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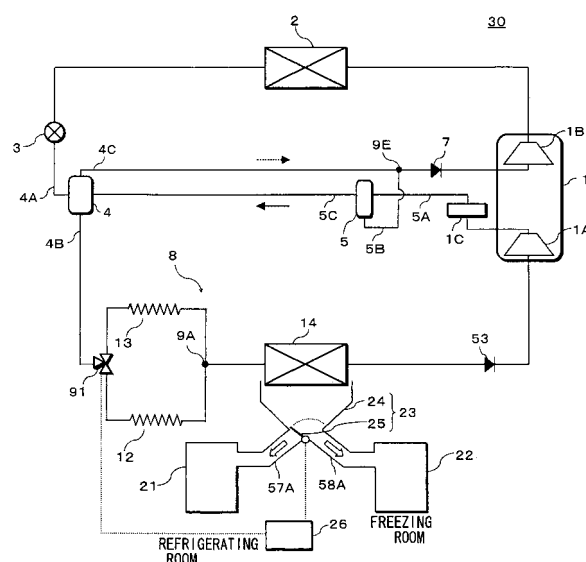
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(54) Refrigerating device and refrigerator

(57) 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



Description

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 re-

frigerant 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;

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

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;

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

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

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

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0017] Preferable embodiments of the present invention will be described hereinafter in detail with reference to the drawings.

[Embodiment 1]

[0018] 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.

[0019] 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.

[0020] 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.

[0021] 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 sep-

arator 4 can be changed.

[0022] 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.

[0023] 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 4A is separated into a gas and a liquid in the gas-liquid separator 4. One gas refrigerant flows out of the refrigerant pipe 4C, and the other liquid refrigerant flows out of a refrigerant pipe 4B. After the oil is separated from the intermediate-pressure refrigerant discharged from the first-stage compressing section 1A by the oil separator 5, the refrigerant flows from the refrigerant pipe 5C 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 4C. It is to be noted that the refrigerant pipe 4C 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 1B of the compressor 1 owing to a differential pressure in the refrigerant pipe 4C as shown by a broken-line arrow.

[0024] 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 1A and a second compression sec-

tion 1B 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).

[0025] The sealed container 112 is constituted of: a container main body 112A which contains the electromotive element 114 and the rotary compression section 118; and a substantially bowl-shaped end cap (lid member) 112B which closes an end portion of the container main body 112A on the side of the electromotive element 114. A circular attaching hole 112D is formed in this end cap 112B, and a terminal 120 (a wiring line is omitted) for supplying power to the electromotive element 114 is attached to the attaching hole 112D.

[0026] 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.

[0027] 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 112B. It is to be noted that this oil passage 182 also communicates with sliding portions of the compression sections 1A and 1B so that the oil can be supplied to the compression sections 1A and 1B.

[0028] The first-stage compression section 1A and the second-stage compression section 1B 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 1A, 1B 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.

[0029] 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.

[0030] 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.

[0031] 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 1B 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 1B, 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.

[0032] 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 1A; 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 1A; 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 1B of the compressor 1 via the intermediate cooler 1C, 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 1B and discharged into the sealed container 112 by the discharge duct 221 as described

above.

[0033] Furthermore, in the refrigerating device 30 of the present embodiment, a carbon dioxide refrigerant (CO₂) 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.

[0034] 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 1B 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.

[0035] 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.

[0036] 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.

[0037] 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 4A 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 4C, 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 4B 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 58A side during the freezing operation, the freezing room 22 is cooled.

[0038] 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.

[0039] 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 57A 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.

[0040] 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 1A, the compression efficiency in the compressor 1 is lowered.

[0041] 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 1B via the intermediate pressure section of the compressor 1, that is, the refrigerant pipe 4C, 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.

[0042] Moreover, the intermediate-pressure refrigerant discharged from the first-stage compression section 1A 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 1A 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 1B drops.

[0043] However, the refrigerating device 30 of the

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

[0044] 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 1B 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 1A, 1B of the respective stages can be appropriately lubricated.

[0045] Here, in the oil duct 5B and the refrigerant pipe 4C, the vicinity of the suction port of the second-stage compression section 1B has the lowest pressure owing to pressure losses caused by the intermediate cooler 1C from the discharge side of the first-stage compression section 1A to the suction port of the second-stage compression section 1B, the refrigerant pipes 5A, 5C, and 4C, the gas-liquid separator 4 and the like. Therefore, the oil is smoothly supplied to the second-stage compression section 1B.

[0046] 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 1A and cooled by the intermediate cooler 1C. 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 1A and cooled by the intermediate cooler 1C, 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 1B can further be cooled, and the compression efficiency of the compressor 1 can be improved.

[0047] 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 1A of the compressor 1 and the suction side of the second-stage compression section 1B.

[0048] 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.

[0049] 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.

[0050] 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]

[0051] 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.

[0052] 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 9B, 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.

[0053] 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 57A, 58B 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.

[0054] 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.

[0055] 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.

[0056] 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]

[0057] 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 10B, 11B 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 92A extending out of this three-way valve 92 is connected to a refrigerant pipe 4C.

[0058] The third heat absorbing means 10B includes: a first expansion valve 65 as pressure reducing means through which a refrigerant from a branch point 9C circulates; and a heat sink 57 for refrigerating. The fourth heat absorbing means 11B is disposed in parallel with the third heat absorbing means 10B, 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 9D, 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 9D, a refrigerant pipe 92C is disposed between the heat sink 57 and the three-way valve, and a refrigerant pipe 92B is disposed between the three-way valve 92 and the confluent point 9D. Furthermore, a remaining port of the three-way valve 92 is connected to the refrigerant pipe 92A, and this refrigerant pipe 92A is connected to the refrigerant pipe 4C connecting a gas-liquid separator 4 to a suction port of a second-stage compression section 1B in a confluent point 9F.

[0059] 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.

[0060] 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.

[0061] 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 4A. Furthermore, the liquid refrigerant separated by the gas-liquid separator 4 reaches the branch point 9C by a refrigerant pipe 4B. 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 9D through a check valve 53 to return to a suction port of the first-stage compression section 1A. Accordingly, during the present freezing operation, the freezing room 22 is cooled.

[0062] 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 92C side to communicate with a refrigerant pipe 92B side. That is, the three-way valve 92 on the refrigerant pipe 92A side is closed.

[0063] 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 4A. Furthermore, the liquid refrigerant separated by the gas-liquid separator 4 reaches the branch point 9C by a refrigerant pipe 4B; 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 9B by the three-way valve 92, and flows from the confluent point 9D through the check valve 53 to return to the suction port of the first-stage compression section 1A. Accordingly, during the present refrigerating operation, the refrigerating room 21 is cooled.

[0064] 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,

tion, a control device (not shown) fully opens the first expansion valve 65. That is, the third heat absorbing means 10B 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 92C side to communicate with the refrigerant pipe 92A side. That is, the three-way valve 92 on the refrigerant pipe 92B side is closed.

[0065] 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 4A. Furthermore, the liquid refrigerant separated by the gas-liquid separator 4 reaches the branch point 9C. One refrigerant circulates through the fourth heat absorbing means 11B side, evaporates in the heat sink 58, and absorbs heat from its periphery. Thereafter, the refrigerant is introduced from the confluent point 9D into the suction port of the first-stage compression section 1A via the check valve 53. The other refrigerant circulates through the third heat absorbing means 10B, evaporates in the heat sink 57, and absorbs heat from its periphery. Thereafter, the refrigerant flows from the refrigerant pipe 92C to the three-way valve 92, and flows from the three-way valve 92 to the confluent point 9F via the refrigerant pipe 92A. 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 4C. Thereafter, the refrigerant is introduced into a suction port of the second-stage compression section 1B via a check valve 7. Accordingly, during the present freezing/refrigerating operation, the refrigerating room 21 and the freezing room 22 are cooled.

[0066] As described above, according to the refrigerating device 70 of the present embodiment, since the heat absorbing means 10B, 11B 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.

[0067] 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.

[0068] 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.

[0069] 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.

[0070] 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 4C may be returned to the intermediate pressure section of the one-stage compressor. Alternatively, a plurality of compressors may be connected to a constitution.

Claims

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
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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. 30
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. 35
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. 40
9. The refrigerating device according to any one of claims 1 to 8, wherein carbon dioxide is used as the refrigerant. 45
10. A refrigerator comprising:

the refrigerating device according to any one of claims 1 to 9. 50

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FIG. 1

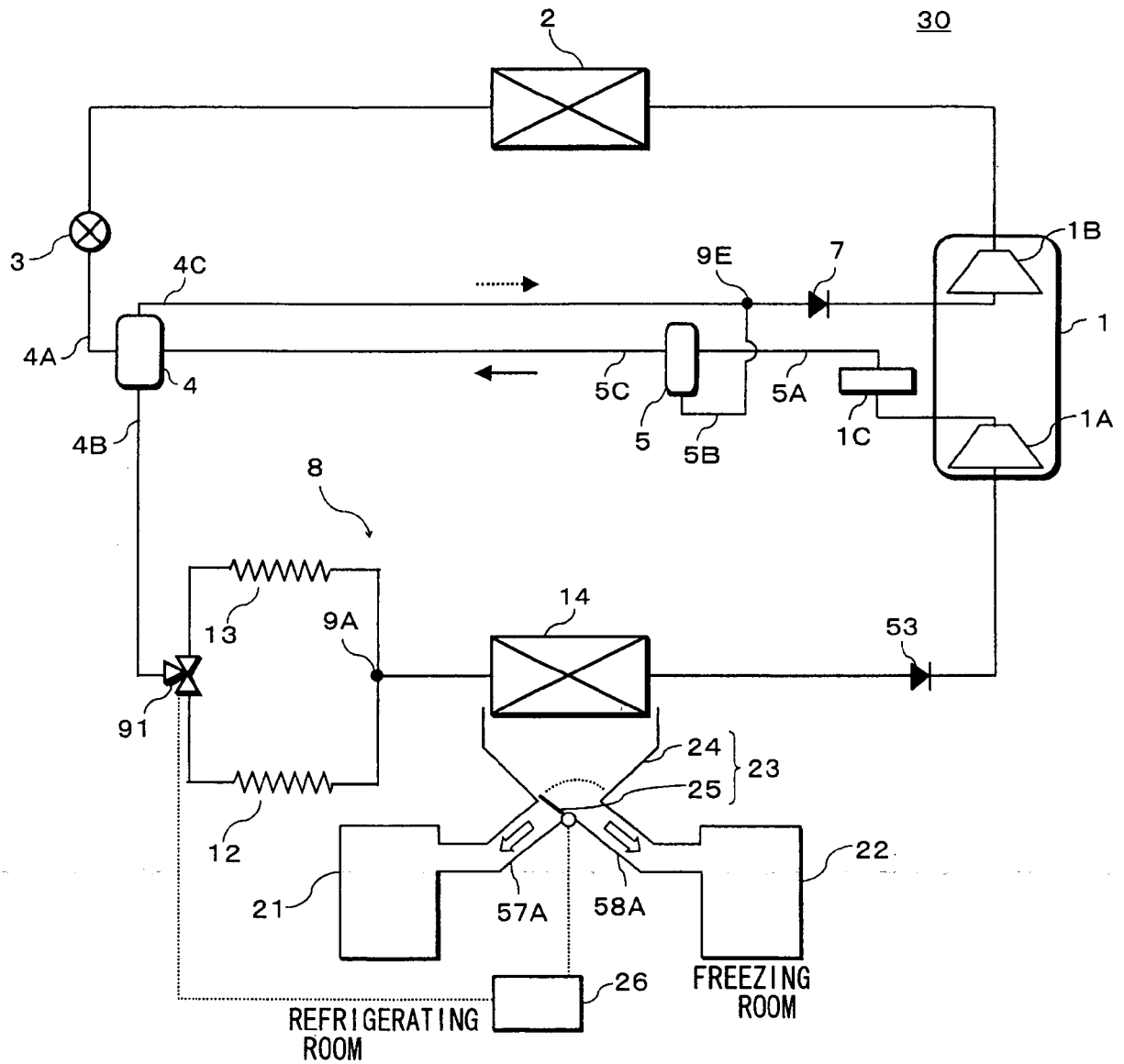


FIG. 2

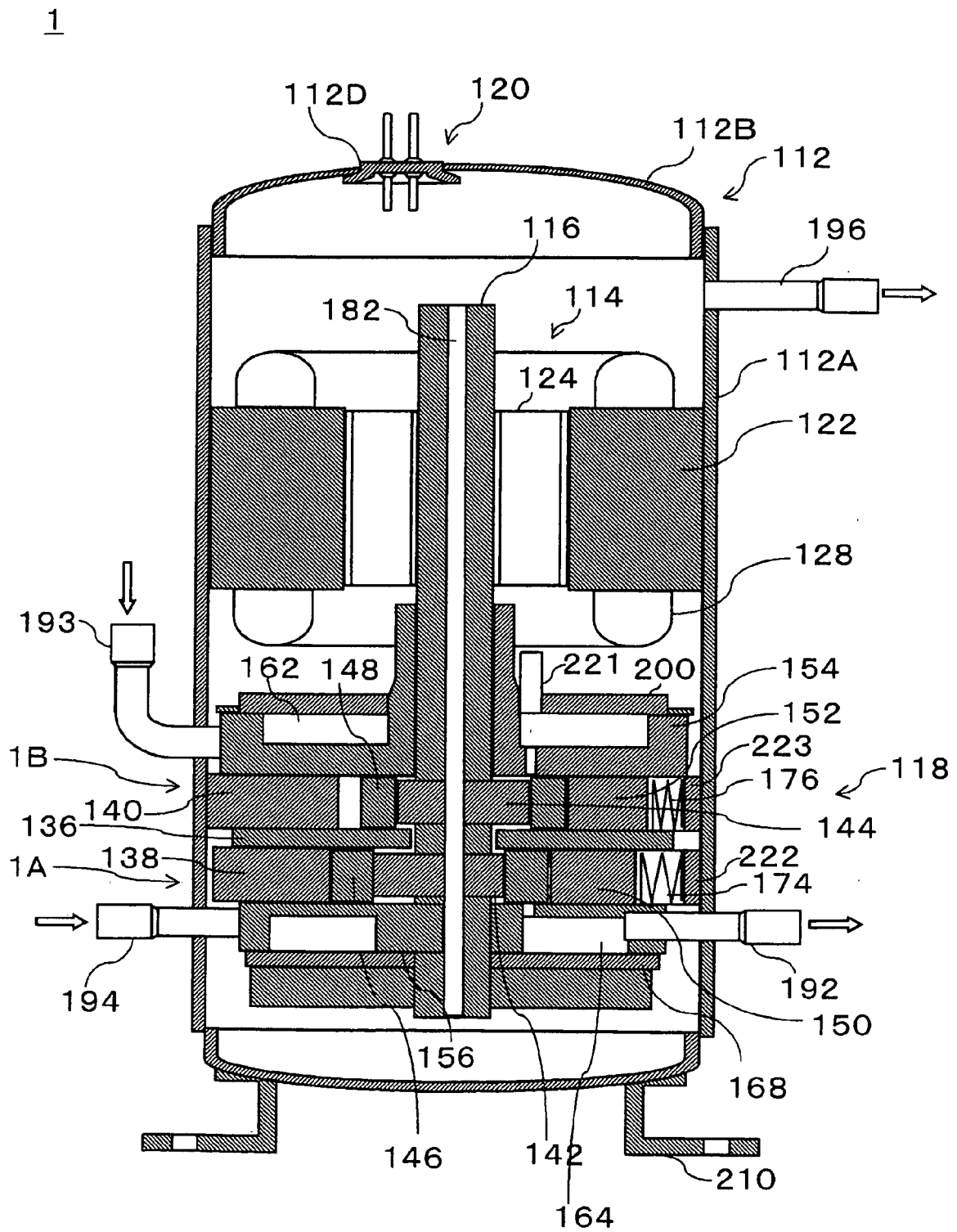


FIG. 3

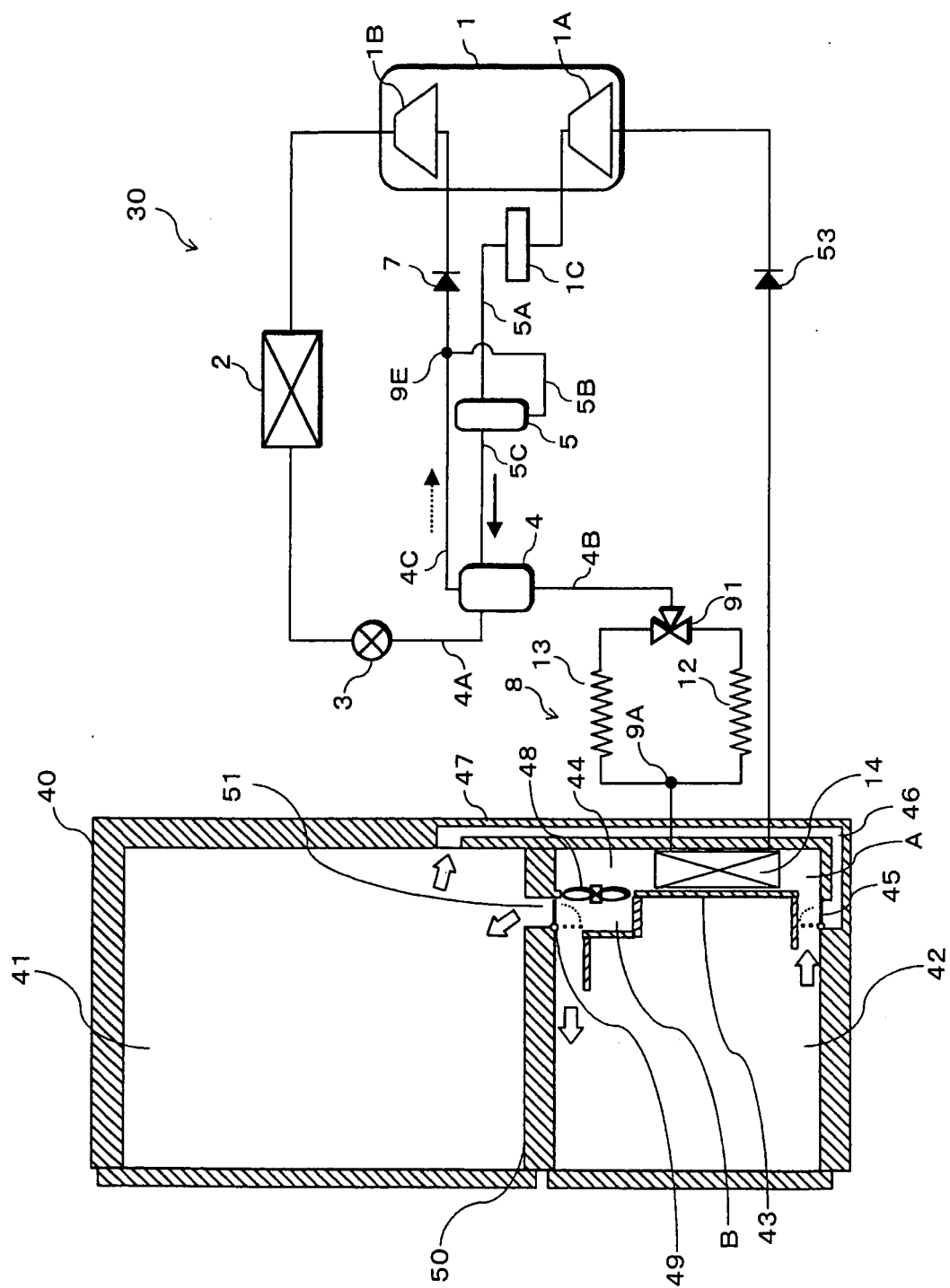


FIG. 4

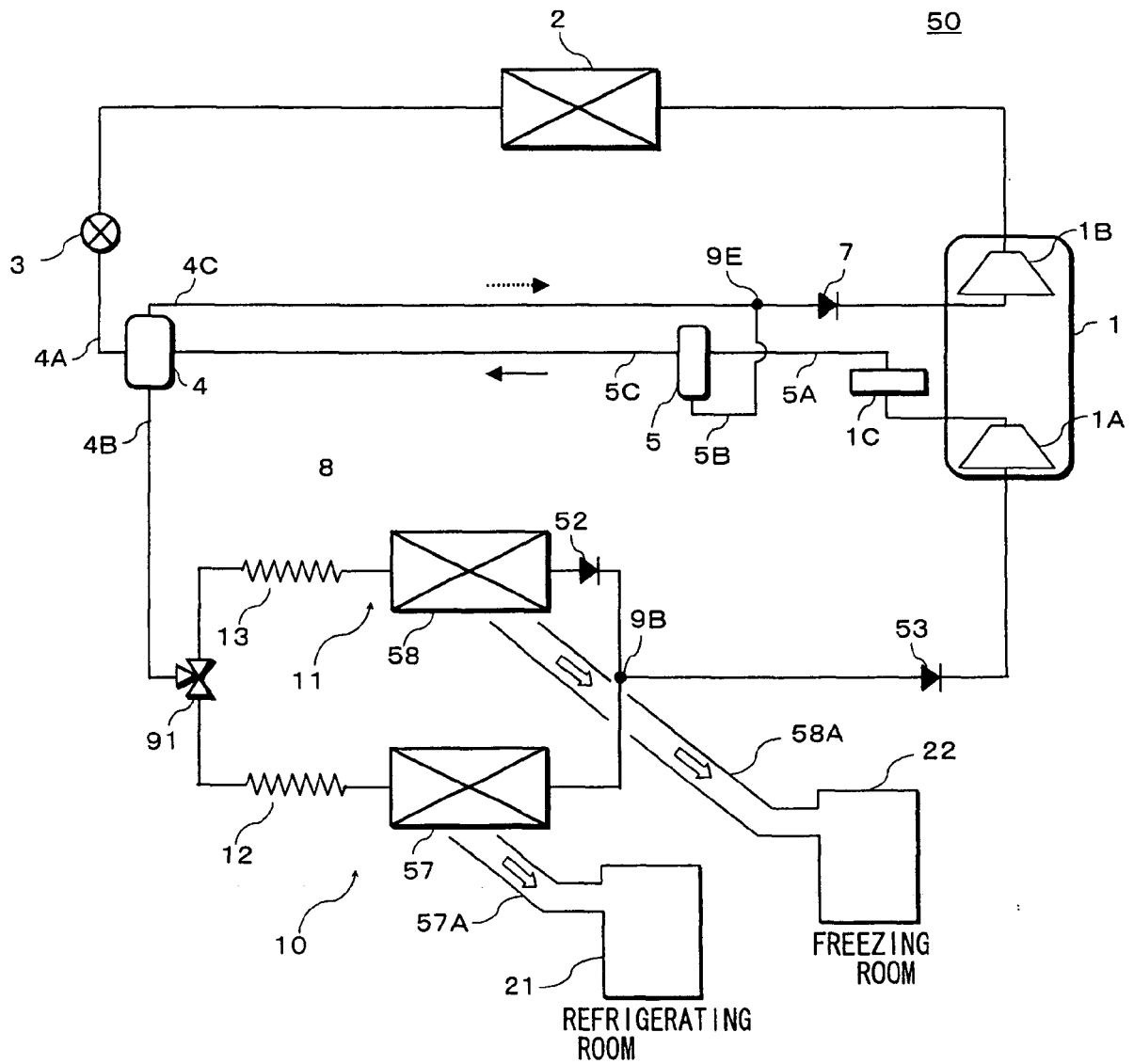


FIG. 5

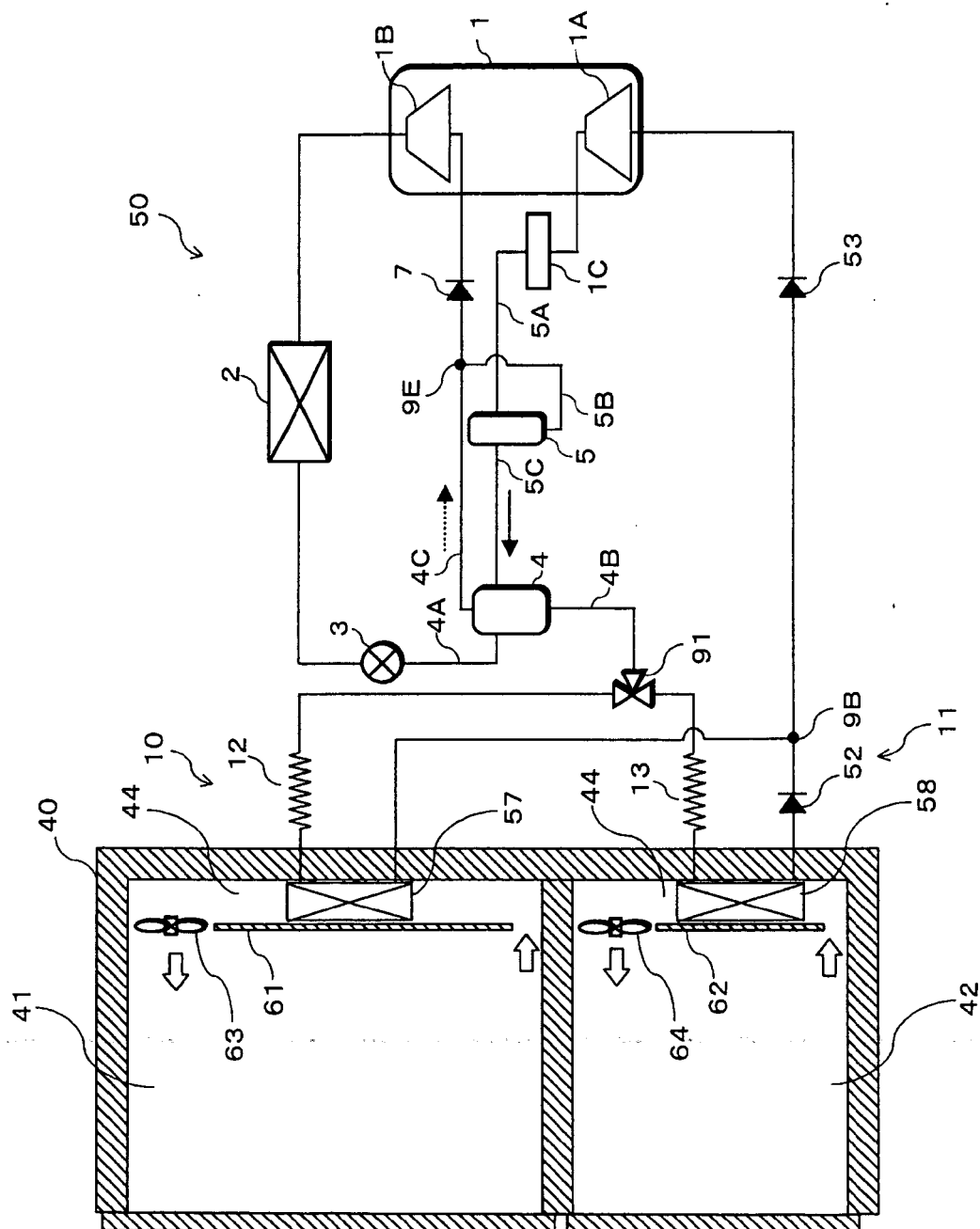
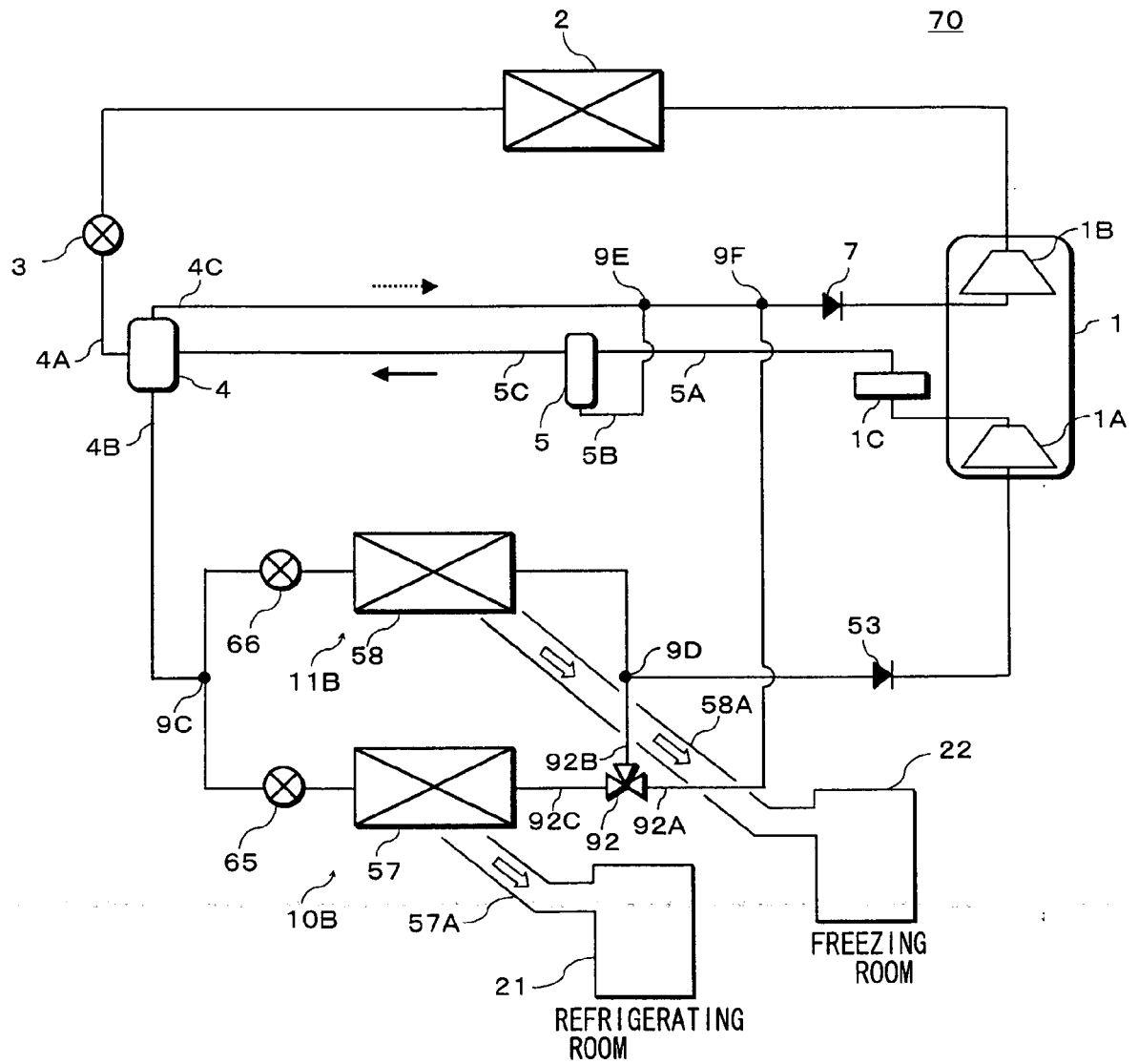


FIG. 6



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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