more.

[0045] A liquid connection pipe **93***b* may be connected to the liquid pipe **93** of the outdoor unit **1***a* through a first connection valve **93***a*, and may be connected to a liquid pipe

191 of the heat recovery unit 1*b* through a second connection valve 103. The liquid pipe 93, the liquid connection pipe 93*b*, and the liquid pipe 191 may be a liquid pipe through which medium pressure liquid refrigerant flows.

[0046] The first high pressure pipe **111** of the high pressure pipe **110** and the first low pressure pipe **121** of the low pressure pipe **120** may be connected to a first refrigerant pipe **131**. The first refrigerant pipe **131** may be connected to the first connection pipe **210** through a first valve **100***a*. The second high pressure pipe **112** of the high pressure pipe **110** and the second low pressure pipe **122** of the low pressure pipe **120** may be connected to a second refrigerant pipe **132**. The second refrigerant pipe **132** may be connected to the second connection pipe **220** through a third valve **100***c*.

[0047] A supercooler **151**, **161** may connect the indoor pipe **212**, **222** and the liquid connection pipe **93***b*. One or a first end of a first supercooling pipe **150** may be connected to first supercooler **151**, and the other or a second end of the first supercooling pipe **150** may be connected to the first indoor pipe **212** through a second valve **100***b*. A first pipe **152** may connect a header **190** and the first supercooler **151**. One or a first end of a second supercooling pipe **160** may be connected to second supercooler **161**, and the other or a second end of the second supercooling pipe **160** may be connected to the second indoor pipe **222** through a fourth valve **100***d*. A second pipe **162** may connect the header **190** and the second supercooler **161**.

[0048] One or a first end of the liquid pipe **191** of the heat recovery unit **1***b* may be connected to the liquid connection pipe **93***b* through the second connection valve **103**, and the other or a second end of the liquid pipe **191** of the heat recovery unit **1***b* may be connected to the header **190**. One or a first end of a supercooling bypass pipe **192** may be connected to the header **190**, and the other or a second end of the supercooling bypass pipe **192** may be connected to the supercooler **151**, **161** (see reference numerals **193** and **194** in FIG. **2**). A supercooling expansion valve **190**E may be installed in the supercooling bypass pipe **192**, and expand the refrigerant flowing through the supercooling bypass pipe **192**. The supercooling expansion valve **190**E may be an electronic expansion valve (EEV).

[0049] One or a first end of an evaporation pipe **195** of the heat recovery unit **1***b* may be connected to the supercooler **151**, **161** (see reference numerals **196** and **197** in FIG. **2**), and the other or a second end of the evaporation pipe **195** may be connected to the low pressure pipe **120**.

[0050] Accordingly, a part or portion of the refrigerant in the liquid pipe **191** flows through the supercooling bypass pipe **192**, and may be expanded by the supercooling expansion valve **190**E, and evaporated while passing through the supercooler **151**, **161**. The evaporated refrigerant may be provided to the low pressure pipe **120** via the evaporation pipe **195** and the header **190**. The rest of the refrigerant in the liquid pipe **191** may flow through the pipe **152**, **162** and may be cooled while passing through the supercooler **151**, **161**. The cooled refrigerant may be supplied to the indoor heat exchanger **211**, **221** via the supercooling pipe **150**, **160**, the indoor pipe **212**, **222**, and the indoor expansion valve **213**, **223**.

[0051] Referring to FIG. **3**, the air conditioner may perform a heating operation (see FIG. **3**A)) or a cooling operation (see FIG. **3**B). For example, the indoor heat exchanger(s) may serve as a condenser or an evaporator. As another example, among the indoor heat exchangers, an indoor heat exchanger installed in an indoor space requiring heating may serve as a condenser, and an indoor heat exchanger installed in an indoor space requiring cooling may serve as an evaporator. As another example, among indoor heat exchangers, an indoor heat exchanger installed in an indoor space requiring heating or cooling may serve as a condenser or an evaporator, and an indoor heat exchanger installed in an indoor space not requiring heating or cooling may be inoperative.

[0052] Referring to FIG. **3**A, the first high pressure valve **111**E and the first indoor expansion valve **213** may be opened. The first low pressure valve **121**E, the second low pressure valve **122**E, and the second high pressure valve **112**E may be closed.

[0053] The high-temperature, high pressure refrigerant discharged from the compressor **10**, **20** may flow into the high pressure pipe **110** (see FIGS. **1** and **2**) via the oil separator **11**, **21**, the second switching valve **52**, the high pressure pipe **91**, and the high pressure connection pipe **91***b*. The refrigerant in the high pressure pipe **110** may flow into the first indoor heat exchanger **211** through the first high pressure valve **111**E and the first valve **100***a*, and may be condensed while passing through the first indoor heat exchanger **211**. Accordingly, the indoor space in which the first indoor heat exchanger **211** is installed may be heated. The first indoor expansion valve **213** may control a degree of supercooling. The degree of supercooling is a difference between a saturation temperature corresponding to the condensing pressure of the first indoor heat exchanger **211** and an outlet temperature of the first indoor heat exchanger **211**.

[0054] The condensed refrigerant flows into the liquid pipe **93** via the first indoor expansion valve **213**, the second valve **100***b*, the first supercooler **151**, the header **190**, and the liquid connection pipe **93***b* (see FIGS. **1** and **2**). The refrigerant in the liquid pipe **93** may be cooled while passing through the supercooler **81**, expanded by the outdoor expansion valve **63**, **73**, and evaporated while passing through the outdoor heat exchanger **61**, **71**.

[0055] The evaporated refrigerant may be returned to the compressor **10**, **20** via the first connection pipe **60**, the first switching valve **51**, the low pressure pipe **92**, and the accumulator **30**. Accordingly, a heating cycle of the air conditioner using the first indoor heat exchanger **211** may be completed.

[0056] Referring to FIG. **3**B, the first low pressure valve **121**E and the first indoor expansion valve **213** may be opened. The first high pressure valve **111**E, the second low pressure valve **122**E, and the second high pressure valve **112**E may be closed.

[0057] The high-temperature, high pressure refrigerant discharged from the compressor **10**, **20** may flow into the first connection pipe **60** via the oil separator **11**, **21** and the first switching valve **51**, and the refrigerant in the first connection pipe **60** may be condensed while passing through the outdoor heat exchanger **61**, **71** (see FIGS. **1** and **2**). The condensed refrigerant may flow into the liquid pipe **191** via the outdoor expansion valve **63**, **73**, the supercooler **81**, the liquid pipe **93**, and the liquid connection pipe **93***b* (see FIGS. **1** and **2**). The refrigerant in the liquid pipe **191** may be cooled while passing through the first supercooler **151**, expanded while passing through the first indoor expansion valve **213**, and evaporated while passing through the first indoor heat exchanger **211**. Accordingly, the indoor space in which the first indoor heat exchanger **211** is installed may be cooled. The first indoor expansion valve **213** may control the degree of superheat. The degree of superheat is a difference between the temperature of the refrigerant suctioned into the compressor **10**, **20** (or the temperature of the refrigerant at the outlet side of the first indoor heat exchanger **211**) and a saturation temperature corresponding to the evaporating pressure of the first indoor heat exchanger **211** (or a temperature of the refrigerant at an inlet side of the first indoor heat exchanger **211**).

[0058] The evaporated refrigerant may be returned to the compressor **10**, **20** via the first valve **100***a*, the first low pressure valve **121**E, the low pressure pipe **120**, the low pressure connection pipe **92***b*, the low pressure pipe **92**, and the accumulator **30**. Accordingly, the cooling cycle of the air conditioner using the first indoor heat exchanger **211** may be completed.

[0059] Referring to FIG. **4**, four indoor heat exchangers **211**, **221**, **231**, and **241** may be connected to the heat recovery unit **1***b*.

[0060] For example, the air conditioner may perform a heating operation using four indoor heat exchangers **211**, **221**, **231**, and **241**. The first to fourth high pressure valves **111**E, **112**E, **113**E, and **114**E may be opened, and the first to fourth low pressure valves **121**E, **122**E, **123**E, and **124**E may be closed. The first to fourth high pressure valves **111**E, **112**E, **113**E, and **114**E may be referred to as first to fourth control valves **111**E, **112**E, **113**E, and **114**E. The first to fourth low pressure valves **121**E, **122**E, **123**E, and **124**E may be referred to as first to fourth variable valves **121**E, **122**E, **123**E, and **124**E.

[0061] Further, the refrigerant of high pressure pipe **110** may flow into the first to fourth indoor heat exchangers **211**, **221**, **231**, **241** through the first to fourth high pressure valves **111**E, **112**E, **113**E, and **114**E and first to fourth connection pipes **210**, **220**, **230**, and **240**, and may be condensed while passing through the first to fourth indoor heat exchangers **211**, **221**, **231**, **241**. Accordingly, the indoor space in which the first to fourth indoor heat exchangers **211**, **221**, **231**, and **241** are installed may be heated. The condensed refrigerant may be provided to the liquid pipe **191** via the first to fourth indoor expansion valves **213**, **223**, **233**, and **243**, the first to fourth indoor pipes **212**, **222**, **232**, and **242**, and the first to fourth supercoolers **151**, **161**, **171**, **181**.

[0062] For example, the air conditioner may perform a heating operation using the first and second indoor heat exchangers **211** and **221**, and perform a cooling operation using the third and fourth indoor heat exchangers **231** and **241**. The first and second high pressure valves **111**E and **112**E may be opened, and the first and second low pressure valves **121**E and **122**E may be closed. The third and fourth low pressure valves **123**E and **124**E may be opened, and the third and fourth high pressure valves **113**E and **114**E may be closed.

[0063] In addition, the refrigerant of the high pressure pipe **110** may flow into the first and second indoor heat exchangers **211** and **221** through the first and second high pressure valves **111**E and **112**E and the first and second connection pipes **210** and **220**, and may be condensed while passing through the first and second indoor heat exchangers **211** and **221**. Thus, the indoor space in which the first and second indoor heat exchanger **211**, **221** are installed may be heated. The condensed refrigerant may be provided to the liquid pipe **191** via the first and second indoor expansion valve **213** and **223**, the first and second indoor pipes **212** and **222**, and the first and second supercoolers **151** and **161**.

[0064] In addition, the refrigerant in the liquid pipe **191** may be cooled while passing through third and fourth supercoolers **171** and **181**. The cooled refrigerant may pass through third and fourth supercooling pipes **170** and **180** and third and fourth indoor pipes **232** and **242**, be expanded by third and fourth indoor expansion valves **233** and **243**, and be evaporated while passing through the third and fourth indoor heat exchangers **231** and **241**. Thus, the indoor space in which the third and fourth indoor heat exchangers **231** and **241** are installed may be cooled. The evaporated refrigerant may be supplied to the low pressure pipe **120** via the third and fourth connection pipes **230** and **240** and the third and fourth low pressure valves **123**E and **124**E.

[0065] The air conditioner may perform a cooling operation using four indoor heat exchangers **211**, **221**, **231**, and **241**.

[0066] Referring to FIGS. **4** and **5**, the plurality of indoor heat exchangers **211**, **221**, **231**, and **241** may serve as an evaporator, and may have the same or different evaporation pressures. The plurality of low pressure valves **121**E, **122**E, **123**E, and **124**E and the plurality of indoor expansion valves **213**, **223**, **233**, and **243** may be opened, and the plurality of high pressure valves **111**E, **112**E, **113**E, and **114**E may be closed.

[0067] The high-temperature, high-pressure refrigerant discharged from the compressor **10**, **20** may flow into the first connection pipe **60** via the oil separator **11**, **21** and the first switching valve **51**, and the refrigerant in the first connection pipe **60** may be condensed while passing through the outdoor heat exchanger **61**, **71** (see FIGS. **1** and **2**). The condensed refrigerant may flow into the liquid pipe **191** via the outdoor expansion valve **63**, **73**, the supercooler **81**, the liquid pipe **93**, and the liquid connection pipe **93***b* (see FIGS. **1** and **2**).

[0068] The refrigerant in the liquid pipe **191** may be cooled while passing through the plurality of supercoolers **151**, **161**, **171**, and **181**. The cooled refrigerant may pass through the plurality of supercooling pipes **150**, **160**, **170**, and **180**, be expanded by the plurality of indoor expansion valves **213**, **223**, **233**, and **243**, and be evaporated while passing through the plurality of indoor heat exchangers **211**, **221**, **231**, and **241**. Thus, the indoor space in which the plurality of indoor heat exchangers **211**, **221**, **231**, and **241** are installed may be cooled. The evaporated refrigerant may be provided to the low pressure pipe **120** via the plurality of connection pipes **210**, **220**, **230**, and **240** and the plurality of low pressure valves **121**E, **122**E, **123**E, and **124**E.

[0069] The refrigerant in the low pressure pipe **120** may be returned to the compressor **10**, **20** via the low pressure pipe **92** and the accumulator **30** (see FIGS. **1** and **2**). Accordingly, the cooling cycle of the air conditioner using the plurality of indoor heat exchangers **211**, **221**, **231**, and **241** may be completed.

[0070] In this case, each of the plurality of indoor expansion valves **213**, **223**, **233**, and **243** may control the degree of superheat of each of the plurality of indoor heat exchangers **211**, **221**, **231**, and **241**. The degree of superheat is a difference between the temperature of the refrigerant suctioned into the compressor **10**, **20** (or the temperature of the refrigerant at the outlet side of each indoor heat exchanger) and the saturation temperature corresponding to the evaporation pressure of each indoor heat exchanger (or the temperature of the refrigerant at the inlet side of each indoor heat exchanger). For example, the temperature (To_1, To_2, To_3, and To_4) of the refrigerant at the outlet side of each of the plurality of indoor heat exchangers **211**, **221**, **231**, and **241** may be measured by each of the plurality of temperature sensors (So_1, So_2, So_3, and So_4).

[0071] When the compressor **10**, **20** of the outdoor unit **1***a* operates at a specific operating frequency, the pressure of the refrigerant suctioned into the compressor **10**, **20** may be constant. In this case, the evaporation pressure of each of the plurality of indoor heat exchangers **211**, **221**, **231**, and **241** may be adjusted by adjusting the opening degree of each of the plurality of low pressure valves **121**E, **122**E, **123**E, and **124**E. In addition, the refrigerant that passes through each of the plurality of indoor expansion valves **213**, **223**, **233**, and **243**, and flows into the inlet of each of the plurality of indoor heat exchangers **211**, **221**, **231**, and **241** has a two-phase state. Thus, it may be said that the temperature of the refrigerant at the inlet side of each of the plurality of indoor heat exchangers **211**, **221**, **231**, and **241** may be adjusted by adjusting the opening degree of each of the plurality of low pressure valves **121**E, **122**E, **123**E, **124**E. This may be expressed as in Equation 1 below.

$$L1=f(Ti\_1), L2=f(Ti\_2), L3=f(Ti\_3), L4=f(Ti\_4) \quad \text{Equation 1:}$$

[0072] Here, L1 is the opening degree of the first low pressure valve **121**E, and Ti_1 is the temperature of the refrigerant at the inlet side of the first indoor heat exchanger **211**, which may be measured by a first temperature sensor Si_1. L2 is the opening degree of the second low pressure valve **122**E, and Ti_2 is the temperature of the refrigerant at the inlet side of the second indoor heat exchanger **221**, which may be measured by a second temperature sensor Si_2. L3 is the opening degree of the third low pressure valve **123**E, and Ti_3 is the temperature of the refrigerant at the inlet side of the third indoor heat exchanger **231**, which may be measured by a third temperature sensor Si_3. L4 is the opening degree of the fourth low pressure valve **124**E, and Ti_4 is the temperature of the refrigerant at the inlet side of the fourth indoor heat exchanger **241**, which may be measured by a fourth temperature sensor Si_4. Alternatively, more specifically, the opening degree of the low pressure valve described above and hereinafter may be adjusted based on the pressure of the refrigerant at the inlet side of the indoor heat exchanger measured by a pressure sensor.

[0073] In this case, if the pressure drop of the refrigerant in the refrigerant pipe connecting the indoor heat exchanger and the compressor is excluded from being considered, the evaporation pressure of the indoor heat exchanger **211**, **221**, **231**, **241** connected to the fully opened low pressure valves **121**E, **122**E, **123**E, **124**E may be the same as the pressure of the refrigerant at the inlet side of the compressor **10**, **20**. In addition, as the opening degree of the low pressure valves **121**E, **122**E, **123**E, **124**E decreases, the evaporation pressure of the indoor heat exchanger **211**, **221**, **231**, **241** connected thereto increases and may be greater than the pressure (fixed value) of the refrigerant at the inlet side of the compressor **10**, **20**.

[0074] Accordingly, the controller C of the air conditioner adjusts the opening degree of each of the plurality of low pressure valves **121**E, **122**E, **123**E, and **124**E, thereby adjusting the temperature (or pressure) of the refrigerant at the inlet side of each of the plurality of indoor heat exchangers **211**, **221**, **231**, and **241**. In other words, in order to adjust the temperature (or pressure) of the refrigerant at the inlet side of each of the plurality of indoor heat exchangers **211**, **221**, **231**, and **241** to the target temperature (or target pressure), the opening degree of each of the plurality of low pressure valves **121**E, **122**E, **123**E, **124**E may be adjusted. As a result, the temperature (blowdown temperature) of indoor air supplied to the cooling space through each of the plurality of indoor heat exchangers **211**, **221**, **231**, and **241** may be adjusted for each indoor heat exchanger.

[0075] For example, the opening degree of the second low pressure valve **122**E may be smaller than the opening degree of the first low pressure valve **121**E, and larger than the opening degree of the third low pressure valve **123**E. The opening degree of the fourth low pressure valve **124**E may be smaller than the opening degree of the third low pressure valve **123**E. Based on a case in which the indoor heat exchangers have the same superheat, the blowdown temperature may be higher in the order of the fourth indoor heat exchanger **241**, the third indoor heat exchanger **231**, the second indoor heat exchanger **221**, and the first indoor heat exchanger **211**.

[0076] Referring to FIG. **6**, unlike the above with reference to FIGS. **1** to **5**, the heat recovery unit **1***b* may be omitted, and the plurality of indoor heat exchangers **411** and **421** may be connected to the outdoor unit **1***a* through the refrigerant pipe. For example, the number of indoor heat exchangers **411** and **421** may be 2 or 4 (see FIG. **7**), or 3 or 5 or more.

[0077] The gas pipe **91***b* may be connected to a gaseous refrigerant connection pipe **310** through a second connection valve **104**. The liquid pipe **93***b* may be connected to a liquid refrigerant connection pipe **491** through a second connection valve **105**. A first indoor heat exchanger **411** may connect a first connection pipe **311** of the gaseous refrigerant connection pipe **310** and a first connection pipe **412** of the liquid refrigerant connection pipe **491**. A second indoor heat exchanger **421** may connect a second connection pipe **312** of the gaseous refrigerant connection pipe **310** and a second connection pipe **422** of the liquid refrigerant connection pipe **491**.

[0078] A first indoor expansion valve **413** may be installed in the first connection pipe **412**, and expand the refrigerant flowing through the first connection pipe **412**. A second indoor expansion valve **423** may be installed in the second connection pipe **422**, and may expand the refrigerant flowing through the second connection pipe **422**. The indoor expansion valves **413**, **423** may be electronic expansion valves (EEVs).

[0079] A first low pressure valve **311**E may be installed in the first connection pipe **311**, and the opening degree of the first low pressure valve **311**E may be adjusted. A second low pressure valve **312**E may be installed in the second connection pipe **312**, and the opening degree of the second low pressure valve **312**E may be adjusted. The low pressure valve **311**E, **312**E may be Electronic Expansion Valves (EEVs). The low pressure valves **311**E, **312**E may be large-capacity EEVs having a large flow coefficient. The low pressure valves **311**E and **312**E and the refrigerant pipes in which they are installed may constitute an evaporation pressure control device **1***d*. The low pressure valve **311**E, **312**E may be referred to as a variable valve **311**E, **312**E.

[0080] The high-temperature, high-pressure refrigerant discharged from the compressor **10**, **20** may flow into the gaseous refrigerant connection pipe **310** via the oil separator

11, **21**, the second switching valve **52**, the high pressure pipe **91**, and the gas pipe **91***b*. The refrigerant of the gaseous refrigerant connection pipe **310** may be condensed while passing through the first and second indoor heat exchangers **411** and **421**. Accordingly, the indoor space in which the first and second indoor heat exchangers **411** and **421** are installed may be heated. The first and second indoor expansion valves **413** and **423** may control the degree of supercooling. The degree of supercooling is a difference between the saturation temperature corresponding to the condensation pressure of the first and second indoor heat exchangers **411** and **421** and the outlet temperature of the first and second indoor heat exchangers **411** and **421**.

[0081] The condensed refrigerant may flow into the liquid pipe **93***b* through the liquid refrigerant connection pipe **491**. The refrigerant in the liquid pipe **93** may be cooled while passing through the supercooler **81**, expanded by the outdoor expansion valve **63**, **73**, and evaporated while passing through the outdoor heat exchanger **61**, **71**.

[0082] The evaporated refrigerant may be returned to the compressor **10**, **20** via the first connection pipe **60**, the first switching valve **51**, the low pressure pipe **92**, and the accumulator **30**. Accordingly, the heating cycle of the air conditioner using the first and second indoor heat exchangers **411** and **421** may be completed.

[0083] The high-temperature, high-pressure refrigerant discharged from the compressor **10**, **20** may flow into the first connection pipe **60** via the oil separator **11**, **21** and the first switching valve **51**, and the refrigerant in the first connection pipe **60** may be condensed while passing through the outdoor heat exchanger **61**, **71**.

[0084] The condensed refrigerant may flow into the liquid refrigerant connection pipe **491** via the outdoor expansion valve **63**, **73**, the supercooler **81**, the liquid pipe **93**, and the liquid pipe **93***b*. The refrigerant in the liquid refrigerant connection pipe **491** may be expanded while passing through the first and second indoor expansion valves **413** and **423**, and may be evaporated while passing through the first and second indoor heat exchangers **411** and **421**. Accordingly, the indoor space in which the first and second indoor heat exchangers **411** and **421** are installed may be cooled. The first and second indoor expansion valves **413** and **423** may control the degree of superheat. The degree of superheat is a difference between the temperature of the refrigerant suctioned into the compressor **10**, **20** (or the temperature of the refrigerant at the outlet side of the first and second indoor heat exchangers **411** and **421**) and the saturation temperature corresponding to the evaporation pressure of the first and second indoor heat exchangers **411** and **421** (or the temperature of the refrigerant at the inlet side of the first and second indoor heat exchangers **411** and **421**).

[0085] The evaporated refrigerant may flow into the low pressure pipe **92** through the gaseous refrigerant connection pipe **310**, the gas pipe **91***b*, **91**, and the second switching valve **52**. The refrigerant in the low pressure pipe **92** may be returned to the compressor **10**, **20** via the accumulator **30**. Accordingly, the cooling cycle of the air conditioner using the first and second indoor heat exchangers **411** and **421** may be completed.

[0086] Referring to FIGS. **6** and **7**, the plurality of indoor heat exchangers **411**, **421**, **431**, and **441** may serve as an evaporator and may have the same or different evaporation pressures. The plurality of low pressure valves **311**E, **312**E, **313**E, and **314**E and the plurality of indoor expansion valves **413**, **423**, **433**, and **443** may be opened. The low pressure valves **311**E, **312**E, **313**E, and **314**E may be referred to as variable valves **311**E, **312**E, **313**E, and **314**E.

[0087] The high-temperature, high-pressure refrigerant discharged from the compressor **10**, **20** may flow into the first connection pipe **60** via the oil separator **11**, **21** and the first switching valve **51**, and the refrigerant of the first connection pipe **60** may be condensed while passing through the outdoor heat exchanger **61**, **71**. The condensed refrigerant may flow into the liquid refrigerant connection pipe **491** via the outdoor expansion valve **63**, **73**, the supercooler **81**, the liquid pipe **93**, and the liquid pipe **93***b*.

[0088] The refrigerant of the liquid refrigerant connection pipe **491** may pass through the plurality of connection pipes **412**, **422**, **432**, and **442**, be expanded by the plurality of indoor expansion valves **413**, **423**, **433**, and **443**, and be evaporated while passing through the plurality of indoor heat exchangers **411**, **421**, **431**, and **441**. Thus, the indoor space in which the plurality of indoor heat exchangers **411**, **421**, **431**, and **441** are installed may be cooled. The evaporated refrigerant may be provided to the gaseous refrigerant connection pipe **310** via the plurality of connection pipes **311**, **312**, **313**, and **314** and the plurality of low pressure valves **311**E, **312**E, **313**E, and **314**E.

[0089] The refrigerant of the gaseous refrigerant connection pipe **310** may flow into the low pressure pipe **92** through the gas pipe **91***b*, **91** and the second switching valve **52**. The refrigerant in the low pressure pipe **92** may be returned to the compressor **10**, **20** via the accumulator **30**. Accordingly, the cooling cycle of the air conditioner using the plurality of indoor heat exchangers **411**, **421**, **431**, and **441** may be completed.

[0090] In this case, each of the plurality of indoor expansion valves **413**, **423**, **433**, and **443** may control the degree of superheat of each of the plurality of indoor heat exchangers **411**, **421**, **431**, and **441**. The degree of superheat is a difference between the temperature of the refrigerant suctioned into the compressor **10**, **20** (or the temperature of the refrigerant at the outlet side of each indoor heat exchanger) and the saturation temperature corresponding to the evaporation pressure of each indoor heat exchanger (or the temperature of the refrigerant at the inlet side of each indoor heat exchanger). For example, the temperature (To_1, To_2, To_3, To_4) of the refrigerant at the outlet side of each of the plurality of indoor heat exchangers **411**, **421**, **431**, and **441** may be measured by each of the plurality of temperature sensors So_1, So_2, So_3, and So_4.

[0091] When the compressor **10**, **20** of the outdoor unit **1***a* operates at a specific operating frequency, the pressure of the refrigerant suctioned into the compressor **10**, **20** may be constant. In this case, the evaporation pressure of each of the plurality of indoor heat exchangers **411**, **421**, **431**, and **441** may be adjusted by adjusting the opening degree of each of the plurality of low pressure valves **311**E, **312**E, **313**E, and **314**E. In addition, the refrigerant that passes through each of the plurality of indoor expansion valves **413**, **423**, **433**, and **443**, and flows into the inlet of each of the plurality of indoor heat exchangers **411**, **421**, **431**, and **441** has a two-phase state. Thus, it may be said that the temperature of the refrigerant at the inlet side of each of the plurality of indoor heat exchangers **411**, **421**, **431**, and **441** may be adjusted by adjusting the opening degree of each of the plurality of low pressure valves **311**E, **312**E, **313**E, and **314**E. This may be expressed as in Equation 2 below.

$$L1=f(Ti\_1), L2=f(Ti\_2), L3=f(Ti\_3), L4=f(Ti\_4) \quad \text{Equation 2:}$$

[0092] Here, L1 is the opening degree of the first low pressure valve **311**E, and Ti_1 is the temperature of the refrigerant at the inlet side of the first indoor heat exchanger **411**, which may be measured by a first temperature sensor Si_1. L2 is the opening degree of the second low pressure valve **312**E, and Ti_2 is the temperature of the refrigerant at the inlet side of the second indoor heat exchanger **421**, which may be measured by a second temperature sensor Si_2. L3 is the opening degree of the third low pressure valve **313**E, and Ti_3 is the temperature of the refrigerant at the inlet side of the third indoor heat exchanger **431**, which may be measured by a third temperature sensor Si_3. L4 is the opening degree of the fourth low pressure valve **314**E, and Ti_4 is the temperature of the refrigerant at the inlet side of the fourth indoor heat exchanger **441**, which may be measured by a fourth temperature sensor Si_4. Alternatively, more specifically, the opening degree of the low pressure valve described above and later may be adjusted based on the pressure of the refrigerant at the inlet side of the indoor heat exchanger measured by a pressure sensor.

[0093] In this case, if the pressure drop of the refrigerant in the refrigerant pipe connecting the indoor heat exchanger and the compressor is excluded from being considered, the evaporation pressure of the indoor heat exchanger **411**, **421**, **431**, **441** connected to the fully opened low pressure valves **311**E, **312**E, **313**E, **314**E may be the same as the pressure of the refrigerant at the inlet side of the compressor **10**, **20**. In addition, as the opening degree of the low pressure valve **311**E, **312**E, **313**E, **314**E decreases, the evaporation pressure of the indoor heat exchanger **411**, **421**, **431**, **441** connected thereto increases and may be greater than the pressure (fixed value) of the refrigerant at the inlet side of the compressor **10**, **20**.

[0094] Accordingly, the controller C of the air conditioner adjusts the opening degree of each of the plurality of low pressure valves **311**E, **312**E, **313**E, and **314**E, thereby adjusting the temperature (or pressure) of the refrigerant at the inlet side of each of the plurality of indoor heat exchangers **411**, **421**, **431**, and **441**. In other words, in order to adjust the temperature (or pressure) of the refrigerant at the inlet side of each of the plurality of indoor heat exchangers **411**, **421**, **431**, and **441** to the target temperature (or target pressure), the opening degree of each of the plurality of low pressure valves **311**E, **312**E, **313**E, and **314**E may be adjusted. As a result, the temperature (blowdown temperature) of indoor air supplied to the cooling space through each of the plurality of indoor heat exchangers **411**, **421**, **431**, and **441** may be adjusted for each indoor heat exchanger.

[0095] For example, the opening degree of the second low pressure valve **312**E may be smaller than the opening degree of the first low pressure valve **311**E, and larger than the opening degree of the third low pressure valve **313**E. The opening degree of the fourth low pressure valve **314**E may be smaller than the opening degree of the third low pressure valve **313**E. Based on a case in which the indoor heat exchangers have the same superheat, the blowdown temperature may be higher in the order of the fourth indoor heat exchanger **441**, the third indoor heat exchanger **431**, the second indoor heat exchanger **421**, and the first indoor heat exchanger **411**.

[0096] Referring to FIG. **8**, the following method may be used to determine the target temperature of the refrigerant at the inlet side of the indoor heat exchanger. The temperature range (range A) of the indoor space that may be selected by a user may be 18 to 30° C., and the temperature range (range B) of the indoor space that a user mainly selects may be 25 to 27° C. For example, if a user selects a temperature within the temperature range (range B), it may be estimated that the user wishes to provide air at 14 to 15° C. to the indoor space, and the target temperature of the refrigerant at the inlet side of the indoor heat exchanger may be controlled at 1213° C. and the degree of superheat may be controlled at 1-2° C.

[0097] In initial settings, the target temperature of the refrigerant at the inlet side of the specific indoor heat exchanger may decrease as a set temperature of a specific indoor space selected by a user decreases. That is, as the set temperature of the specific indoor space selected by a user decreases, the opening degree of the low pressure valves (**121**E, **122**E, **123**E, **124**E, see FIG. **5**; **311**E, **312**E, **313**E, **314**E, see FIG. **7**) connected to the specific indoor heat exchanger increases.

[0098] In a first user settings (opt 1), the target temperature of the refrigerant at the inlet side of a specific indoor heat exchanger may decrease as a set temperature of a specific indoor space selected by a user decreases. That is, as a set temperature of a specific indoor space selected by a user decreases, the opening degree of the low pressure valves (**121**E, **122**E, **123**E, **124**E, see FIG. **5**; **311**E, **312**E, **313**E, **314**E, see FIG. **7**) connected to the specific indoor heat exchanger increases. However, in a set temperature-target temperature graph, the first user settings (opt 1) may be offset toward the (+) side of a target temperature axis than the initial settings. That is, for the same set temperature, the target temperature according to the first user settings may be higher than the target temperature according to the initial settings. The first user settings may be referred to as a low speed cooling setting.

[0099] In a second user settings (opt 2), the target temperature of the refrigerant at the inlet side of a specific indoor heat exchanger may decrease as a set temperature of a specific indoor space selected by a user decreases. That is, as a set temperature of a specific indoor space selected by a user decreases, the opening degree of the low pressure valves (**121**E, **122**E, **123**E, **124**E, see FIG. **5**; **311**E, **312**E, **313**E, **314**E, see FIG. **7**) connected to the specific indoor heat exchanger increases. However, in a set temperature-target temperature graph, the second user settings (opt 2) may be offset toward the (−) side of a target temperature axis than the initial settings. That is, for the same set temperature, the target temperature according to the second user settings may be lower than the target temperature according to the initial settings. The second user settings may be referred to as a high speed cooling setting.

[0100] Referring to FIG. **9**, the following method may be used to determine the target temperature of the refrigerant at the inlet side of the indoor heat exchanger.

[0101] In initial settings, as a difference between a current temperature of a specific indoor space of interest to a user and a set temperature of the specific indoor space selected by the user (hereinafter referred to as temperature difference) increases, a target temperature of the refrigerant at the inlet side of the specific indoor heat exchanger may be lowered. That is, as the temperature difference increases, the opening degree of the low pressure valve (**121**E, **122**E, **123**E, **124**E, see FIG. **5**; **311**E, **312**E, **313**E, **314**E, see FIG. **7**) connected to the specific indoor heat exchanger may increase.

[0102] In a third user settings (opt 3), the target temperature of the refrigerant at the inlet side of a specific indoor heat exchanger may decrease as the temperature difference increases. That is, as the temperature difference increases, the opening degree of the low pressure valve (**121**E, **122**E, **123**E, **124**E, see FIG. **5**; **311**E, **312**E, **313**E, **314**E, see FIG. **7**) connected to the specific indoor heat exchanger may increase. However, in the temperature difference-target temperature graph, the third user settings (opt 3) may be offset toward the (+) side of a target temperature axis than the initial settings. That is, with respect to the same temperature difference, the target temperature according to the third user settings may be higher than the target temperature according to the initial settings. The third user settings may be referred to as a low speed cooling settings.

[0103] In a fourth user settings (opt 4), the target temperature of the refrigerant at the inlet side of a specific indoor heat exchanger may decrease as the temperature difference increases. That is, as the temperature difference increases, the opening degree of the low pressure valve (**121**E, **122**E, **123**E, **124**E, see FIG. **5**; **311**E, **312**E, **313**E, **314**E, see FIG. **7**) connected to the specific indoor heat exchanger may increase. However, in the temperature difference-target temperature graph, the fourth user settings (opt 4) may be offset toward the (+) side of a target temperature axis than the initial settings. That is, with respect to the same temperature difference, the target temperature according to the fourth user settings may be lower than the target temperature according to the initial settings. The fourth user settings may be referred to as a high speed cooling settings.

[0104] Referring to FIG. **10**, a look up table may be used to adjust the opening of the low pressure valve in order to adjust the temperature of the refrigerant at the inlet side of the indoor heat exchanger to a target temperature. An error, which is a variable on a vertical axis of the lookup table of FIG. **10**, is a difference between the current temperature (Ti_present) of the refrigerant at the inlet side of the indoor heat exchanger and the target temperature (Ti_target). An error slope, which is a variable on a horizontal axis of the lookup table of FIG. **10**, is a difference between the current temperature (Ti_present) of the refrigerant at the inlet side of the indoor heat exchanger for a certain time period (at) and the previous temperature (Ti_past).

$$\text{Error}=Ti\_\text{present}-Ti\_\text{target};\text{Error slope}=(Ti\_\text{present}-Ti\_\text{past})/\Delta t \qquad \text{Equation 3:}$$

[0105] The numbers in the look-up table of FIG. **10** indicates that the opening degree of the low pressure valve (**121**E, **122**E, **123**E, **124**E, see FIG. **5**; **311**E, **312**E, **313**E, **314**E, see FIG. **7**) is maintained intactly, or indicates the degree to which the opening degree is increased or decreased. The number 0 means that the opening degree of the low pressure valve (**121**E, **122**E, **123**E, **124**E, see FIG. **5**; **311**E, **312**E, **313**E, **314**E, see FIG. **7**) is maintained intactly. For example, the number 1 means that the opening degree of the low pressure valve (**121**E, **122**E, **123**E, **124**E, see FIG. **5**; **311**E, **312**E, **313**E, **314**E, see FIG. **7**) is increased by 1% from the current state. For example, the number −3 means that the opening degree of the low pressure valve (**121**E, **122**E, **123**E, **124**E, see FIG. **5**; **311**E, **312**E, **313**E, **314**E, see FIG. **7**) is decreased by −3% from the current state. For example, the weight of the error for the change in the opening degree of the low pressure valve (**121**E, **122**E, **123**E, **124**E, see FIG. **5**; **311**E, **312**E, **313**E, **314**E, see FIG. **7**) may be greater than the weight of the error slope.

[0106] If the error is '0' but the error slope is a positive number greater than or equal to a certain value, the controller C of the air conditioner may lower the temperature of the refrigerant at the inlet side of a specific indoor heat exchanger by increasing the opening degree of a specific low pressure valve connected to the specific indoor heat exchanger. If the error is '0' but the error slope is a negative number less than a certain value, the controller C of the air conditioner reduces the opening degree of a specific low pressure valve connected to a specific indoor heat exchanger to increase the temperature of the refrigerant at the inlet side of the specific indoor heat exchanger.

[0107] If the error slope is '0' but the error is a positive number, the controller C of the air conditioner may increase the opening degree of a specific low pressure valve connected to a specific indoor heat exchanger to lower the temperature of the refrigerant at the inlet side of the specific indoor heat exchanger. If the error slope is '0' but the error is negative, the controller C of the air conditioner may decrease the opening degree of a specific low pressure valve connected to a specific indoor heat exchanger to increase the temperature of the refrigerant at the inlet side of the specific indoor heat exchanger.

[0108] Referring to FIG. **11**, the low pressure valve connected to a specific indoor heat exchanger in which the lowest target temperature (min(Ttarget)) is set among the target temperatures of the refrigerant at the inlet side of the plurality of indoor heat exchangers may be fully opened, and the operating frequency Hz of the compressor **10**, **20** may be controlled to adjust the temperature of the refrigerant at the inlet side of the specific indoor heat exchanger to the lowest target temperature (min(Ttarget)).

[0109] For example, the target temperature (Ttarget-1) of the refrigerant at the inlet side of the first indoor heat exchanger (**211**, see FIG. **5**; **411**, see FIG. **7**) may be the lowest target temperature (min(Ttarget)). The target temperature (Ttarget-2) of the refrigerant at the inlet side of the second indoor heat exchanger (**221**, see FIG. **5**; **421**, see FIG. **7**) may be greater than the target temperature (Ttarget-1). The target temperature (Ttarget-3) of the refrigerant at the inlet side of the third indoor heat exchanger (**231**, see FIG. **5**; **431**, see FIG. **7**) may be the highest target temperature (max(Ttarget)).

[0110] The opening degree of the first low pressure valve (EEV-1) (**121**E, see FIG. **5**; **311**E, see FIG. **7**) connected to the first indoor heat exchanger (**211**, see FIG. **5**; **411**, see FIG. **7**) may be set to the maximum. The target temperature (Ttarget-1) or a corresponding target pressure (Ptarget-1) may be adjusted by controlling the operating frequency Hz of the compressor **10**, **20**.

[0111] The opening degree of the second low pressure valve (EEV-2) (**122**E, see FIG. **5**; **312**E, see FIG. **7**) connected to the second indoor heat exchanger (**221**, see FIG. **5**; **421**, see FIG. **7**) may be adjusted to meet the target temperature (Ttarget-2). Further, the opening degree of the third low pressure valve (EEV-3) (**123**E, see FIG. **5**; **313**E, see FIG. **7**) connected to the third indoor heat exchanger (**231**, see FIG. **5**; **431**, see FIG. **7**) may be adjusted to meet the target temperature (Ttarget-3). Accordingly, compared to a case where all the low pressure valves are partially closed, unnecessary pressure loss and efficiency reduction may be prevented.

[0112] Referring to FIGS. **5** and **12**, the controller C of the air conditioner may be electrically connected to components of the air conditioner to control their operations.

[0113] When the i-th indoor heat exchanger, among the plurality of indoor heat exchangers **211**, **221**, **231**, and **241**, serves as an evaporator (S**10**: Yes), the controller C may receive a set temperature (Tset_i, for example, a temperature selected (input) by a user) of the i-th indoor heat exchanger (S**20**), and calculate a target temperature (Ttarget_i, see FIGS. **8** and **9**) of the refrigerant at the inlet side of the i-th indoor heat exchanger (S**21**). When the i-th indoor heat exchanger, among the plurality of indoor heat exchangers **211**, **221**, **231**, and **241**, does not serve as an evaporator (S**10**: No) and serves as a condenser, the controller C may perform a heating operation while controlling supercooling of the i-th indoor heat exchanger (S**11**, S**12**). Here, i starts from 1 and may terminate at n, which is the total number of indoor heat exchangers (S**22**, S**23**). That is, the above described steps (S**10**, S**20**, S**21**, S**11**, S**12**) may be sequentially performed for all indoor heat exchangers (S**22**, S**23**).

[0114] The controller C may search for m-th indoor heat exchanger having a minimum target temperature (min(Ttarget)) among indoor heat exchangers serving as an evaporator (S**30**). For example, some of indoor heat exchangers serving as an evaporator may have a minimum target temperature (min(Ttarget)). In this case, m may be a number(s) corresponding to the sequence number(s) of some of the indoor heat exchangers serving as an evaporator. For another example, all indoor heat exchangers serving as an evaporator may have a minimum target temperature (min(Ttarget)). In this case, m may be numbers corresponding to the sequence numbers of all indoor heat exchangers serving as an evaporator.

[0115] With respect to the m-th indoor heat exchanger (S**40**: Yes), the controller C may completely open the low pressure valve (**121**E, **122**E, **123**E, **124**E, see FIG. **5**) connected to the m-th indoor heat exchanger (S**41**), and may control the operating frequency Hz of the compressor **10**, **20** so as to correspond to the minimum target temperature (min(Ttarget)) (S**42**). With respect to other indoor heat exchanger (S**40**: No), the controller C may control the opening degree of the low pressure valve **121**E, **122**E, **123**E, **124**E (see FIG. **5**) connected to the other indoor heat exchanger to match the target temperature (Ttarget) of the refrigerant at the inlet side of the other indoor heat exchanger (S**43**). Accordingly, if necessary, the blowdown temperature, which is the temperature of the air supplied to the cooling space, may be adjusted differently for each indoor heat exchanger.

[0116] Referring to FIGS. **7** and **13**, the controller C of the air conditioner may be electrically connected to components of the air conditioner to control their operations.

[0117] When the plurality of indoor heat exchangers **411**, **421**, **431**, and **441** serve as an evaporator (S**50**: Yes), the controller C may receive a set temperature (Tset_i) (for example, a temperature selected (input) by a user) of the i-th indoor heat exchanger (S**60**), and may calculate the target temperature (Ttarget_i, see FIGS. **8** and **9**) of the refrigerant at the inlet side of the i-th indoor heat exchanger (S**61**). When the i-th indoor heat exchanger, among the plurality of indoor heat exchangers **211**, **221**, **231**, and **241**, does not serve as an evaporator (S**50**: No) and serves as a condenser, the controller C may perform a heating operation while controlling supercooling of indoor heat exchanger (S**51**, S**52**). Here, i starts from 1 and may terminate at n, which is the total number of indoor heat exchangers (S**62**, S**63**). That is, the above described steps (S**60**, S**61**) may be sequentially performed for all indoor heat exchangers (S**62**, S**63**).

[0118] The controller C may search for m-th indoor heat exchanger having a minimum target temperature (min(Ttarget)) among indoor heat exchangers serving as an evaporator (S**70**). For example, some of indoor heat exchangers serving as an evaporator may have a minimum target temperature (min(Ttarget)). In this case, m may be a number(s) corresponding to the sequence number(s) of some of the indoor heat exchangers serving as an evaporator. For another example, all indoor heat exchangers serving as an evaporator may have a minimum target temperature (min(Ttarget)). In this case, m may be number(s) corresponding to the sequence numbers of all indoor heat exchangers serving as an evaporator.

[0119] With respect to the m-th indoor heat exchanger (S**80**: Yes), the controller C may completely open the low pressure valve (**311**E, **312**E, **313**E, **314**E, see FIG. **7**) connected to the m-th indoor heat exchanger (S**81**), and may control the operating frequency Hz of the compressor **10**, **20** so as to correspond to the minimum target temperature (min(Ttarget)) (S**82**). With respect to other indoor heat exchanger (S**80**: No), the controller C may control the opening degree of the low pressure valve **311**E, **312**E, **313**E, **314**E (see FIG. **7**) connected to the other indoor heat exchanger to match the target temperature (Ttarget) of the refrigerant at the inlet side of the other indoor heat exchanger (S**83**). Accordingly, if necessary, the blowdown temperature, which is the temperature of the air supplied to the cooling space, may be adjusted differently for each indoor heat exchanger.

[0120] Advantages of the air conditioner according to embodiments disclosed herein include at least the following.

[0121] According to at least one of embodiments disclosed herein, it is possible to provide an air conditioner capable of setting different evaporation pressures of a plurality of indoor heat exchangers functioning as an evaporator, thereby differently setting a blowdown temperature for each indoor space.

[0122] According to at least one of embodiments disclosed herein, it is possible to provide a method for setting a target temperature of a refrigerant in an inlet side of an indoor heat exchanger.

[0123] According to at least one of embodiments disclosed herein, it is possible to provide a method for adjusting the opening degree of a variable valve to adjust the temperature of the refrigerant in an inlet side of an indoor heat exchanger to a target temperature.

[0124] According to at least one of embodiments disclosed herein, it is possible to provide an air conditioner capable of preventing unnecessary pressure drop and efficiency reduction.

[0125] Embodiments disclosed herein solve at least the above and other problems.

[0126] Embodiments disclosed herein provide an air conditioner capable of setting different evaporation pressures of a plurality of indoor heat exchangers functioning as an evaporator, thereby differently setting a blowdown temperature for each indoor space.

[0127] Embodiments disclosed herein provide a method for setting a target temperature of a refrigerant in an inlet side of an indoor heat exchanger.

[0128] Embodiments disclosed herein provide a method for adjusting the opening degree of a variable valve to adjust the temperature of the refrigerant in an inlet side of an indoor heat exchanger to a target temperature.

[0129] Embodiments disclosed herein provide an air conditioner capable of preventing unnecessary pressure drop and efficiency reduction.

[0130] Embodiments disclosed herein provide an air conditioner that may include a compressor that compresses a refrigerant; an outdoor heat exchanger through which the refrigerant discharged from the compressor flows; a plurality of expansion valves that expands the refrigerant passed through the outdoor heat exchanger; a plurality of indoor heat exchangers through which the refrigerant passed through the plurality of expansion valves flows; a plurality of connection pipes that connect the plurality of indoor heat exchangers and the compressor; and a plurality of variable valves installed in the plurality of connection pipes. An opening degree of each of the plurality of variable valves may be adjustable.

[0131] The variable valve may be an electronic expansion valve (EEV). A pressure of refrigerant at an inlet side of the indoor heat exchanger may increase as the opening degree of the variable valve decreases.

[0132] The opening degree of the variable valve may increase as a user's set temperature for the indoor heat exchanger decreases. The opening degree of the variable valve may increase as a difference between a current temperature of a room where the indoor heat exchanger is located and the user's set temperature for the indoor heat exchanger increases.

[0133] The opening degree of the variable valve may be adjusted based on an error which is a difference between a current temperature of refrigerant at an inlet side of the indoor heat exchanger and a target temperature, and an error slope which is a temperature change of the refrigerant at the inlet side of the indoor heat exchanger for a certain period of time. The opening degree of the variable valve may be increased than current one when the error is '0' and the error slope is positive. The opening degree of the variable valve may be decreased than current one when the error is '0' and the error slope is negative. The opening degree of the variable valve may be increased than current one when the error slope is '0' and the error is positive. The opening degree of the variable valve may be decreased than current one when the error slope is '0' and the error is negative.

[0134] A weight of the error may be greater than a weight of the error slope with respect to a change in the opening degree of the variable valve.

[0135] One of the plurality of variable valves may be connected to a specific indoor heat exchanger in which the lowest target temperature is set among target temperatures of refrigerant at an inlet side of the plurality of indoor heat exchangers, and may be fully opened. An operating frequency of the compressor may be adjustable to match a temperature of refrigerant at an inlet side of the specific indoor heat exchanger to the lowest target temperature.

[0136] An opening degree of the expansion valve may be adjustable to adjust a superheat degree which is a difference between a temperature of refrigerant at an outlet side of the indoor heat exchanger and a temperature of refrigerant at an inlet side.

[0137] The air conditioner may further include a temperature sensor that measures a temperature of refrigerant at an outlet side of the indoor heat exchanger and a temperature of refrigerant at an inlet side. Some of the plurality of indoor heat exchangers may be maintained as an evaporator through which the refrigerant passed through the expansion valve flows, and the rest of the plurality of indoor heat exchangers may be switchable into a condenser through which the refrigerant discharged from the compressor flows.

[0138] The plurality of indoor heat exchangers may be switchable from an evaporator through which the refrigerant passed through the expansion valve flows into a condenser through which the refrigerant discharged from the compressor flows.

[0139] Certain embodiments or other embodiments described above are not mutually exclusive or distinct from each other. Any or all elements of the embodiments of the invention described above may be combined or combined with each other in configuration or function.

[0140] For example, a configuration "A" described in one embodiment of the invention and the drawings and a configuration "B" described in another embodiment of the invention and the drawings may be combined with each other. Namely, although the combination between the configurations is not directly described, the combination is possible except in the case where it is described that the combination is impossible.

[0141] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

[0142] It will be understood that when an element or layer is referred to as being "on" another element or layer, the element or layer can be directly on another element or layer or intervening elements or layers. In contrast, when an element is referred to as being "directly on" another element or layer, there are no intervening elements or layers present. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0143] It will be understood that, although the terms first, second, third, etc., may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer or section from another region, layer or section. Thus, a first element, component, region, layer or section could be termed a second element, component, region, layer or section without departing from the teachings of the present invention.

[0144] Spatially relative terms, such as "lower", "upper" and the like, may be used herein for ease of description to describe the relationship of one element or feature to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation, in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "lower" relative to other elements or features would then be oriented "upper" relative to the other elements or features. Thus, the exemplary term "lower" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

[0145] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0146] Embodiments are described herein with reference to cross-section illustrations that are schematic illustrations of idealized embodiments (and intermediate structures). As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, embodiments should not be construed as limited to the particular shapes of regions illustrated herein but are to include deviations in shapes that result, for example, from manufacturing.

[0147] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0148] Any reference in this specification to "one embodiment," "an embodiment," "example embodiment," etc., means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to effect such feature, structure, or characteristic in connection with other ones of the embodiments.

[0149] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

What is claimed is:

1. An air conditioner comprising:
a controller;
a compressor that compresses a refrigerant;
an outdoor heat exchanger through which the refrigerant discharged from the compressor flows;
a plurality of expansion valves that expands the refrigerant passed through the outdoor heat exchanger;
a plurality of indoor heat exchangers through which the refrigerant passed through the plurality of expansion valves flows;
a plurality of connection pipes that connects the plurality of indoor heat exchangers and the compressor; and
a plurality of variable valves installed in the plurality of connection pipes, wherein an opening degree of each of the plurality of variable valves is adjustable via the controller.

2. The air conditioner of claim **1**, wherein the variable valves are electronic expansion valves (EEVs).

3. The air conditioner of claim **1**, wherein a pressure of refrigerant at an inlet side of each indoor heat exchanger of the plurality of indoor heat exchangers increases as the opening degree of the respective variable valve is decrease by the controller.

4. The air conditioner of claim **1**, wherein the opening degree of the variable valve is increased by the controller as a user's set temperature for the respective indoor heat exchanger is decreased.

5. The air conditioner of claim **1**, wherein the opening degree of the variable valve is increased by the controller as a difference between a current temperature of a room in which the respective indoor heat exchanger is located and a user's set temperature for the respective indoor heat exchanger increases.

6. The air conditioner of claim **1**, wherein the opening degree of the variable valve is adjusted by the controller based on an error, which is a difference between a current temperature of refrigerant at an inlet side of the respective indoor heat exchanger and a target temperature, and an error slope, which is a temperature change of the refrigerant at the inlet side of the respective indoor heat exchanger for a predetermined period of time.

7. The air conditioner of claim **6**, wherein the opening degree of the variable valve is increased by the controller when the error is '0' and the error slope is positive, and is decreased when the error is '0' and the error slope is negative.

8. The air conditioner of claim **6**, wherein the opening degree of the variable valve is increased by the controller when the error slope is '0' and the error is positive, and is decreased when the error slope is '0' and the error is negative.

9. The air conditioner of claim **6**, wherein a weight of the error is greater than a weight of the error slope with respect to a change in the opening degree of the variable valve.

10. The air conditioner of claim **1**, wherein one of the plurality of variable valves is connected to a specific indoor heat exchanger of the plurality of indoor heat exchangers in which a lowest target temperature is set among target temperatures of refrigerant at an inlet side of the plurality of indoor heat exchangers, and is fully opened by the controller.

11. The air conditioner of claim **10**, wherein the controller is configured to adjust an operating frequency of the compressor to match a temperature of refrigerant at an inlet side of the specific indoor heat exchanger to the lowest target temperature.

12. The air conditioner of claim **1**, wherein an opening degree of each expansion valve is adjustable by the controller to adjust a superheat degree, which is a difference between a temperature of refrigerant at an outlet side of the respective indoor heat exchanger and a temperature of refrigerant at an inlet side.

13. The air conditioner of claim **12**, further comprising a temperature sensor that measures the temperature of refrigerant at the outlet side of the respective indoor heat exchanger and the temperature of refrigerant at the inlet side.

14. The air conditioner of claim **1**, wherein some of the plurality of indoor heat exchangers is maintained as an evaporator through which the refrigerant passed through the expansion valve flows, and the rest of the plurality of indoor heat exchangers is switchable into a condenser through which the refrigerant discharged from the compressor flows.

15. The air conditioner of claim **1**, wherein the plurality of indoor heat exchangers is switchable from an evaporator through which the refrigerant passed through the expansion valve flows into a condenser through which the refrigerant discharged from the compressor flows.

16. An air conditioner comprising:

a controller;

at least one compressor that compresses a refrigerant;

at least one outdoor heat exchanger through which the refrigerant discharged from the at least one compressor flows;

a plurality of expansion valves that expands the refrigerant passed through the at least one outdoor heat exchanger;

a plurality of indoor heat exchangers through which the refrigerant passed through the plurality of expansion valves flows;

a plurality of connection pipes that connects the plurality of indoor heat exchangers and the at least one compressor; and

a plurality of variable valves installed in the plurality of connection pipes, wherein an opening degree of each of the plurality of variable valves is adjustable via the controller, and wherein the opening degree of the variable valve is increased by the controller as a difference between a current temperature of a room in which the respective indoor heat exchanger is located and a user's set temperature for the respective indoor heat exchanger increases.

17. An air conditioner comprising:

a controller;

at least one compressor that compresses a refrigerant;

at least one outdoor heat exchanger through which the refrigerant discharged from the at least one compressor flows;

a plurality of expansion valves that expands the refrigerant passed through the at least one outdoor heat exchanger;

a plurality of indoor heat exchangers through which the refrigerant passed through the plurality of expansion valves flows;

a plurality of connection pipes that connects the plurality of indoor heat exchangers and the at least one compressor; and

a plurality of variable valves installed in the plurality of connection pipes, wherein an opening degree of each of the plurality of variable valves is adjustable via the controller, and wherein the opening degree of the variable valve is adjusted by the controller based on an error, which is a difference between a current temperature of refrigerant at an inlet side of the respective indoor heat exchanger and a target temperature, and an error slope, which is a temperature change of the refrigerant at the inlet side of the respective indoor heat exchanger for a predetermined period of time.

18. The air conditioner of claim **17**, wherein the opening degree of the variable valve is increased by the controller at least one when the error is '0' and the error slope is positive, and is decreased when the error is '0' and the error slope is negative.

19. The air conditioner of claim **17**, wherein the opening degree of the variable valve is increased by the controller at least one when the error slope is '0' and the error is positive, and is decreased when the error slope is '0' and the error is negative.

20. The air conditioner of claim **17**, wherein a weight of the error is greater than a weight of the error slope with respect to a change in the opening degree of the variable valve.

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