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(54) REFRIGERATING DEVICE AND REFRIGERATOR

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(57) ABSTRACT

An object is to provide a refrigerating device capable of realizing a high-efficiency operation in a case where a compressor having an intermediate pressure section is applied, and a refrigerator including this refrigerating device. A refrigerating device **30** includes: a compressor **1**; a radiator **2**; an expansion valve **3**; a gas-liquid separator **4**; and a heat absorbing unit **8** through which a liquid refrigerant discharged from this gas-liquid separator circulates. The refrigerating device further includes: a refrigerant pipe in which the refrigerant discharged from the heat absorbing unit **8** can be introduced into a suction port of the compressor **1** and which introduces a gas refrigerant separated by the gas-liquid separator **4** into the intermediate pressure section of the compressor **1**; and a refrigerant pipe which introduces an intermediate-pressure refrigerant of the compressor **1** into the gas-liquid separator **4**.

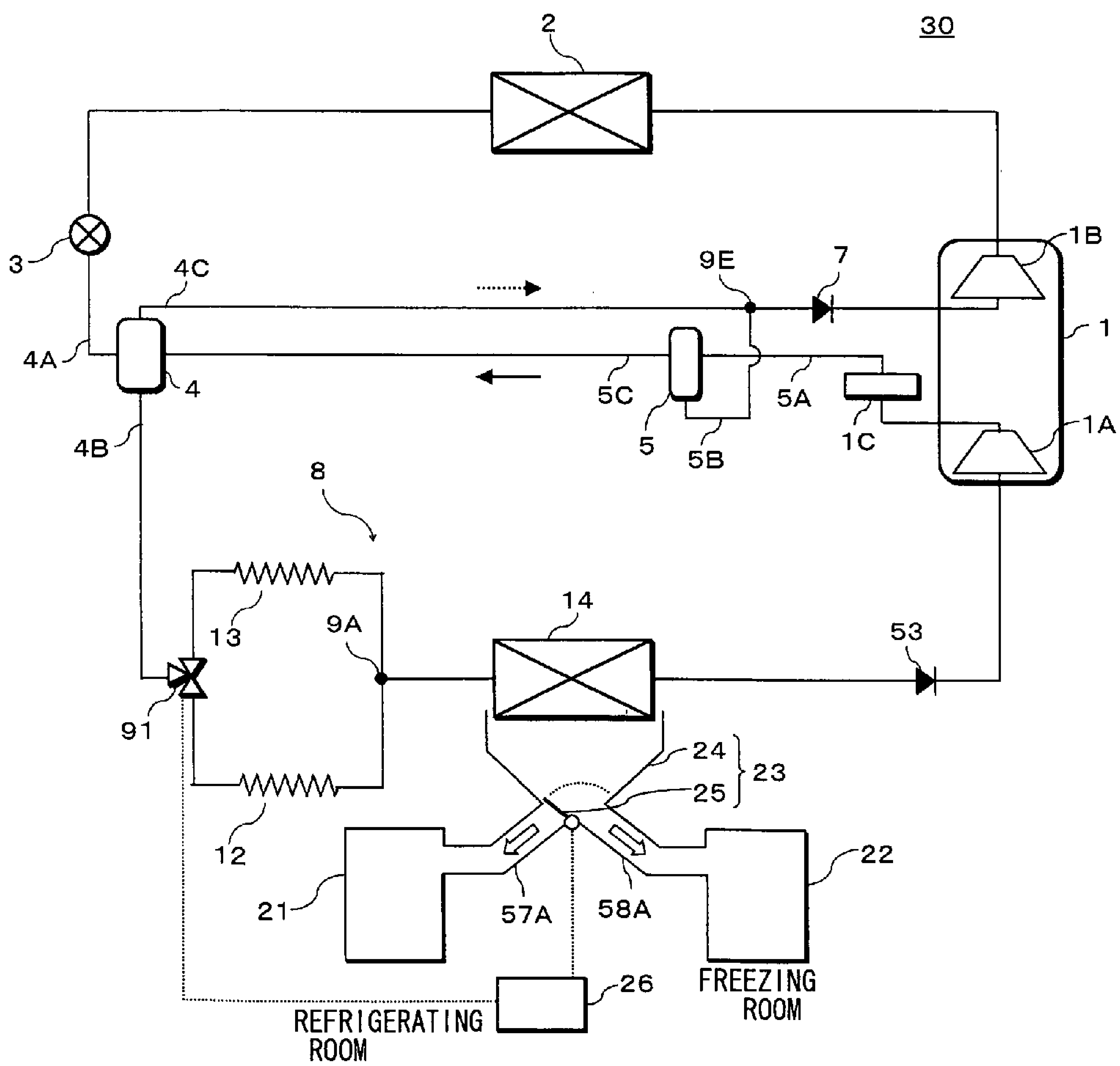
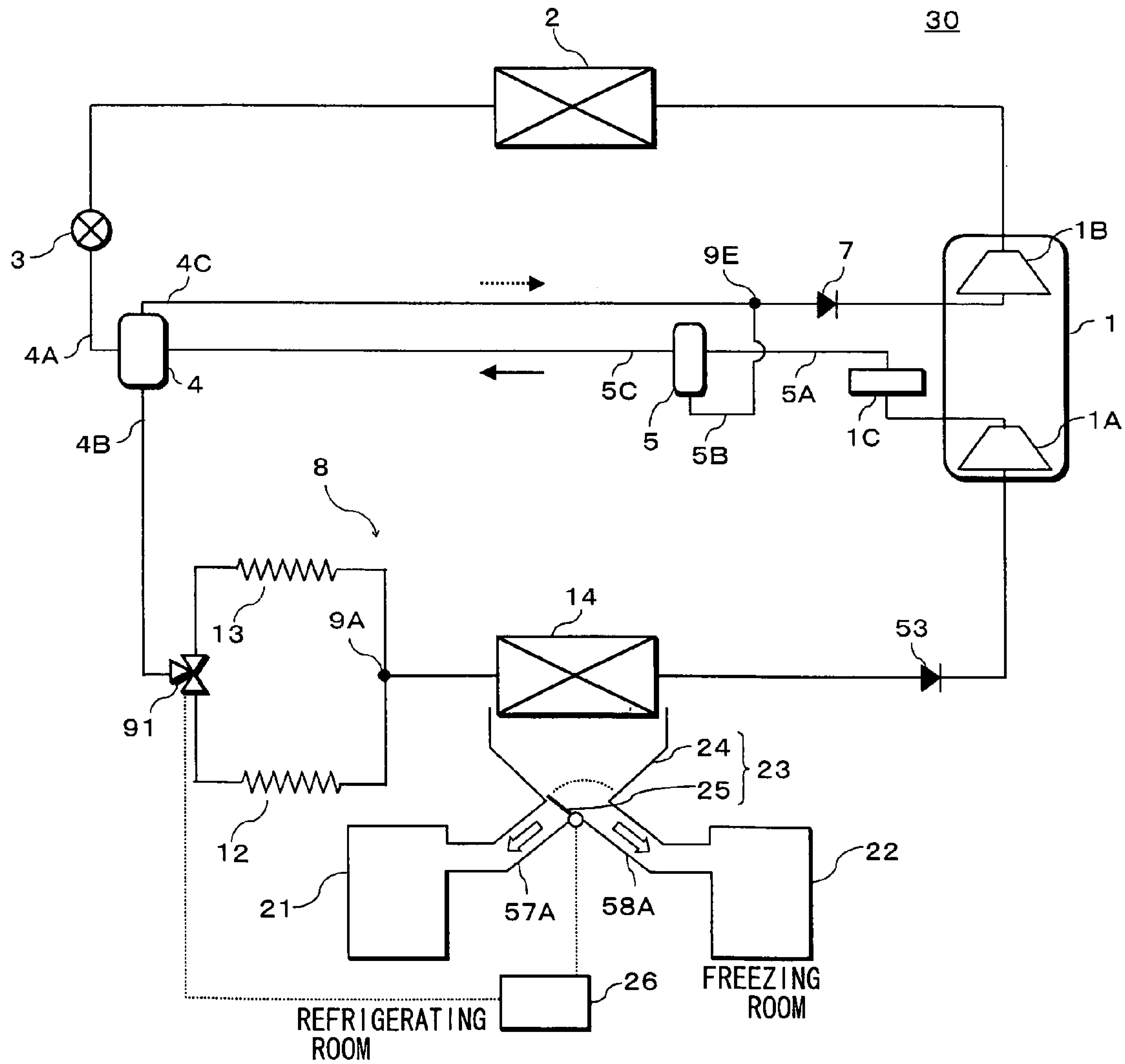
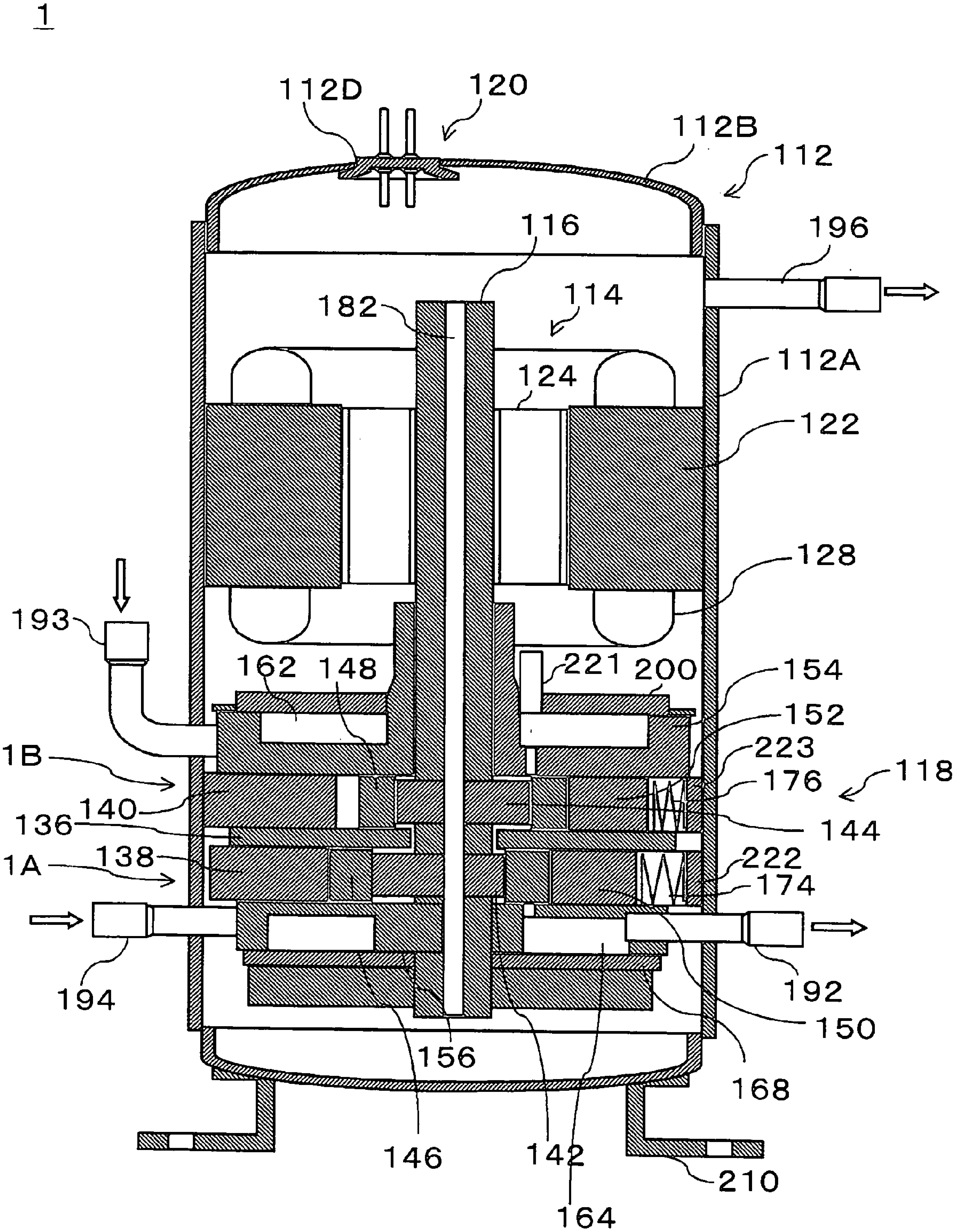


FIG. 1



2
30
3
4C
9E
7
1B
1
4A
4
5C
5
5B
5A
1C
1A
4B
8
13
9A
14
53
91
24
25
23
12
21
57A
58A
22
26
REFRIGERATING ROOM
FREEZING ROOM

FIG. 2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112D
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112B
112
116
196
182
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112A
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122
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162
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1B
223
118
140
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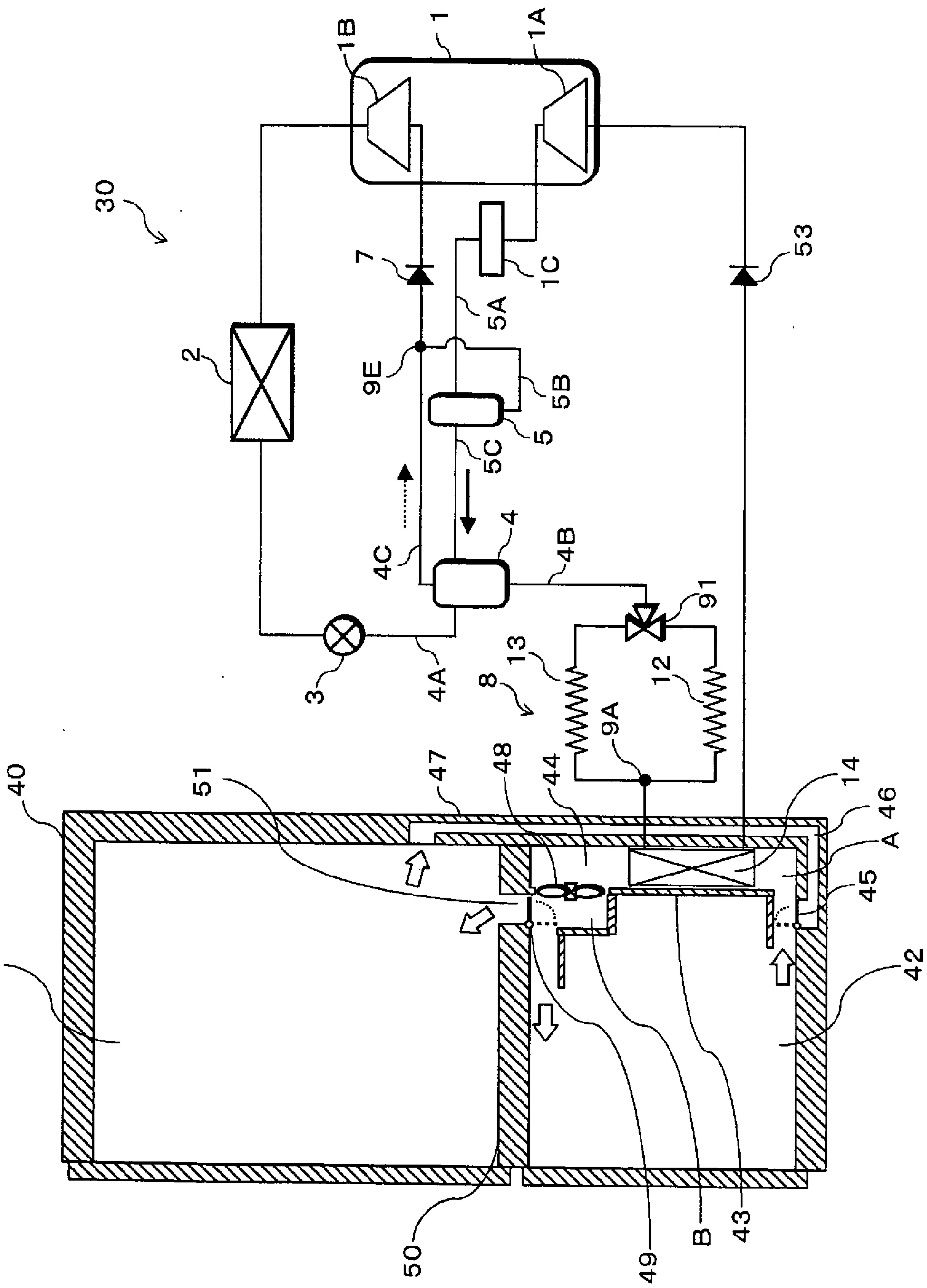
136
144
138
222
1A
174
194
192
150
156
168
146
142
210
164

FIG. 3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1A
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1C
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4A
4B
4C
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5A
5B
5C
7
8
9A
9E
12
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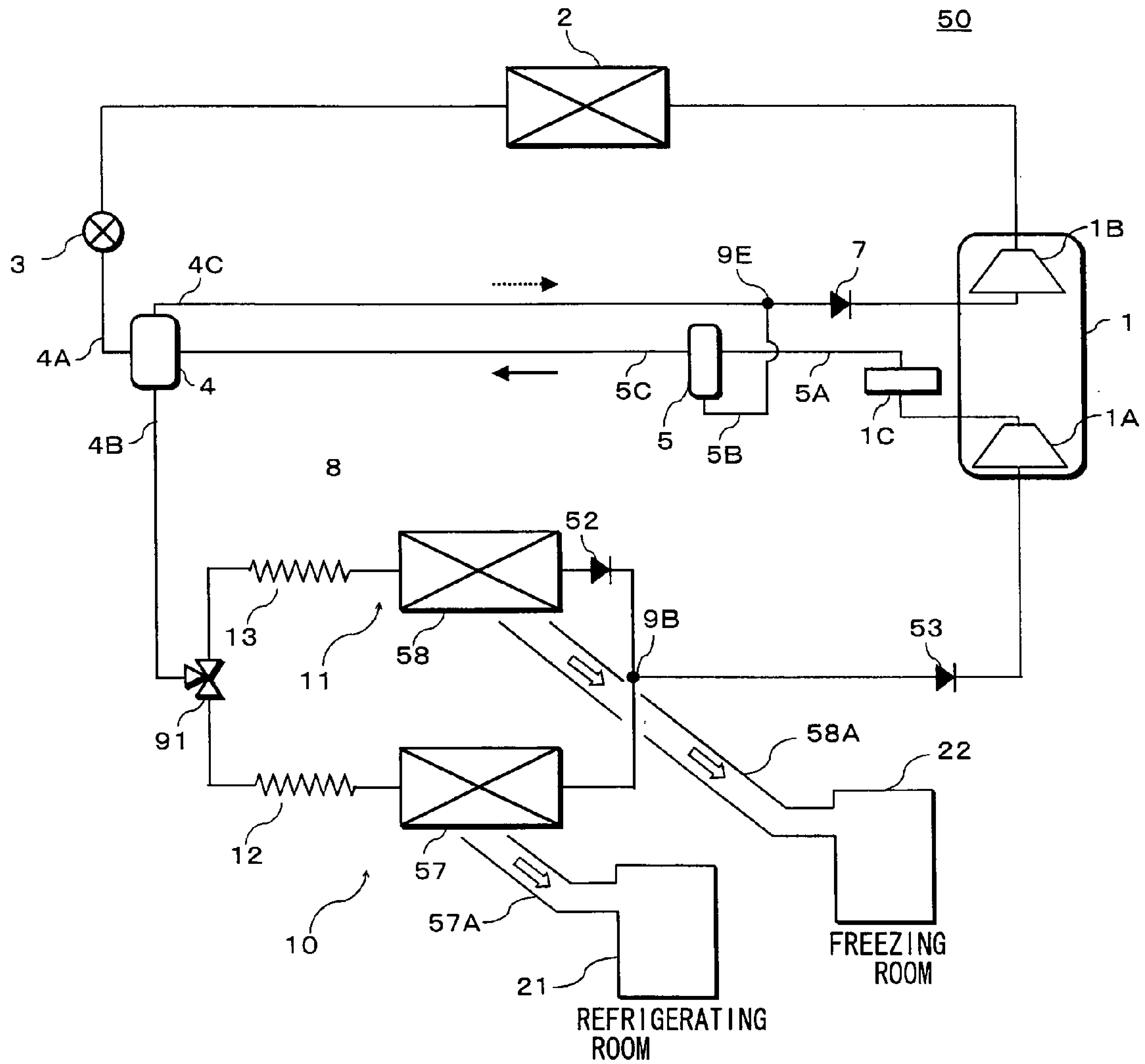
46
47
48
49
50
51
53
91
A
B

FIG. 4



2
50
3
4C
9E
7
1B
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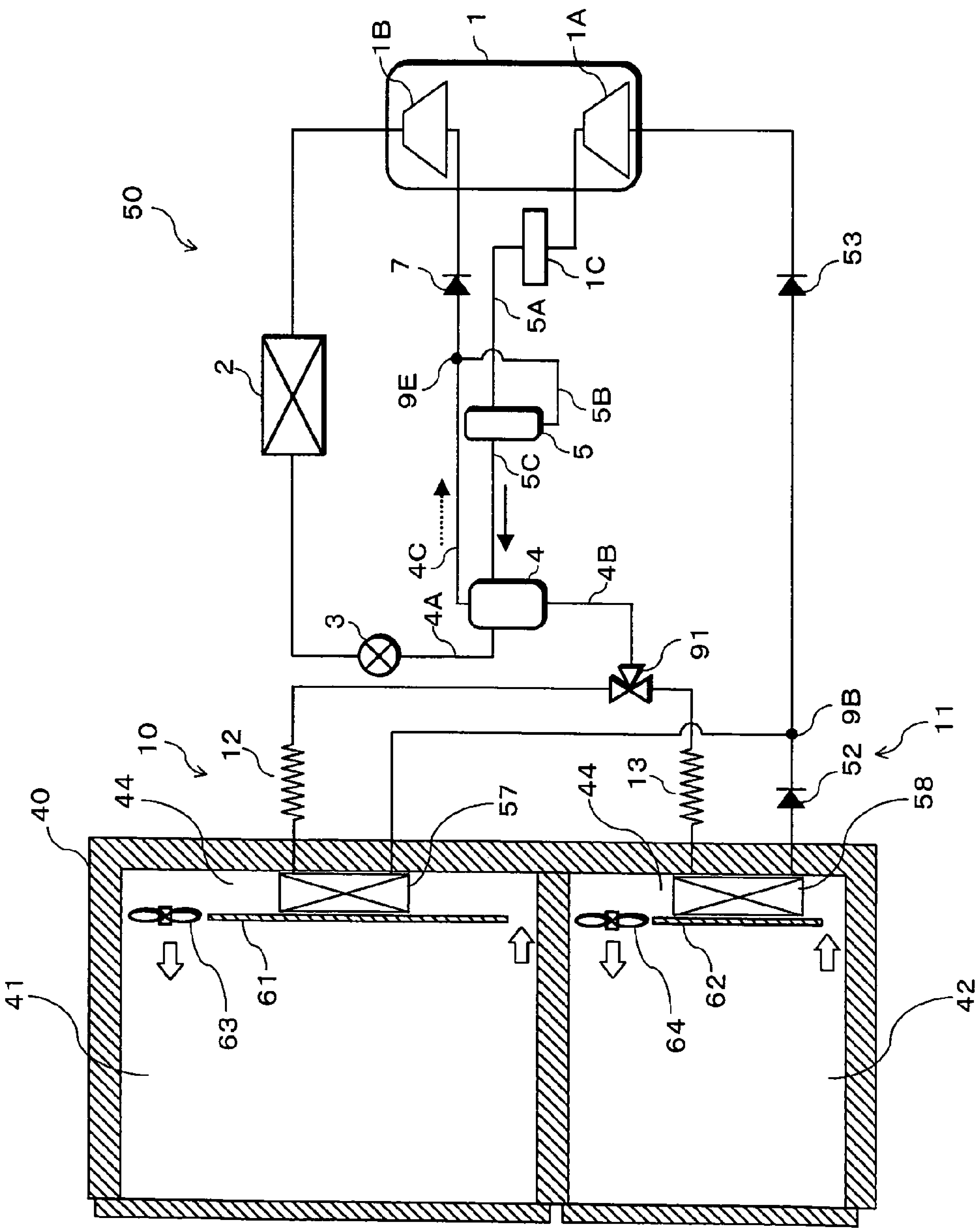
4A
4
5C
5
5B
5A
1C
1A
4B
8
52
13
11
58
9B
53
91
58A
22
12
57
10
57A
21
FREEZING ROOM
REFRIGERATING ROOM

FIG. 5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1B
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1A
2
7
1C
5A
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9E
5B
5
5C
4C
4
4B
3
4A
91
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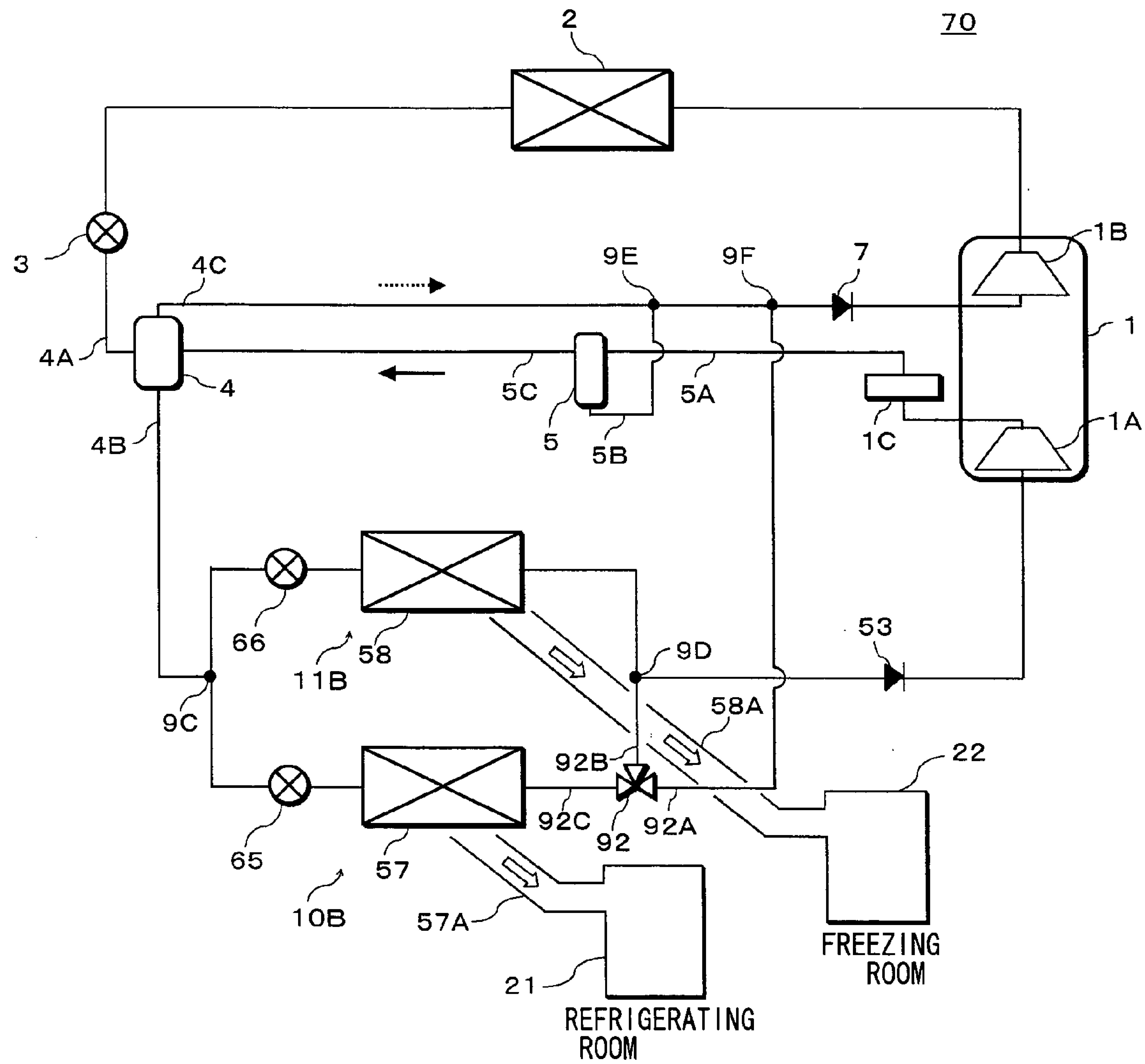
44
40
57
13
52
9B
11
58
41
63
61
64
62
42

FIG. 6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9E
9F
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66
58
11B
9D
53
9C
58A
92B
22
92C
92
92A
65
57
10B
57A
FREEZING
ROOM
21
REFRIGERATING
ROOM

REFRIGERATING DEVICE AND REFRIGERATOR

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a refrigerating device including means capable of introducing a gas refrigerant separated from a gas-liquid separator into an intermediate pressure section of a compressor, and a refrigerator including this refrigerating device.

DESCRIPTION OF THE RELATED ART

[0002] In general, there is known a refrigerating device including: a two-stage compressor; a radiator; a pressure reducing unit; a gas-liquid separator; and means capable of introducing a gas refrigerant separated by this gas-liquid separator into an intermediate pressure section between first and second stages of the compressor (see Japanese Patent Application Laid-Open No. 2003-106693). In this type of refrigerating device, since the gas refrigerant separated by the gas-liquid separator is introduced into the intermediate pressure section of the compressor in a gas state as such, an efficiency in the compressor can be improved.

[0003] However, this type of refrigerating device has a problem that a temperature of the refrigerant introduced into the second stage of the two-stage compressor, an operation efficiency of the compressor sometimes drops, and accordingly the operation efficiency of the whole refrigeration cycle drops.

SUMMARY OF THE INVENTION

[0004] Therefore, an object of the present invention is to provide a refrigerating device capable of realizing a high-efficiency operation in a case where a compressor having an intermediate pressure section is applied, and a refrigerator including this refrigerating device.

[0005] In a first aspect of the present invention, there is provided a refrigerating device comprising: a compressor having an intermediate pressure section; a radiator connected to a discharge side of the compressor; first pressure reducing means connected to an outlet side of the radiator; a gas-liquid separator into which a refrigerant having the pressure reduced by this first pressure reducing means and having a gas and liquid mixing state is introduced to separate the refrigerant into a gas refrigerant and a liquid refrigerant; and heat absorbing means through which the liquid refrigerant discharged from the gas-liquid separator flows and which includes second pressure reducing means and a first heat sink, the refrigerant discharged from the heat absorbing means being introduced into a suction port on a lower pressure side than the intermediate pressure section of the compressor, the refrigerating device further comprising: a first refrigerant pipe which introduces the gas refrigerant into the intermediate pressure section; and a second refrigerant pipe which introduces an intermediate-pressure refrigerant of the compressor into the gas-liquid separator.

[0006] In a second aspect of the present invention, in the refrigerating device of the first aspect, wherein the second refrigerant pipe includes an oil separator which separates oil included in the refrigerant flowing in the refrigerant pipe.

[0007] In a third aspect of the present invention, the refrigerating device of the second aspect further comprising: an oil duct capable of circulating the oil separated by the oil separator through the first refrigerant pipe.

[0008] In a fourth aspect of the present invention, in the refrigerating device of any one of the first to third aspects, wherein the heat absorbing means includes: first heat absorbing means including third pressure reducing means and a second heat sink; and second heat absorbing means disposed in parallel with the first heat absorbing means and including fourth pressure reducing means and a third heat sink, the refrigerant discharged from the first heat absorbing means and the refrigerant discharged from the second heat absorbing means are combined, and introduced into the suction port on the low-pressure side, the refrigerant pipe includes switching means for switching the refrigerant pipe to circulate the refrigerant discharged from the first heat absorbing means before the refrigerant discharged from the first heat absorbing means is combined, and one refrigerant pipe branched from this switching means is connected to the first refrigerant pipe.

[0009] In a fifth aspect of the present invention, in the refrigerating device of the fourth aspect, the second heat sink and the third heat sink selectively function at different temperatures.

[0010] In a sixth aspect of the present invention, in the refrigerating device of the fifth aspect, the third heat sink functions at a temperature lower than that of the second heat sink.

[0011] In a seventh aspect of the present invention, in the refrigerating device of any one of the first to sixth aspects, the compressor is a two-stage compressor in which the refrigerant compressed by the first-stage compressing section is further compressed by the second-stage compressing section.

[0012] In an eighth aspect of the present invention, in the refrigerating device of any one of the first to seventh aspects, a high-pressure section of a refrigeration cycle is operated in a supercritical state.

[0013] In a ninth aspect of the present invention, in the refrigerating device of any one of the first to eighth aspects, carbon dioxide is used as the refrigerant.

[0014] A refrigerator of the present invention includes: the refrigerating device of any one of the first to ninth aspects.

[0015] According to the present invention, there are provided a refrigerating device and a refrigerator in a case where a drop of operation efficiency of a compressor can be suppressed in a case where the compressor having an intermediate pressure section is used. Furthermore, according to the present invention, there are provided a refrigerating device and a refrigerator in which an amount of oil circulated into heat absorbing means is suppressed and an amount of oil to be supplied to the compressor can be maintained.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] **FIG. 1** is a refrigerant circuit diagram showing a refrigerating device in one embodiment of the present invention;

[0017] **FIG. 2** is a schematic sectional view showing a compressor in the embodiment of the present invention;

[0018] FIG. 3 is a schematic constitution diagram showing an example in which the refrigerating device of the embodiment of the present invention is applied to a refrigerator;

[0019] FIG. 4 is a refrigerant circuit diagram showing a refrigerating device in another embodiment of the present invention;

[0020] FIG. 5 is a schematic constitution diagram showing an example in which the refrigerating device of the embodiment of the present invention is applied to a refrigerator; and

[0021] FIG. 6 is a refrigerant circuit diagram showing a refrigerating device in still another embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0022] Preferable embodiments of the present invention will be described hereinafter in detail with reference to the drawings.

Embodiment 1

[0023] One embodiment of the present invention will be described in detail with reference to the drawings. FIG. 1 shows a refrigerant circuit diagram of a refrigerating device in one embodiment of the present invention. A refrigerating device 30 includes: a compressor 1; a radiator 2 connected to a discharge side of the compressor 1; an expansion valve 3 connected to an outlet side of the radiator 2; a gas-liquid separator 4 connected to an outlet side of this expansion valve 3; heat absorbing means 8 through which a liquid refrigerant separated by this gas-liquid separator flows; and an oil separator 5. A refrigerant pipe 4C through which a gas refrigerant separated by the gas-liquid separator 4 flows is connected to an intermediate pressure section of the compressor 1, and the outlet side of the heat absorbing means 8 is connected to a suction port of the compressor 1 to constitute a refrigeration cycle. It is to be noted that a check valve 7 is disposed in the refrigerant pipe 4C between the gas-liquid separator 4 and the intermediate pressure section of the compressor 1, and a check valve 53 is disposed between the heat absorbing means 8 and the suction port of the compressor 1.

[0024] The heat absorbing means 8 includes: a three-way valve 91 as channel switching means; a first capillary tube 12 as pressure reducing means; a second capillary tube 13 disposed in parallel with this first capillary tube 12 and having a resistance value which is larger than that of the first capillary tube 12; and a heat sink 14 connected behind a confluent point 9A connected to a refrigerant pipe from these first and second capillary tubes 12, 13 and the suction port of the compressor 1. This heat absorbing means 8 selectively functions at a different temperature zone. When the three-way valve 91 is switched to allow the liquid refrigerant discharged from the gas-liquid separator 4 to flow on a first capillary tube 12 side, a flow rate of the refrigerant flowing in the heat sink 14 increases to perform a refrigerating operation. On the other hand, when the three-way valve 91 is switched to allow the refrigerant to flow on a second capillary tube 13 side, the flow rate of the refrigerant flowing through the heat sink 14 drops to perform a freezing operation. It is to be noted that in addition to the method of switching the first and second capillary tubes 12, 13 as described above, the freezing operation and the refrigerating operation can be switched by a method of changing a rotational speed of the compressor 1 to thereby control the flow rate of the refrigerant flowing in the heat sink 14. Furthermore, these methods may be combined to realize the switching.

[0025] Moreover, the refrigerating device 30 includes selection means 23 for sending cold air generated in the heat sink 14 by a fan (not shown), and selectively guiding air to a plurality of rooms (refrigerating room 21, freezing room 22) controlled in different temperature zones. This selection means 23 includes a blowing duct 24 and a switching damper 25. A duct 57A is disposed between this switching damper 25 and the refrigerating room 21, and a duct 58A is disposed between the switching damper and the freezing room 22. The switching damper 25 is connected to a control device 26. This control device 26 is connected to the three-way valve 91. For example, during the refrigerating operation, the three-way valve 91 is switched on the second capillary tube 13 side. Moreover, the switching damper 25 is switched so that cold air flows in the duct 58A, and cold air is introduced into the freezing room 22. During the refrigerating operation, the three-way valve 91 is switched to the first capillary tube 12 side. Moreover, the switching damper 25 is switched so that cold air flows in the duct 57A, and cold air is introduced into the refrigerating room 21.

[0026] The expansion valve 3 functions as pressure reducing means, and a squeezing degree is variable. Moreover, when the squeezing degree is changed, a pressure of the refrigerant is lowered to a predetermined pressure before the refrigerant reaches the gas-liquid separator 4 to generate the gas refrigerant. When a refrigerant in a gas and liquid mixing state (two-phase mixture of gas and liquid) is introduced into the gas-liquid separator 4, a separation efficiency in the gas-liquid separator 4 can be changed.

[0027] The compressor 1 is a two-stage compressor, a sealed container contains a first-stage compressing section 1A and a second-stage compressing section 1B, and an intermediate cooler 1C is disposed in the discharge-side refrigerant pipe of the first-stage compressing section 1A, and a refrigerant pipe 5A extending out of this intermediate cooler 1C is connected to the oil separator 5. Moreover, after the gas refrigerant from which oil is separated by the oil separator 5 is introduced into the gas-liquid separator 4 by a refrigerant pipe 5C as shown by a solid-line arrow in the drawing, the gas refrigerant is introduced into the suction port of the second-stage compressing section 1B by the refrigerant pipe 4C as shown by a broken-line arrow in the drawing. It is to be noted that the oil separated by the oil separator 5 flows through an oil duct 5B including, for example, a capillary tube. The oil is mixed with the gas refrigerant flowing in the refrigerant pipe 4C in a confluent point 9E, and flows into the suction port of the second-stage compressing section 1B.

[0028] Moreover, in the gas-liquid separator 4, the refrigerant is introduced as a two-phase mixture whose pressure has been reduced to an intermediate pressure by the expansion valve 3, and this refrigerant as the two-phase mixture is separated into a gas refrigerant and a liquid refrigerant. In this gas-liquid separator 4, the refrigerant as the two-phase mixture introduced from a refrigerant pipe **4**A is separated into a gas and a liquid in the gas-liquid separator **4**. One gas refrigerant flows out of the refrigerant pipe **4**C, and the other liquid refrigerant flows out of a refrigerant pipe **4**B. After the oil is separated from the intermediate-pressure refrigerant discharged from the first-stage compressing section **1**A by the oil separator **5**, the refrigerant flows from the refrigerant pipe **5**C into the gas-liquid separator **4**. The refrigerant is mixed with the gas refrigerant separated by the gas-liquid separator **4**, and flows in the refrigerant pipe **4**C. It is to be noted that the refrigerant pipe **4**C is connected so that the gas refrigerant separated by the gas-liquid separator **4** can be introduced into the intermediate pressure section of the compressor **1** as described above. The gas refrigerant is introduced into the suction port of the second-stage compressing section **1**B of the compressor **1** owing to a differential pressure in the refrigerant pipe **4**C as shown by a broken-line arrow.

[**0029**] Here, the compressor **1** of the present embodiment will be described with reference to **FIG. 2**. **FIG. 2** is a schematic sectional view of the compressor **1**. This compressor **1** is an inner high-pressure type two-stage compressive type rotary compressor. The compressor **1** includes a vertically long and substantially cylindrical sealed container **112** whose upper and lower ends are hermetically closed, and a bottom of this sealed container **112** is constituted as an oil reservoir. The sealed container **112** includes: an electromotive element **114**; and a rotary compression section **118** constituted of a first compression section **1**A and a second compression section **1**B driven by a rotation shaft **116** of the electromotive element **114**. An outer face of a bottom section of the sealed container is provided with leg portions **210** for fixing the compressor **1** to, for example, a refrigerator housing (not shown).

[**0030**] The sealed container **112** is constituted of: a container main body **112**A which contains the electromotive element **114** and the rotary compression section **118**; and a substantially bowl-shaped end cap (lid member) **112**B which closes an end portion of the container main body **112**A on the side of the electromotive element **114**. A circular attaching hole **112**D is formed in this end cap **112**B, and a terminal **120** (a wiring line is omitted) for supplying power to the electromotive element **114** is attached to the attaching hole **112**D.

[**0031**] The electromotive element **114** includes: a stator **122** attached annularly along an inner peripheral face of the sealed container **112**; and a rotor **124** inserted into the stator **122** at a small interval from an inner peripheral face of the stator. This rotor **124** passes through the center of the sealed container **122**, and is attached to the rotation shaft **116** extending in an axial center direction of the sealed container. Here, the stator **122** has a laminate (not shown) constituted by laminating donut-shaped electromagnetic steel plates, and a stator coil **128** wound around a tooth portion of this laminate in a direct winding system. Moreover, the rotor **124** is also constituted of a laminate of electromagnetic steel plate in the same manner as in the stator **122**, and a permanent magnet is inserted into this laminate of the rotor.

[**0032**] Moreover, an oil passage **182** is passed through an axial center of the rotation shaft **116** along a vertical direction. One end of this oil passage **182** on a rotary compression section **118** side opens into an oil reservoir in a bottom of the sealed container **112**, and the other end of the oil passage on an electromotive element **114** side opens into the end cap **112**B. It is to be noted that this oil passage **182** also communicates with sliding portions of the compression sections **1**A and **1**B so that the oil can be supplied to the compression sections **1**A and **1**B.

[**0033**] The first-stage compression section **1**A and the second-stage compression section **1**B of the oil passage **182** are constituted of first and second cylinders **138**, **140**, and an intermediate partition plate **136** is sandwiched between these cylinders **138**, **140**. The compression sections **1**A, **1**B of the respective stages include: the first and second cylinders **138**, **140** disposed on opposite sides (vertically in **FIG. 1**) of the intermediate partition plate **136**; first and second rollers **146**, **148** which are fitted into first and second eccentric portions **142**, **144** disposed on the rotation shaft **116** and having a phase difference of 180 degrees and which eccentrically rotate in the first and second cylinders **138**, **140**; first and second vanes **150**, **152** which abut on these rollers **146**, **148** to define the cylinders **138**, **140** on a low-pressure-chamber side and a high-pressure-chamber side; and support members **154**, **156** which close an opening face of the cylinder **140** on the electromotive element **114** side and an opening face of the cylinder **138** on a side opposite to the electromotive element **114** and which also function as a bearing of the rotation shaft **116**, respectively.

[**0034**] Springs **174**, **176** for urging the vanes **150**, **152** toward the rollers **146**, **148** are disposed externally from the vanes **150**, **152** (on the right side in **FIG. 1**) to abut on outer end portions of the vanes **150**, **152**. Furthermore, plugs **222**, **223** made of a metal are disposed on the sealed container **112** side of the springs **174**, **176**, and prevent the springs **174**, **176** from being pulled off. A back-pressure chamber (not shown) is constituted in the second vane **152**, and a pressure on a high-pressure-chamber side in the cylinder **140** is applied as a back pressure to this back-pressure chamber.

[**0035**] Moreover, the support members **154**, **156** are provided with discharge noise absorbing chambers **162**, **164** formed by depressing a part of the support members and closing the depressed portions with a baffle plate **200** and a cover **168**, respectively. That is, the depressed portion of the support member **154** is closed with the baffle plate **200** to thereby form the discharge noise absorbing chamber **162**, and the depressed portion of the support member **156** is closed with the cover **168** to thereby form the discharge noise absorbing chamber **164**.

[**0036**] The discharge noise absorbing chamber **162** is connected to the sealed container **112** by a discharge duct **221** which passes through the baffle plate **200** and which opens on the electromotive element **114** side, and a high-pressure refrigerant gas compressed by the second-stage compression section **1**B is discharged from this discharge duct **221** to the electromotive element **114** side in the sealed container **112**. At this time, the refrigerant gas is mixed with the oil supplied to the second-stage compression section **1**B, but this oil is also discharged to the electromotive element **114** side in the sealed container **112**. Moreover, the oil mixed in the refrigerant gas is separated from the refrigerant gas, and stored in the oil reservoir in the bottom part of the sealed container **112**.

[**0037**] Moreover, in the sealed container **112**, there are inserted and connected: a refrigerant introducing tube **194** for introducing the refrigerant gas into the first-stage compression section **1**A; an intermediate refrigerant discharge tube **192** for discharging to the outside of the sealed container **112** the refrigerant gas compressed into an intermediate pressure by the first-stage compression section **1**A; an intermediate refrigerant introducing tube **193** for introducing the intermediate-pressure refrigerant discharged from this intermediate refrigerant discharge tube **192** into the second-stage compression section **1**B of the compressor **1** via the intermediate cooler **1**C, the oil separator **5**, and the gas-liquid separator **4** as described above; and a refrigerant discharge tube **196** for discharging from the compressor **1** the refrigerant gas compressed into a high pressure by the second-stage compression section **1**B and discharged into the sealed container **112** by the discharge duct **221** as described above.

[**0038**] Furthermore, in the refrigerating device **30** of the present embodiment, a carbon dioxide refrigerant (CO_2) which is a natural refrigerant is introduced as a refrigerant having less load on environment in consideration of combustibility, toxicity and the like. As an oil as a lubricant of the compressor **1**, there is used, for example, mineral oil, alkyl benzene oil, ether oil, polyalkylene glycol (PAG), polyol ester (POE) or the like.

[**0039**] In the refrigerating device **30**, carbon dioxide is used as the refrigerant in this manner. Therefore, for example, in a case where outside air temperature is not less than a critical temperature (about +31° C.) of carbon dioxide, a supercritical state is brought in a high-pressure section of the refrigeration cycle, that is, from a discharge side of the second-stage compression section **1**B to an inlet side of the expansion valve **3** via the radiator **2**. Consequently, the refrigerating device **30** is operated as a transitionally critical cycle.

[**0040**] There will be described an operation of the refrigerating device **30** constituted as described above in the present embodiment with reference to **FIG. 1**. In the refrigerating device **30**, there is selected as required: a freezing operation in which the second capillary tube **13** is mainly used; or a refrigerating operation in which the first capillary tube **12** is mainly used.

[**0041**] First, the freezing operation will be described. It is to be noted that this freezing operation is an operation for operating the heat sink **14** at a predetermined temperature (e.g., around −26° C.) to cool the freezing room **22**.

[**0042**] In the present freezing operation, when the compressor **1** is operated, the refrigerant discharged from the compressor **1** radiates heat, and is cooled in the radiator **2**. Thereafter, the refrigerant discharged from the radiator **2** reaches the expansion valve **3**, and the pressure of the refrigerant is reduced in the expansion valve to obtain the two-phase mixture of gas and liquid. The mixture is introduced into the gas-liquid separator **4** from the refrigerant pipe **4**A of the gas-liquid separator **4**. Furthermore, as described above, the refrigerant is separated into the gas refrigerant and the liquid refrigerant in this gas-liquid separator **4**. The gas refrigerant is circulated through the refrigerant pipe **4**C, passed through the check valve **7**, and thereafter introduced into the intermediate pressure section of the compressor **1**. On the other hand, the liquid refrigerant separated by the gas-liquid separator **4** is circulated through the refrigerant pipe **4**B to reach the three-way valve **91**. Moreover, this liquid refrigerant is circulated through the second capillary tube **13** by the three-way valve **91**, and the pressure of the refrigerant is reduced. Thereafter, the pressure-reduced refrigerant evaporates in the heat sink **14**, absorbs heat from its periphery, and returns to the suction port of the compressor **1**. It is to be noted that since the control device **26** switches the switching damper **25** so as to circulate cold air through the duct **58**A side during the freezing operation, the freezing room **22** is cooled.

[**0043**] Next, the refrigerating operation will be described. It is to be noted that this refrigerating operation is an operation for operating the heat sink **14** at a temperature (e.g., around −5° C.) higher than that of the freezing operation to cool the refrigerating room **21**.

[**0044**] In the present refrigerating operation, a temperature zone in which the heat absorbing means **8** functions is different from that in the freezing operation. That is, the liquid refrigerant discharged from the gas-liquid separator **4** is circulated through the first capillary tube **12** by the three-way valve **91**. After the pressure of the refrigerant is reduced, the refrigerant evaporates in the heat sink **14**, and absorbs heat from its periphery. It is to be noted that during the present refrigerating operation, since the control device **26** switches the switching damper **25** so as to circulate cold air through a duct **57**A side, the refrigerating room **21** is cooled. In the refrigerating device **30** of the present embodiment, the above-described refrigeration cycle is formed to cool the rooms **21**, **22**, respectively, during both of the freezing operation and the refrigerating operation.

[**0045**] It is to be noted that in the refrigerating device **30**, even if the gas refrigerant separated by the gas-liquid separator **4** is circulated through the heat absorbing means **8**, the refrigerant cannot be used for cooling. When this refrigerant is returned to the suction port of the first-stage compression section **1**A, the compression efficiency in the compressor **1** is lowered.

[**0046**] Therefore, in the present embodiment, since the gas refrigerant separated by the gas-liquid separator **4** is introduced into the suction port of the second-stage compression section **1**B via the intermediate pressure section of the compressor **1**, that is, the refrigerant pipe **4**C, it is possible to suppress the drop of the compression efficiency in the compressor **1**. Especially, since the carbon dioxide refrigerant is introduced in the refrigerant circuit in the refrigerating device **30** of the present embodiment, a ratio of the gas increases in a ratio between the gas and the liquid separated by the gas-liquid separator **4** as compared with a Freon-based or hydrocarbon (HC)-based refrigerant which has heretofore been used. Since a larger amount of gas is introduced into the intermediate pressure section of the compressor **1**, the efficiency of the refrigeration cycle can further be enhanced.

[**0047**] Moreover, the intermediate-pressure refrigerant discharged from the first-stage compression section **1**A contains a large amount of oil. When the refrigerant is introduced into the gas-liquid separator **4** as such, the oil is separated in the gas-liquid separator **4**, and a large amount of separated oil is circulated through the heat absorbing means **8**. A cooling performance in the heat sink **14** remarkably drops. Moreover, a large amount of oil circulates through the first-stage compression section **1**A of the compressor **1**, the gas-liquid separator **4**, and the heat absorbing means **8**, and a problem occurs that an amount of oil to be supplied to the second-stage compression section **1**B drops.

[**0048**] However, the refrigerating device **30** of the present embodiment includes the oil separator **5** on the discharge side of the first-stage compression section **1**A. Here, the oil separated from the intermediate-pressure refrigerant can be supplied to the second-stage compression section **1**B together with the refrigerant circulated through the refrigerant pipe **4**C in the confluent point **9**E by the oil duct **5**B. Therefore, the above-described problem is avoided, and it is possible to supply to the second-stage compression section **1**B the oil discharged together with the intermediate-pressure refrigerant from the first-stage compression section **1**A.

[**0049**] Furthermore, in the present embodiment, the compressor **1** is an inner high-pressure type two-stage compressive rotary compressor, and has a constitution in which the refrigerant including the oil from the second-stage compression section **1**B is discharged into the sealed container **112** by the discharge duct **221**, and thereafter discharged from the refrigerant discharge tube **196**. Therefore, after the oil is separated from the refrigerant discharged from the discharge duct **221** in the sealed container **112**, the refrigerant is discharged from the refrigerant discharge tube **196**. Therefore, the amount of the oil in the oil reservoir of the bottom of the sealed container **112** does not excessively decrease, and the compression sections **1**A, **1**B of the respective stages can be appropriately lubricated.

[**0050**] Here, in the oil duct **5**B and the refrigerant pipe **4**C, the vicinity of the suction port of the second-stage compression section **1**B has the lowest pressure owing to pressure losses caused by the intermediate cooler **1**C from the discharge side of the first-stage compression section **1**A to the suction port of the second-stage compression section **1**B, the refrigerant pipes **5**A, **5**C, and **4**C, the gas-liquid separator **4** and the like. Therefore, the oil is smoothly supplied to the second-stage compression section **1**B.

[**0051**] Additionally, usually the refrigerant as the two-phase mixture whose pressure has been reduced by the expansion valve **3** has a temperature lower than that of the refrigerant discharged from the first-stage compression section **1**A and cooled by the intermediate cooler **1**C. However, in the present embodiment, as described above, after introducing into the gas-liquid separator **4** the refrigerant discharged from the first-stage compression section **1**A and cooled by the intermediate cooler **1**C, the refrigerant is mixed with the gas refrigerant separated from the two-phase mixture by the gas-liquid separator **4**. Therefore, the sucked refrigerant of the second-stage compression section **1**B can further be cooled, and the compression efficiency of the compressor **1** can be improved.

[**0052**] It is to be noted that since the refrigerating device **30** has a constitution to expand the gas in two stages by the expansion valve **3** and the first or second capillary tube **12**, **13**. Therefore, in the present refrigeration cycle, an intermediate pressure portion is formed between the outlet side of the expansion valve **3** and the inlet side of the first and second capillary tubes **12**, **13** and between the discharge side of the first-stage compression section **1**A of the compressor **1** and the suction side of the second-stage compression section **1**B.

[**0053**] Next, there will be described an example in which the refrigerating device **30** of the present embodiment is applied to a refrigerator with reference to **FIG. 3**. **FIG. 3** shows a schematic constitution diagram of the refrigerator including the refrigerating device **30**.

[**0054**] This refrigerator **40** includes an upper-stage refrigerating room **41** and a lower-stage freezing room **42**. An in-chamber partition wall **43** is disposed in an inner part of this freezing room **42**. The above-described heat sink **14** is disposed in an air path **44** defined by the in-chamber partition wall **43**. A first switching damper **45** is disposed in an inlet A of the air path **44**, and this first switching damper **45** is switched between a position (broken-line position) to close the inlet A of the air path **44** and a position (solid-line position) to open the inlet. A backside air path **46** is formed in a back wall **47** of the refrigerator **40**. When the first switching damper **45** is switched in the broken-line position, the inlet A of the air path **44** communicates with the refrigerating room **41** via this backside air path **46**. A fan **48** and a second switching damper **49** are disposed in an outlet B of the air path **44**, and this second switching damper **49** is switched between a position (broken-line position) to close the outlet B of the air path **44** and a position (solid-line position) to open the outlet. In this solid-line position, the second switching damper **49** closes an opening **51** of an intermediate partition wall **50**.

[**0055**] According to the above-described constitution, during the freezing operation, the first switching damper **45** is switched to the position (solid-line position) to open the inlet A of the air path **44**, and the second switching damper **49** is switched to the position (solid-line position) to open the outlet B of the air path **44** to circulate air through the freezing room **42**, thereby cooling air by the heat sink **14**. During the freezing operation, the first switching damper **45** is switched to the position (broken-line position) to close the inlet A of the air path **44**, and the second switching damper **49** is switched to the position (broken-line position) to close the outlet B of the air path **44** to circulate air through the refrigerating room **41** via the backside air path **46**, thereby cooling air by the heat sink **14**.

Embodiment 2

[**0056**] Next, another embodiment of the present invention will be described with reference to **FIG. 4**. **FIG. 4** shows a refrigerant circuit diagram of a refrigerating device **50** in this case. In the present embodiment, components denoted with the same reference numerals of Embodiment 1 have identical or similar functions or effects. The present embodiment is different from Embodiment 1 in that there are disposed first heat absorbing means **10** and second heat absorbing means **11** disposed in parallel with the first heat absorbing means on the outlet side of a three-way valve **91** instead of the heat absorbing means **8**.

[**0057**] The first heat absorbing means **10** includes a first capillary tube **12**, and a first heat sink **57** disposed in series with this first capillary tube **12**. The second heat absorbing means **11** includes a second capillary tube **13**, a second heat sink **58** disposed in series with the second capillary tube **13**, and a check valve **52**. Moreover, refrigerant pipes on an outlet side of the first and second heat absorbing means **10**, **11** are combined in a confluent point **9**B, and connected to a suction port of a compressor **1** via a check valve **53** in the same manner as in Embodiment 1. The first heat absorbing means **10** and the second heat absorbing means **11** selectively function in mutually different temperature zones.

[0058] As described above, in the present embodiment, since the refrigerating device **50** includes the first and second heat absorbing means **10**, **11**, and the heat sinks **57**, **58** function in the different temperature zones, respectively, a refrigerating room **21** and a freezing room **22** can be selectively cooled by ducts **57**A, **58**B extending out of the heat sinks **57**, **58**, respectively. Accordingly, during the freezing operation and the refrigerating operation having different temperature zones, the heat sink suitable for the operation temperature can be used, and an operation efficiency in each operation is improved.

[0059] Next, there will be described an example in which the refrigerating device **50** of the present embodiment is applied to a refrigerator with reference to **FIG. 5**. **FIG. 5** shows a schematic constitution diagram of the refrigerator including the refrigerating device **50** of the present embodiment.

[0060] This refrigerator **40** includes an upper-stage refrigerating room **41** and a lower-stage freezing room **42**. Moreover, in-chamber partition walls **61**, **62** are disposed in inner parts of the chambers **41**, **42**, respectively. The above-described heat sinks **57**, **58**, and fans **63**, **64** are disposed in an air path **44** defined by the in-chamber partition walls **61**, **62**. In the present constitution, when a thermostat turns on or off during the refrigerating operation and the freezing operation, the first heat absorbing means **10** and the second heat absorbing means **11** are switched, the refrigerant is passed through one of the heat sinks **57**, **58**, and the corresponding fans **63**, **64** are driven. In a case where the refrigerant flows in the heat sink **57**, cold air is supplied to the refrigerating room **41**. In a case where the refrigerant flows into the heat sink **58**, cold air is supplied to the freezing room **42**.

[0061] As described above, since the refrigerator **40** of the present embodiment includes the refrigerating device **50** constituted as described above, it is possible to improve a cooling performance and an operation efficiency.

Embodiment 3

[0062] Next, another embodiment of the present invention will be described with reference to **FIG. 6**. **FIG. 6** shows a refrigerant circuit diagram of a refrigerating device **70** in this case. It is to be noted that, in **FIG. 6**, components denoted with the same reference numerals of Embodiments 1, 2 have identical or similar functions or effects. The refrigerating device **70** of the present embodiment is different from Embodiment 2 in that the three-way valve **91** is not disposed, third and fourth heat absorbing means **10**B, **11**B are disposed instead of the first and second heat absorbing means **10**, **11**, a three-way valve **92** is disposed as channel switching means, and a refrigerant pipe **92**A extending out of this three-way valve **92** is connected to a refrigerant pipe **4**C.

[0063] The third heat absorbing means **10**B includes: a first expansion valve **65** as pressure reducing means through which a refrigerant from a branch point **9**C circulates; and a heat sink **57** for refrigerating. The fourth heat absorbing means **11**B is disposed in parallel with the third heat absorbing means **10**B, and includes: a second expansion valve **66** as pressure reducing means; and a heat sink **58** for freezing. Moreover, a refrigerant pipe on an outlet side of the heat sink **57** and a refrigerant pipe on an outlet side of the heat sink **58** are connected to each other in a confluent point **9**D, and connected to a suction port of a compressor **1**. The three-way valve **92** is disposed between the heat sink **57** and the confluent point **9**D, a refrigerant pipe **92**C is disposed between the heat sink **57** and the three-way valve, and a refrigerant pipe **92**B is disposed between the three-way valve **92** and the confluent point **9**D. Furthermore, a remaining port of the three-way valve **92** is connected to the refrigerant pipe **92**A, and this refrigerant pipe **92**A is connected to the refrigerant pipe **4**C connecting a gas-liquid separator **4** to a suction port of a second-stage compression section **1**B in a confluent point **9**F.

[0064] It is to be noted that the first and second expansion valves **65**, **66** are constituted so that a squeezing degree is variable in the same manner as in an expansion valve **3**. Moreover, when the squeezing degree of each valve is changed, and the three-way valve **92** is switched, a freezing operation, a refrigerating operation, and a freezing/refrigerating operation are selected as required in the refrigerating device **70** of the present embodiment.

[0065] First, the freezing operation will be described. This freezing operation is an operation for operating the heat sink **58** at a predetermined temperature (e.g., around −26° C.) to cool a freezing room **22** in the same manner as in Embodiment 2. In the present freezing operation, a control device (not shown) fully closes the first expansion valve **65**, and the second expansion valve **66** is set to an open degree which is appropriate for reducing a predetermined amount of pressure of a liquid refrigerant passing through the expansion valve **66** to operate the heat sink **58** at the temperature. Moreover, the three-way valve **92** is closed.

[0066] In the present freezing operation, when the compressor **1** is operated, the refrigerant discharged from the compressor **1** radiates heat, and is cooled in a radiator **2**. Thereafter, the refrigerant discharged from the radiator **2** reaches the expansion valve **3**, and the pressure of the refrigerant is reduced in the expansion valve to obtain a two-phase mixture of gas and liquid. The mixture is introduced into the gas-liquid separator **4** from a refrigerant pipe **4**A. Furthermore, the liquid refrigerant separated by the gas-liquid separator **4** reaches the branch point **9**C by a refrigerant pipe **4**B. Moreover, after the pressure of the refrigerant is reduced by the second expansion valve **66**, the refrigerant evaporates in the heat sink **58**, and absorbs heat from its periphery. Thereafter, the refrigerant discharged from the heat sink **58** flows from the confluent point **9**D through a check valve **53** to return to a suction port of the first-stage compression section **1**A. Accordingly, during the present freezing operation, the freezing room **22** is cooled.

[0067] Next, the refrigerating operation will be described. It is to be noted that this refrigerating operation is an operation for operating the heat sink **57** at a predetermined temperature (e.g., around −5° C.) higher than that of the freezing operation to cool a refrigerating room **21**. In the present refrigerating operation, a control device (not shown) sets the first expansion valve **65** to an open degree which is appropriate for reducing a predetermined amount of pressure of a liquid refrigerant passing through the expansion valve **65** to operate the heat sink **57** at the temperature. The second expansion valve **66** is fully closed. Moreover, the three-way valve **92** is switched so as to allow a refrigerant pipe **92**C side to communicate with a refrigerant pipe **92**B side. That is, the three-way valve **92** on the refrigerant pipe **92**A side is closed.

[0068] Even in the present refrigerating operation, when the compressor **1** is operated, the refrigerant discharged from the compressor **1** radiates heat, and is cooled in the radiator **2**. Moreover, the refrigerant discharged from the radiator **2** reaches the expansion valve **3**, and the pressure of the refrigerant is reduced in the expansion valve to obtain a two-phase mixture of gas and liquid. The mixture is introduced into the gas-liquid separator **4** from the refrigerant pipe **4**A. Furthermore, the liquid refrigerant separated by the gas-liquid separator **4** reaches the branch point **9**C by a refrigerant pipe **4**B. Moreover, after the pressure of the refrigerant is reduced by the first expansion valve **65**, the refrigerant evaporates in the heat sink **57**, and absorbs heat from its periphery. Thereafter, the refrigerant discharged from the heat sink **57** is circulated through the confluent point **9**B by the three-way valve **92**, and flows from the confluent point **9**D through the check valve **53** to return to the suction port of the first-stage compression section **1**A. Accordingly, during the present refrigerating operation, the refrigerating room **21** is cooled.

[0069] Furthermore, the freezing/refrigerating operation will be described. This freezing/refrigerating operation is an operation for operating the heat sinks **57** and **58** at a predetermined temperature (e.g., the heat sink **57** around −5° C., the heat sink **58** around −26° C.) to cool the refrigerating room **21** and the freezing room **22** at the same time. In the present freezing/refrigerating operation, a control device (not shown) fully opens the first expansion valve **65**. That is, the third heat absorbing means **10**B is set at an intermediate pressure in the same manner as in the gas-liquid separator **4**. The second expansion valve **66** is set to an open degree which is appropriate for reducing a predetermined amount of pressure of the liquid refrigerant passing through the expansion valve **66** to operate the heat sink **58** at the temperature. Moreover, the three-way valve **92** is switched to allow the refrigerant pipe **92**C side to communicate with the refrigerant pipe **92**A side. That is, the three-way valve **92** on the refrigerant pipe **92**B side is closed.

[0070] In the present freezing/refrigerating operation, when the compressor **1** is operated, the refrigerant discharged from the compressor **1** radiates heat, and is cooled in the radiator **2**. Subsequently, the refrigerant discharged from the radiator **2** reaches the expansion valve **3**, and the pressure of the refrigerant is reduced in the expansion valve to obtain a two-phase mixture of gas and liquid. The mixture is introduced into the gas-liquid separator **4** from the refrigerant pipe **4**A. Furthermore, the liquid refrigerant separated by the gas-liquid separator **4** reaches the branch point **9**C. One refrigerant circulates through the fourth heat absorbing means **11**B side, evaporates in the heat sink **58**, and absorbs heat from its periphery. Thereafter, the refrigerant is introduced from the confluent point **9**D into the suction port of the first-stage compression section **1**A via the check valve **53**. The other refrigerant circulates through the third heat absorbing means **10**B, evaporates in the heat sink **57**, and absorbs heat from its periphery. Thereafter, the refrigerant flows from the refrigerant pipe **92**C to the three-way valve **92**, and flows from the three-way valve **92** to the confluent point **9**F via the refrigerant pipe **92**A. In the confluent point, the refrigerant is mixed with a gas refrigerant or the like separated by the gas-liquid separator **4** and flowing in the refrigerant pipe **4**C. Thereafter, the refrigerant is introduced into a suction port of the second-stage compression section **1**B via a check valve **7**. Accordingly, during the present freezing/refrigerating operation, the refrigerating room **21** and the freezing room **22** are cooled.

[0071] As described above, according to the refrigerating device **70** of the present embodiment, since the heat absorbing means **10**B, **11**B can operate alone, that is, the freezing operation can be operated independently of the refrigerating operation, a high load is added to one of the rooms **21**, **22**. Even in a case where one room needs to be cooled in a concentrated manner, the operations can be performed alone, and it is possible to improve a refrigeration cycle efficiency and a cooling capability. Even in a case where the rooms **21**, **22** do not have to be operated alone, or the high load is added to both of the refrigerating room **21** and the freezing room **22**, the above freezing/refrigerating operation can be selected to obtain a high cooling capability.

[0072] It is to be noted that, needless to say, the refrigerating device **70** of the present embodiment can be applied to the refrigerator in the same manner as in the refrigerating device **50** of the Embodiment 2.

[0073] The present invention has been described above in detail in accordance with the embodiments, but the present invention is not limited to them, and can be variously modified. For example, in the above embodiments, the carbon dioxide refrigerant is introduced in the refrigerant circuit, but the present invention is not limited to the embodiments, and the present invention is also applicable to a case where another refrigerant such as a Freon-based refrigerant or the like is introduced.

[0074] Moreover, in the above embodiments, if necessary, the capillary tube may be replaced with the expansion valve, or the expansion valve may be replaced with the capillary tube.

[0075] It is to be noted that the compressor **1** is not limited to the above-described two-stage compressor. For example, in a one-stage compressor, the refrigerant pipe **4**C may be returned to the intermediate pressure section of the one-stage compressor. Alternatively, a plurality of compressors may be connected to a constitution.

What is claimed is:

1. A refrigerating device comprising: a compressor having an intermediate pressure section; a radiator connected to a discharge side of the compressor; first pressure reducing means connected to an outlet side of the radiator; a gas-liquid separator into which a refrigerant having the pressure reduced by the first pressure reducing means and having a gas and liquid mixing state is introduced to separate the refrigerant into a gas refrigerant and a liquid refrigerant; and heat absorbing means through which the liquid refrigerant discharged from the gas-liquid separator flows and which includes second pressure reducing means and a first heat sink,

the refrigerant discharged from the heat absorbing means being introduced into a suction port on a lower pressure side than the intermediate pressure section of the compressor,

the refrigerating device further comprising:

a first refrigerant pipe which introduces the gas refrigerant into the intermediate pressure section; and a second refrigerant pipe which introduces an intermediate-pressure refrigerant of the compressor into the gas-liquid separator.

2. The refrigerating device according to claim 1, wherein the second refrigerant pipe includes an oil separator which separates oil included in the refrigerant flowing in the refrigerant pipe.

3. The refrigerating device according to claim 2, further comprising:

an oil duct capable of circulating the oil separated by the oil separator through the first refrigerant pipe.

4. The refrigerating device according to any one of claims 1 to 3, wherein the heat absorbing means includes: first heat absorbing means including third pressure reducing means and a second heat sink; and second heat absorbing means disposed in parallel with the first heat absorbing means and including fourth pressure reducing means and a third heat sink,

the refrigerant discharged from the first heat absorbing means and the refrigerant discharged from the second heat absorbing means are combined, and introduced into the suction port on the low-pressure side,

the refrigerant pipe includes switching means for switching the refrigerant pipe to circulate the refrigerant discharged from the first heat absorbing means before the refrigerant discharged from the first heat absorbing means is combined, and one refrigerant pipe branched from this switching means is connected to the first refrigerant pipe.

5. The refrigerating device according to claim 4, wherein the second heat sink and the third heat sink selectively function at different temperatures.

6. The refrigerating device according to claim 5, wherein the third heat sink functions at a temperature lower than that of the second heat sink.

7. The refrigerating device according to any one of claims 1 to 6, wherein the compressor is a two-stage compressor in which the refrigerant compressed by the first-stage compressing section is further compressed by the second-stage compressing section.

8. The refrigerating device according to any one of claims 1 to 7, wherein a high-pressure section of a refrigeration cycle is operated in a supercritical state.

9. The refrigerating device according to any one of claims 1 to 8, wherein carbon dioxide is used as the refrigerant.

10. A refrigerator comprising:

the refrigerating device according to any one of claims 1 to 9.

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