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(12) **United States Patent**
Iyoshi et al.

(10) **Patent No.: US 12,385,675 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) **REFRIGERATION CYCLE APPARATUS**

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(73) Assignee: **DAIKIN INDUSTRIES, LTD.**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 213 days.

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(22) Filed: **Nov. 7, 2022**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. PCT/JP2021/017705, filed on May 10, 2021.

(30) **Foreign Application Priority Data**

May 8, 2020 (JP) 2020-082787
May 8, 2020 (JP) 2020-082788
(Continued)

(51) **Int. Cl.**
F25B 13/00 (2006.01)
F25B 9/00 (2006.01)
F25B 9/10 (2006.01)

(52) **U.S. Cl.**
CPC ***F25B 13/00*** (2013.01); ***F25B 9/008*** (2013.01); ***F25B 9/10*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC .. F25B 13/00; F25B 9/008; F25B 9/10; F25B 2313/007; F25B 2313/0233; F25B 2313/02742; F25B 7/00
See application file for complete search history.

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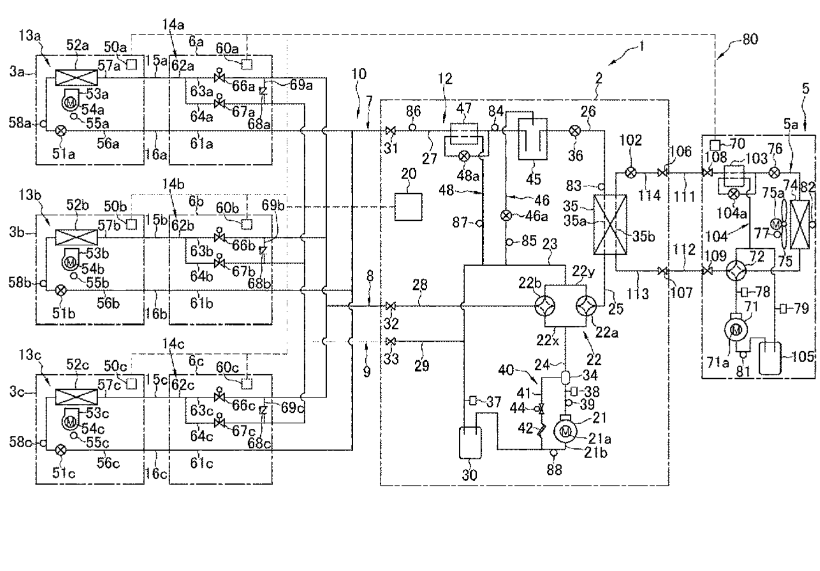
Primary Examiner — Cassey D Bauer
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A refrigeration cycle apparatus includes a primary-side refrigerant circuit in which a first refrigerant circulates and a secondary-side refrigerant circuit in which a second refrigerant circulates. The primary-side refrigerant circuit includes a primary-side compressor, a primary-side flow path of a cascade heat exchanger, a primary-side heat exchanger, and a primary-side switching mechanism. The secondary-side refrigerant circuit includes a secondary-side compressor, a secondary-side flow path of the cascade heat exchanger, a secondary-side switching mechanism, a suction flow path, a plurality of utilization-side heat exchangers, a first connection flow path, connecting the plurality of utilization-side heat exchangers and the secondary-side switching mechanism, including a secondary-side first connection pipe, a first heat source pipe, first branch pipes, junction
(Continued)



pipes, first connection pipes, and first utilization pipes, a second connection flow path, connecting the plurality of utilization-side heat exchangers and the suction flow path, including a secondary side second connection pipe, a second heat source pipe, second branch pipes, the junction pipes, the first connection pipes, and the first utilization pipes, a third connection flow path, connecting the plurality of utilization-side heat exchangers and the secondary-side flow path of the cascade heat exchanger, including a secondary-side third connection pipe, a fourth heat source pipe, a fifth heat source pipe, third branch pipes, second connection pipes, and second utilization pipes.

19 Claims, 13 Drawing Sheets

(30) **Foreign Application Priority Data**

May 8, 2020	(JP)	....	2020-082789
Dec. 1, 2020	(JP)	....	2020-199793
Dec. 1, 2020	(JP)	....	2020-199794
Dec. 1, 2020	(JP)	....	2020-199795
Dec. 1, 2020	(JP)	....	2020-199796

(52) **U.S. Cl.**
CPC . *F25B 2313/007* (2013.01); *F25B 2313/0233* (2013.01); *F25B 2313/02742* (2013.01)

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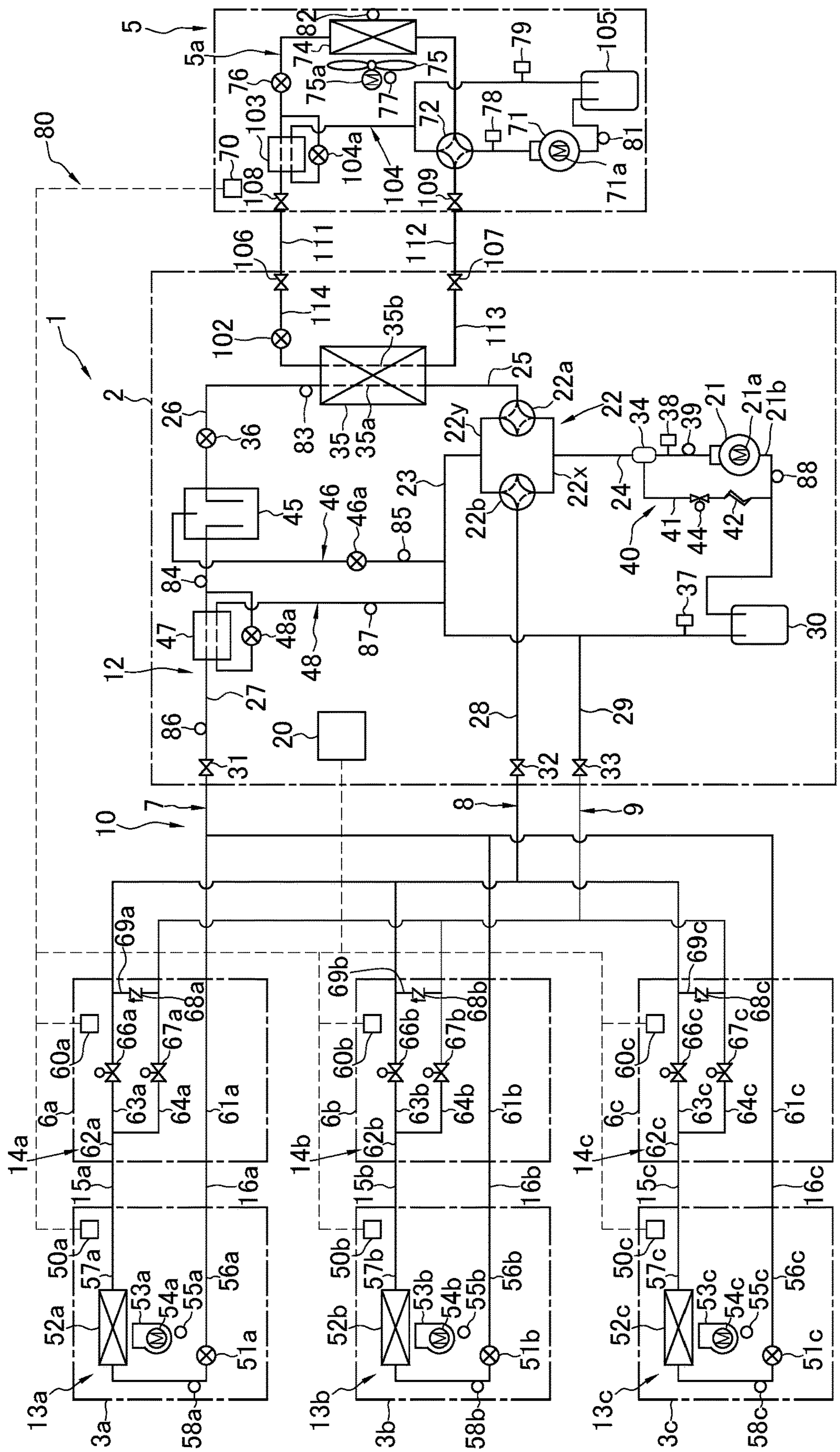
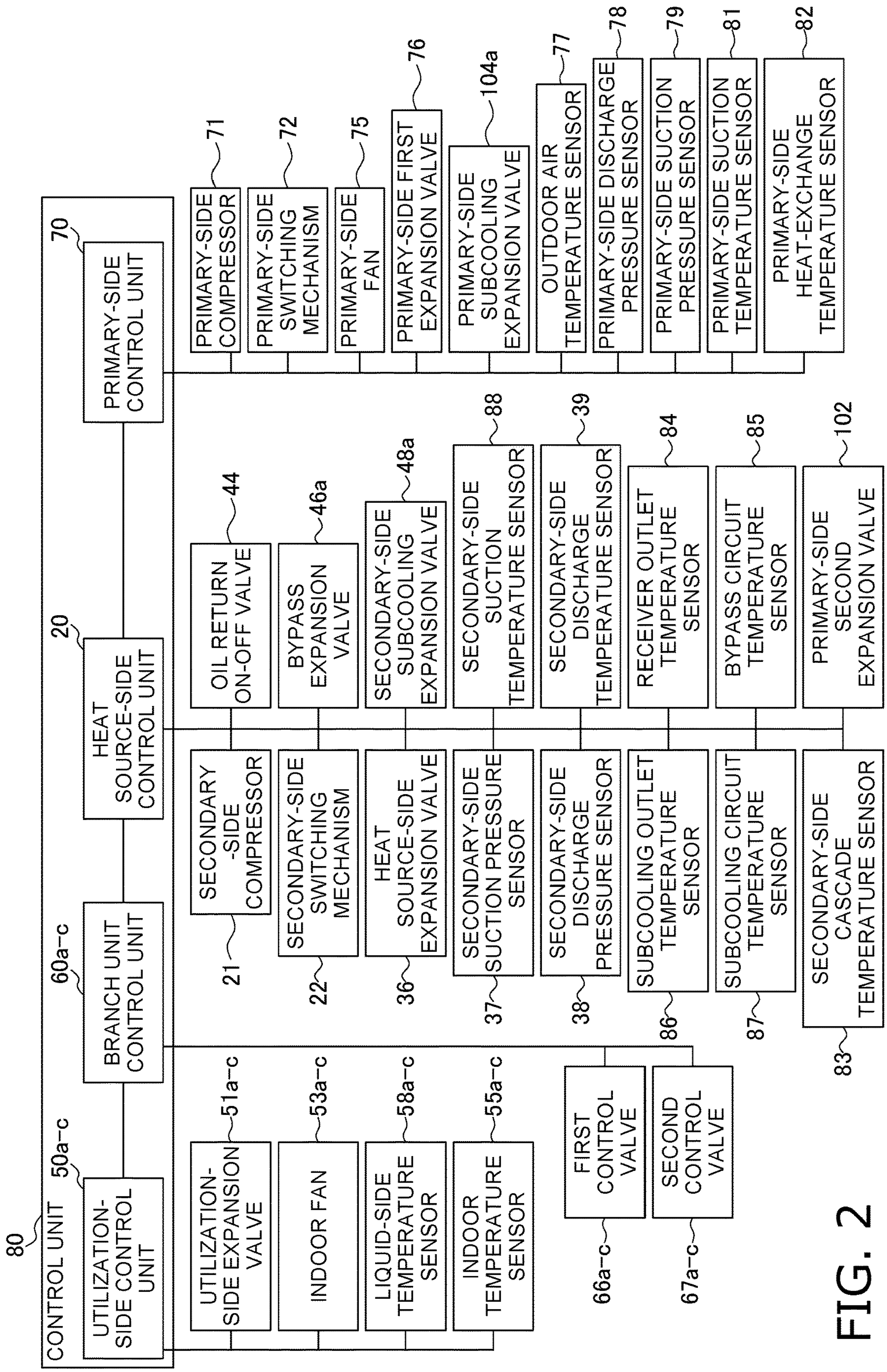


FIG. 1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SECOND CONTROL VALVE
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SECONDARY-SIDE SWITCHING MECHANISM
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HEAT SOURCE-SIDE EXPANSION VALVE
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SECONDARY-SIDE SUCTION PRESSURE SENSOR
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SECONDARY-SIDE DISCHARGE PRESSURE SENSOR
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SUBCOOLING OUTLET TEMPERATURE SENSOR
87
SUBCOOLING CIRCUIT TEMPERATURE SENSOR
83
SECONDARY-SIDE CASCADE TEMPERATURE SENSOR
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OIL RETURN ON-OFF VALVE
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BYPASS EXPANSION VALVE
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SECONDARY-SIDE SUBCOOLING EXPANSION VALVE
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SECONDARY-SIDE SUCTION TEMPERATURE SENSOR
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SECONDARY-SIDE DISCHARGE TEMPERATURE SENSOR
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RECEIVER OUTLET TEMPERATURE SENSOR
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BYPASS CIRCUIT TEMPERATURE SENSOR
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PRIMARY-SIDE COMPRESSOR
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PRIMARY-SIDE SWITCHING MECHANISM
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PRIMARY-SIDE FAN
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PRIMARY-SIDE FIRST EXPANSION VALVE
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PRIMARY-SIDE SUBCOOLING EXPANSION VALVE
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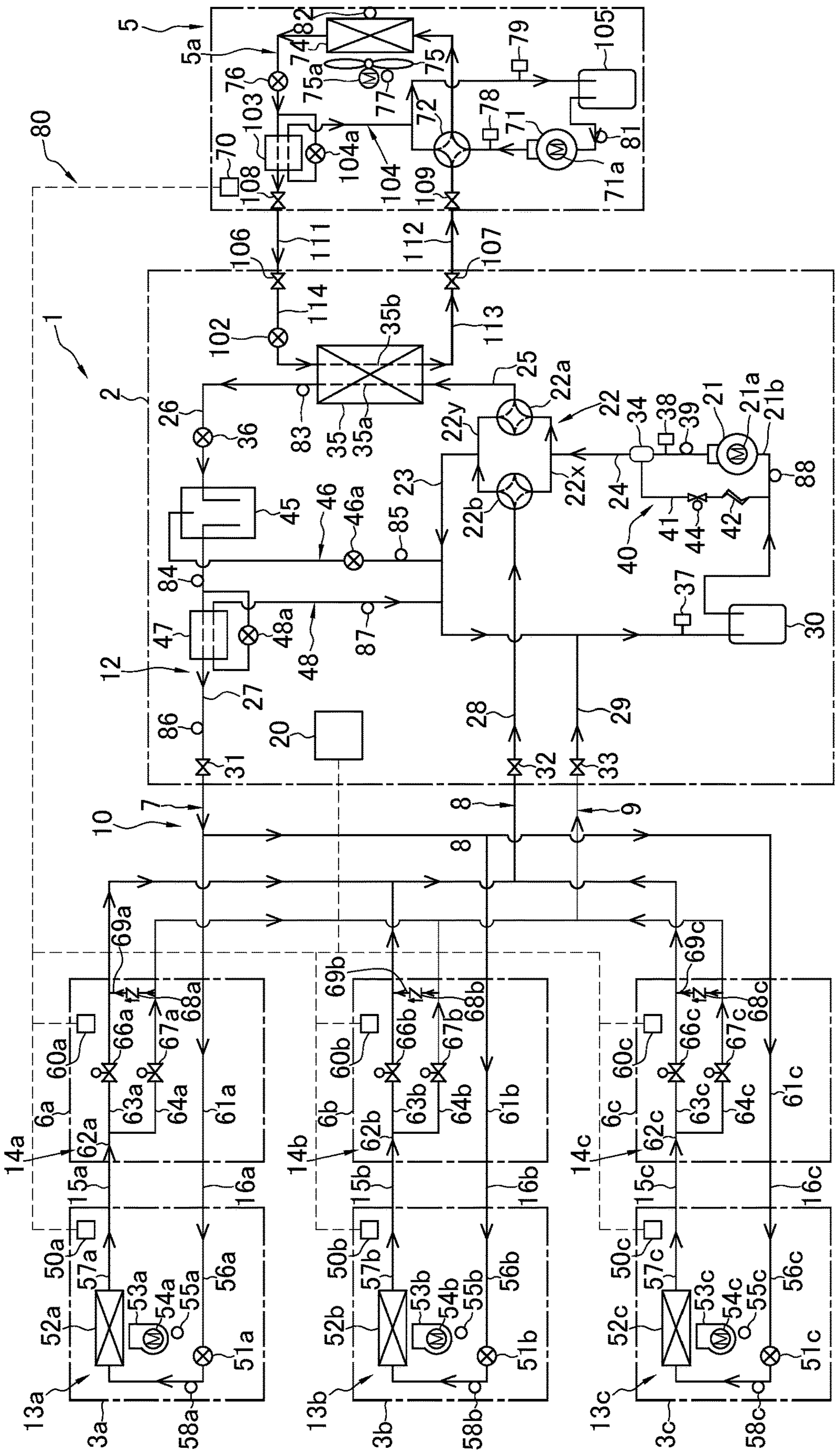
PRIMARY-SIDE HEAT-EXCHANGE TEMPERATURE SENSOR

FIG. 2



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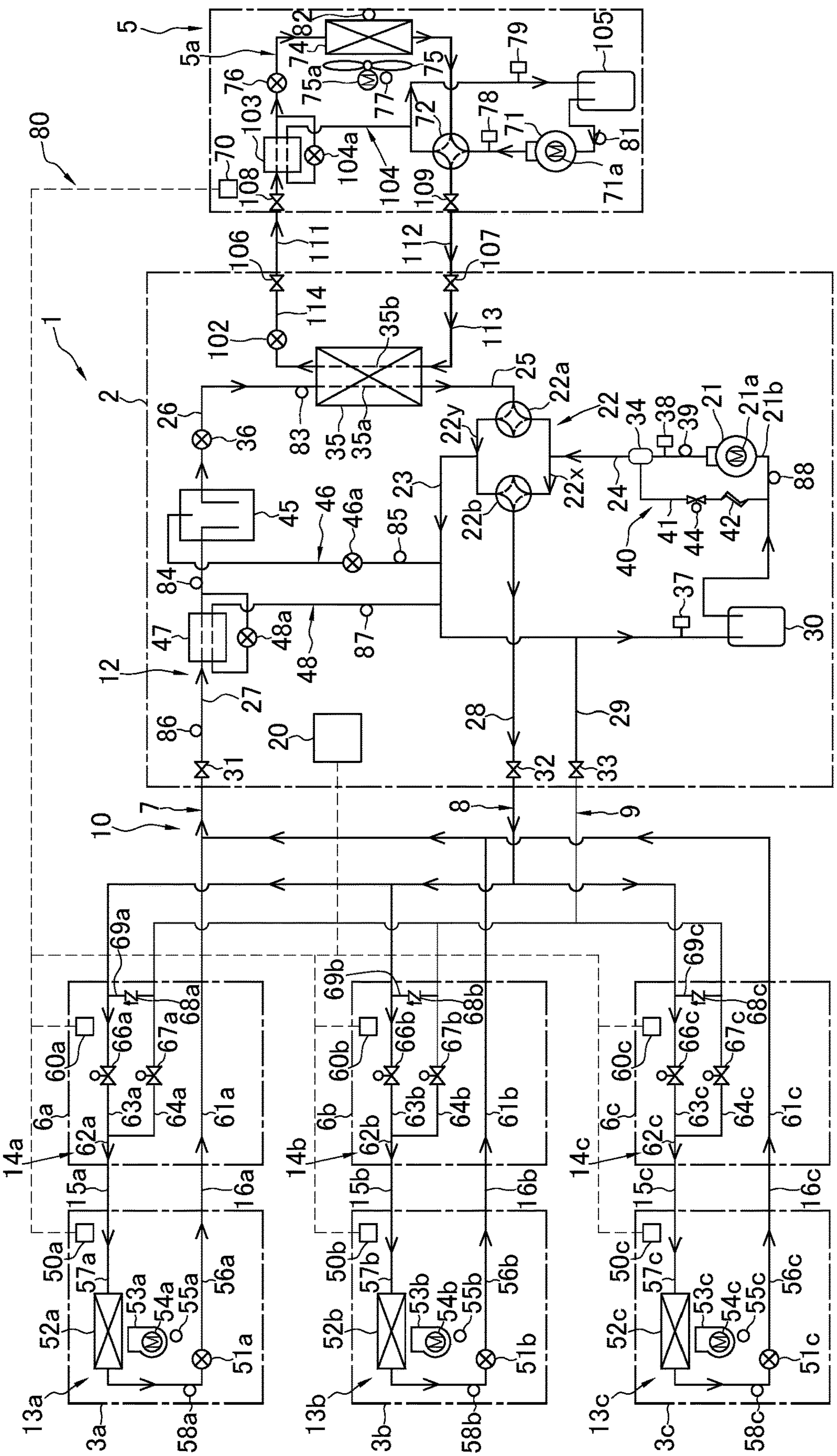

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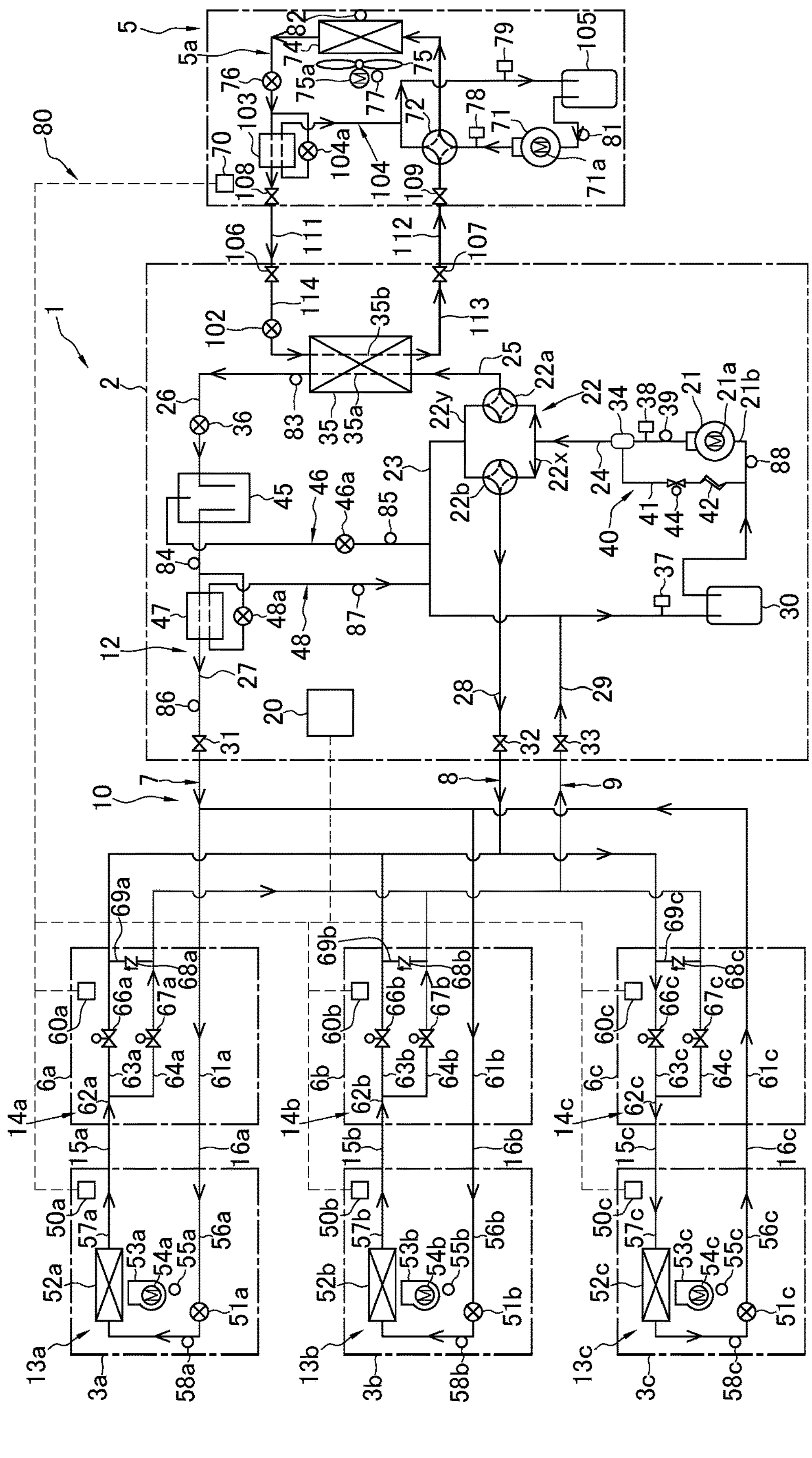

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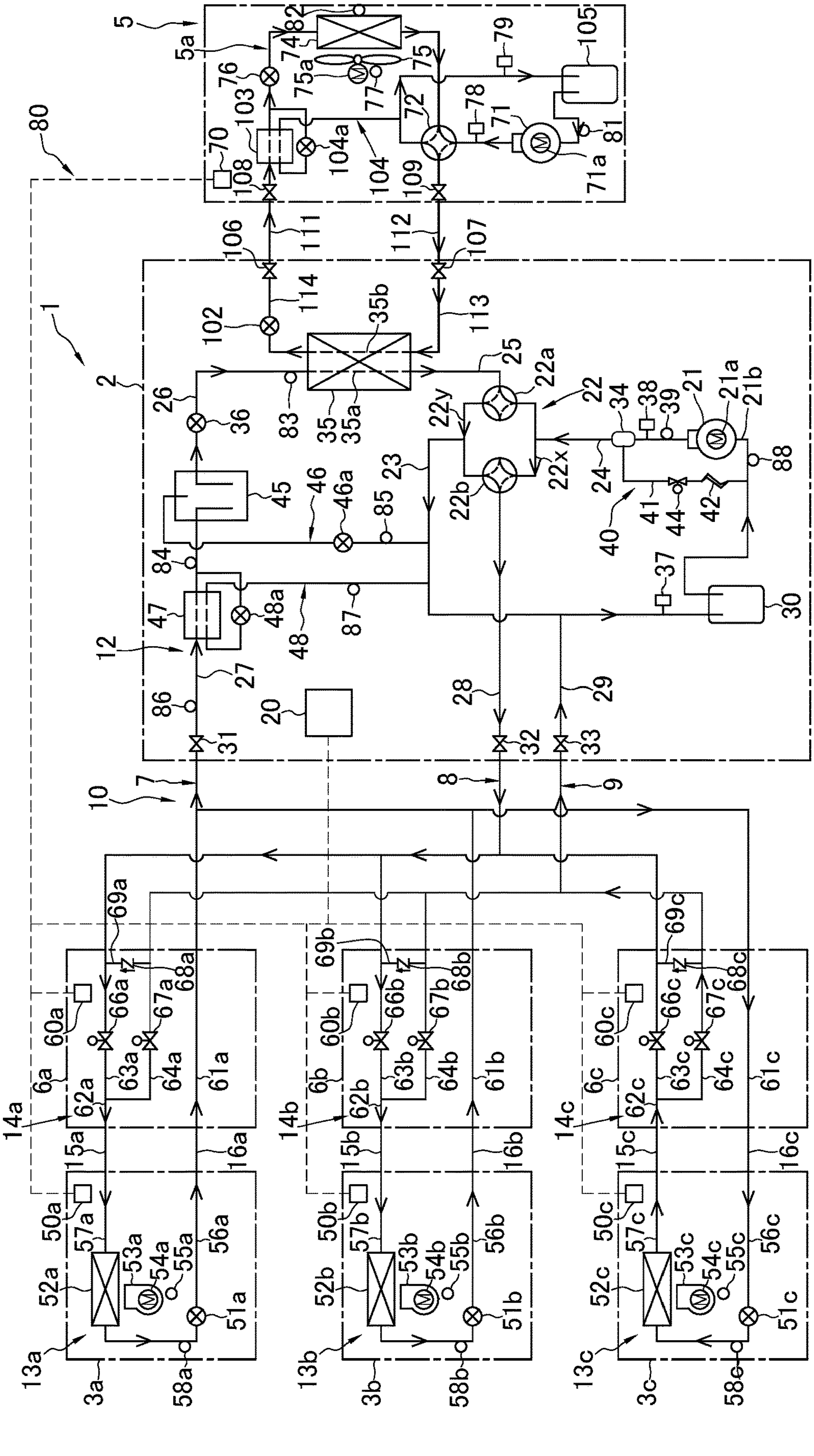
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FIG. 6

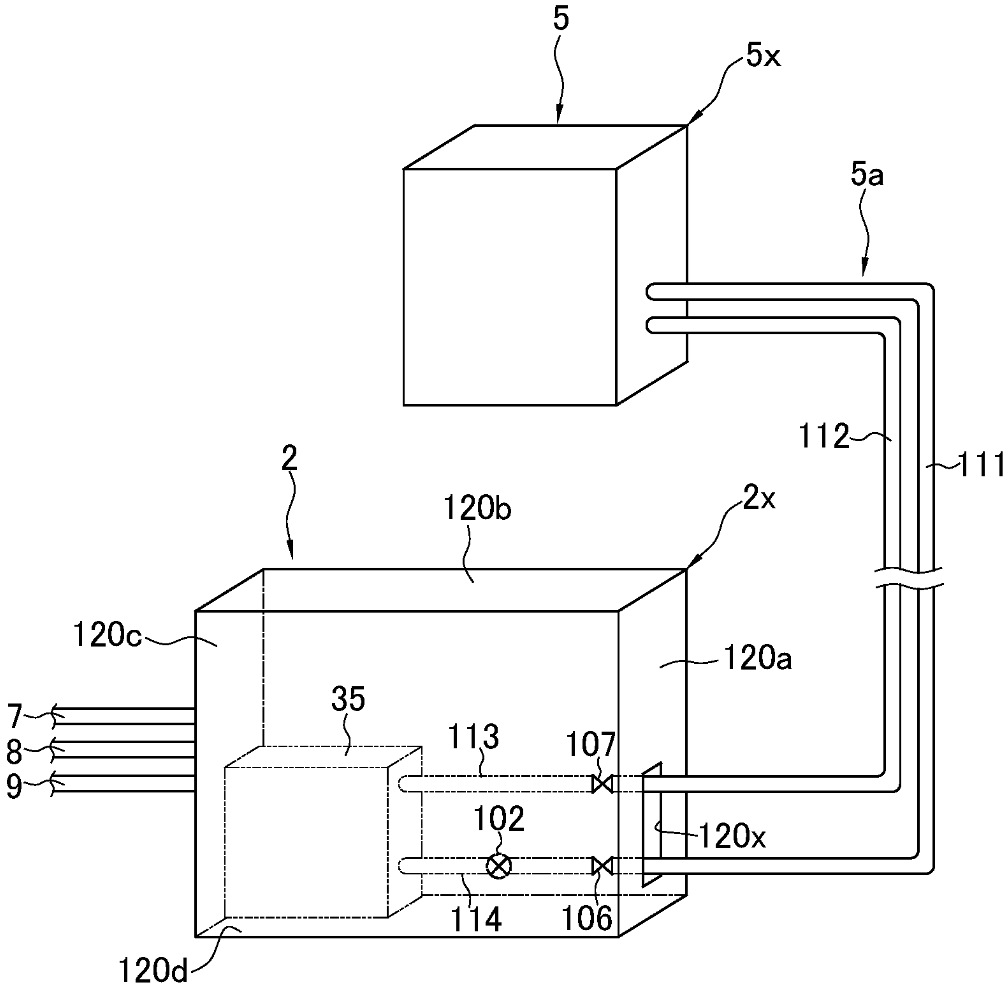
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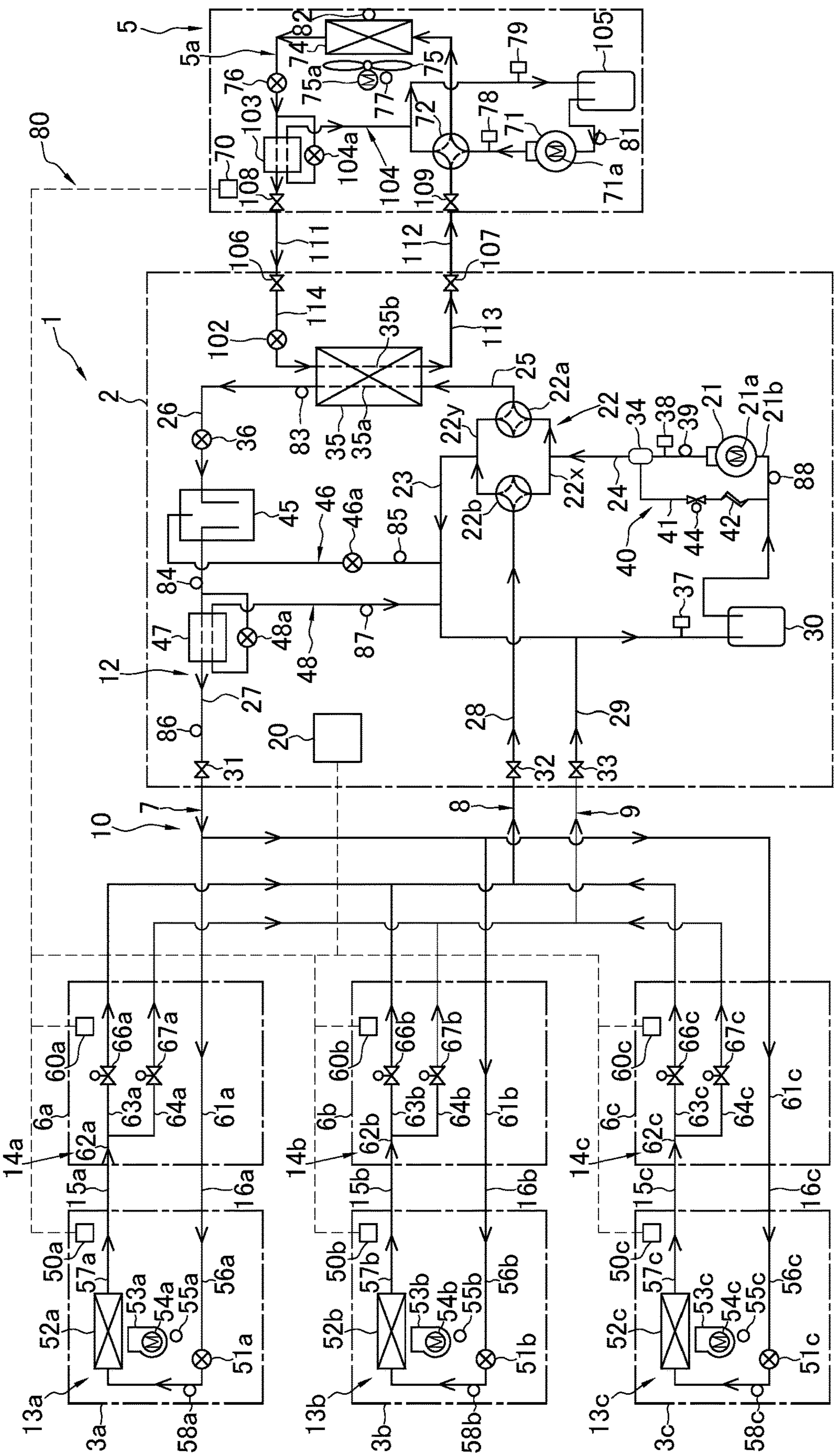
FIG. 7



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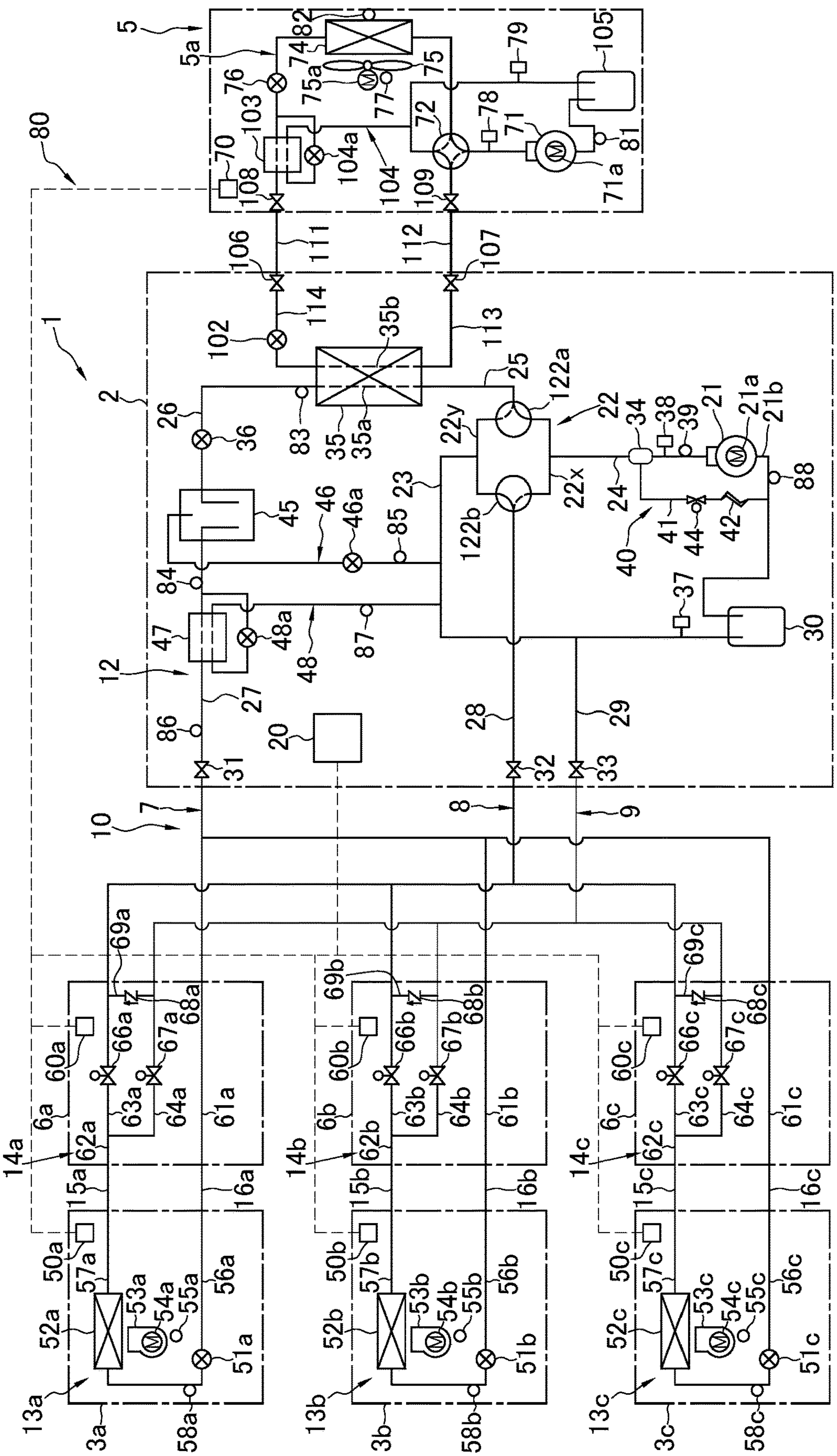

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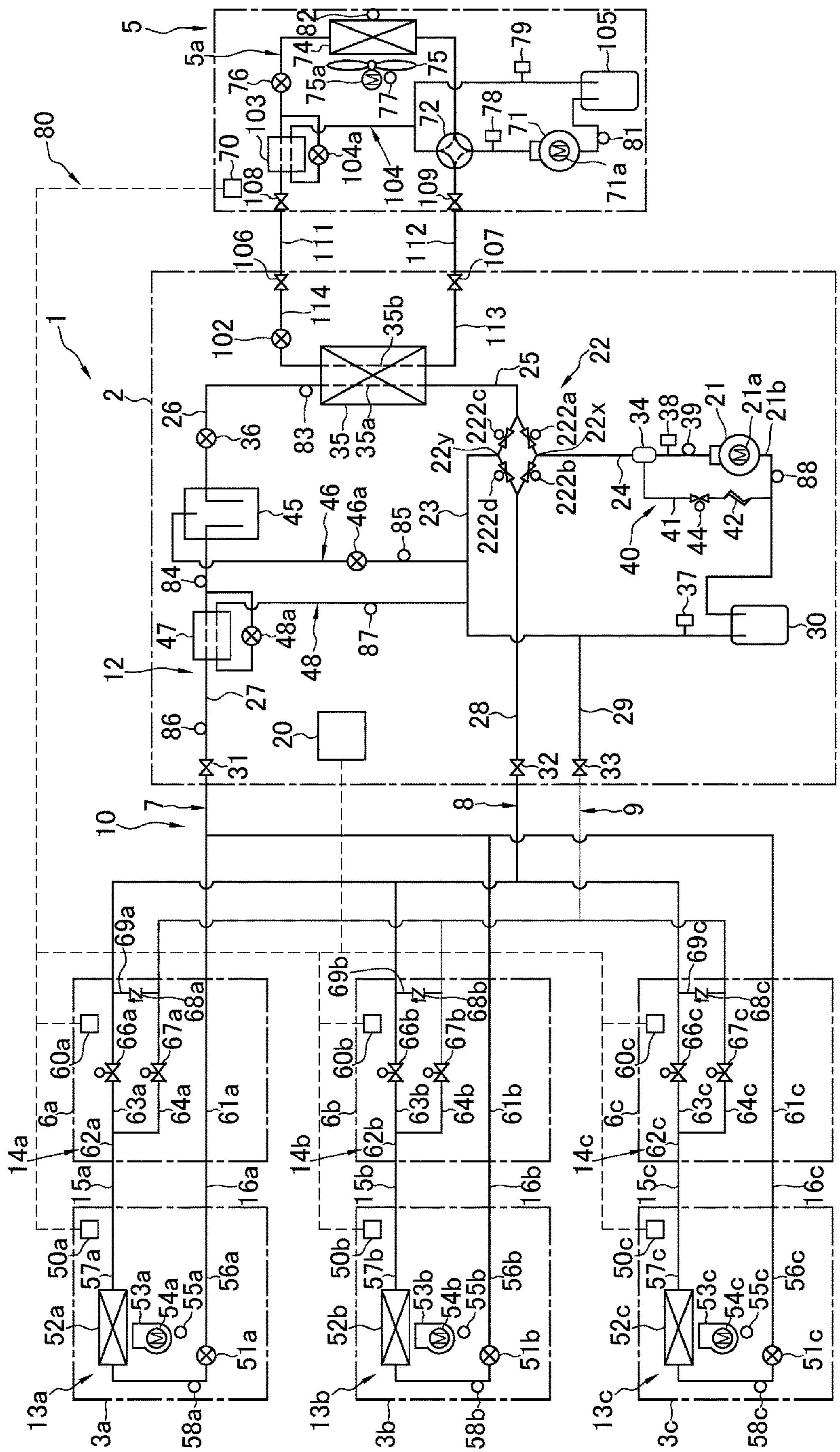
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FIG. 10

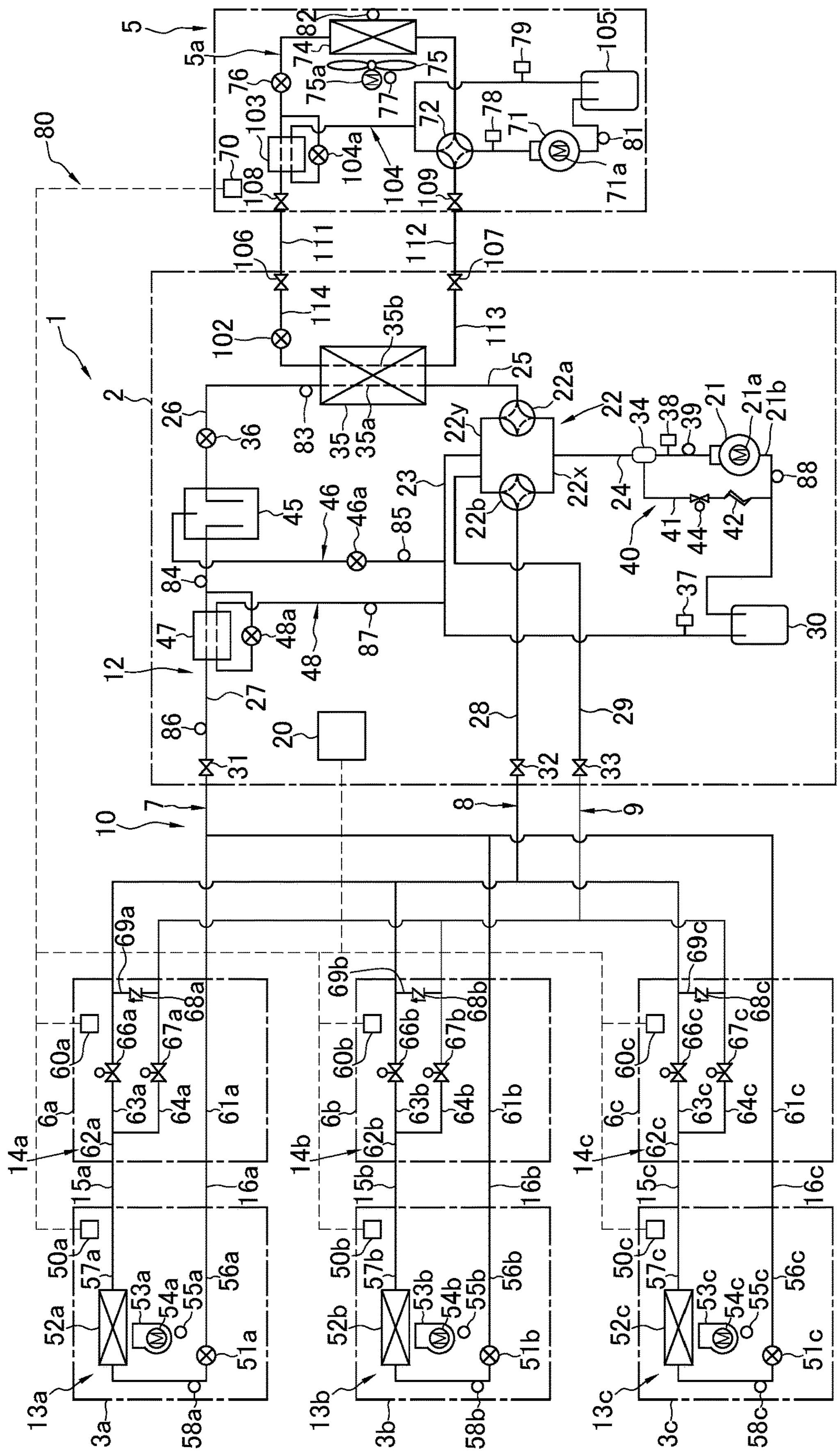
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FIG. 11

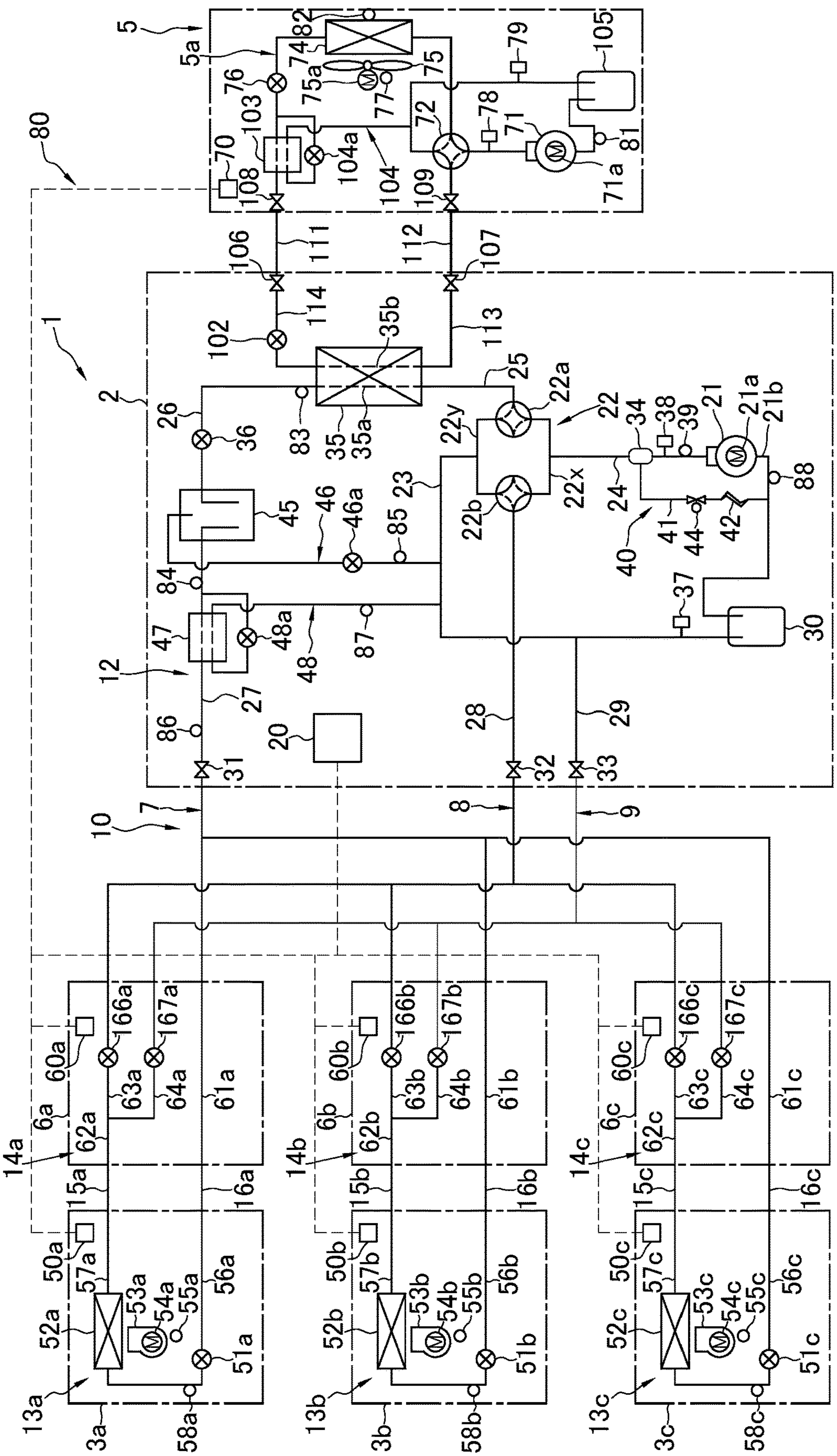

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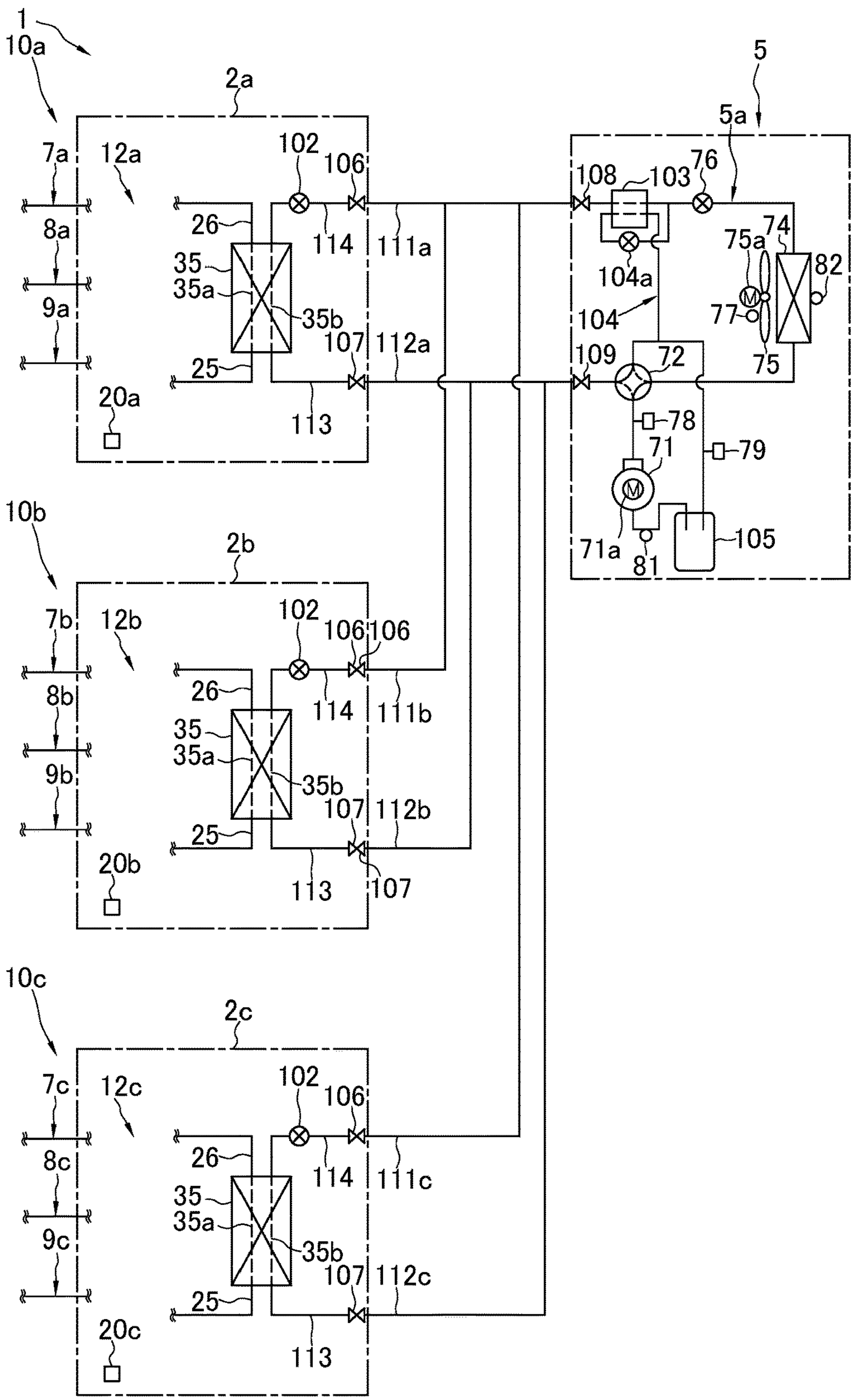
FIG. 12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12c
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20c
111c
112c

FIG. 13

REFRIGERATION CYCLE APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a Continuation of PCT International Application No. PCT/JP2021/017705, filed on May 10, 2021, which claims priority under 35 U.S.C. 119(a) to Patent Application No. 2020-082789, filed in Japan on May 8, 2020, Patent Application No. 2020-082788, filed in Japan on May 8, 2020, Patent Application No. 2020-082787, filed in Japan on May 8, 2020, Patent Application No. 2020-199795, filed in Japan on Dec. 1, 2020, Patent Application No. 2020-199796, filed in Japan on Dec. 1, 2020, Patent Application No. 2020-199793, filed in Japan on Dec. 1, 2020, and Patent Application No. 2020-199794, filed in Japan on Dec. 1, 2020, all of which are hereby expressly incorporated by reference into the present application.

TECHNICAL FIELD

The present disclosure relates to a refrigeration cycle apparatus.

BACKGROUND ART

Conventionally, as described in Patent Literature 1 (WO 2018/235832 A), there has been proposed a refrigeration cycle apparatus that includes a primary-side refrigerant circuit and a secondary-side refrigerant circuit, and is capable of performing cooling operation and heating operation in a plurality of utilization-side heat exchangers in the secondary-side refrigerant circuit.

Further, in the refrigeration cycle apparatus described in Patent Literature 1, there has been proposed a circuit configuration that enables simultaneous cooling and heating operation in which a part of the plurality of utilization-side heat exchangers performs cooling operation while another part of the plurality of utilization-side heat exchangers performs heating operation.

SUMMARY

A refrigeration cycle apparatus according to a first aspect includes a first circuit and a second circuit. The first circuit includes a first compressor, a first portion of a cascade heat exchanger, a first heat exchanger, and a first switching mechanism located between the first compressor and the first heat exchanger and switching a flow path. A first refrigerant circulates through the first circuit. The second circuit includes a second compressor, a discharge flow path extending from a discharge side of the second compressor, a suction flow path extending from a suction side of the second compressor, a second portion of the cascade heat exchanger, a second switching mechanism, a plurality of second heat exchangers, a first connection flow path, a second connection flow path, and a third connection flow path. A second refrigerant circulates through the second circuit. The first connection flow path connects the second switching mechanism and the plurality of second heat exchangers. The second connection flow path connects the plurality of second heat exchangers and the suction flow path or a portion of the second switching mechanism on a suction flow path side. The third connection flow path connects the plurality of second heat exchangers and the second portion of the cascade heat exchanger. The second switching mechanism is connected with the discharge flow path, the suction flow path, a flow path extending from the second portion of the cascade heat exchanger, and the first connection flow path, and switches a flow path.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic configuration diagram of a refrigeration cycle apparatus.

FIG. **2** is a schematic functional block configuration diagram of the refrigeration cycle apparatus.

FIG. **3** is a diagram illustrating an operation (a flow of a refrigerant) in cooling operation of the refrigeration cycle apparatus.

FIG. **4** is a diagram illustrating an operation (a flow of a refrigerant) in heating operation of the refrigeration cycle apparatus.

FIG. **5** is a diagram illustrating an operation (a flow of a refrigerant) in simultaneous cooling and heating operation (cooling main operation) of the refrigeration cycle apparatus.

FIG. **6** is a diagram illustrating an operation (a flow of a refrigerant) in simultaneous cooling and heating operation (heating main operation) of the refrigeration cycle apparatus.

FIG. **7** is a schematic view illustrating a state in which a primary-side unit and a heat source unit are connected.

FIG. **8** is a schematic configuration diagram of a refrigeration cycle apparatus according to another embodiment A.

FIG. **9** is a schematic configuration diagram of a refrigeration cycle apparatus according to another embodiment B.

FIG. **10** is a schematic configuration diagram of a refrigeration cycle apparatus according to another embodiment C.

FIG. **11** is a schematic configuration diagram of a refrigeration cycle apparatus according to another embodiment D.

FIG. **12** is a schematic configuration diagram of a refrigeration cycle apparatus according to another embodiment E.

FIG. **13** is a schematic configuration diagram of a refrigeration cycle apparatus according to another embodiment G.

DESCRIPTION OF EMBODIMENTS

(1) Configuration of Refrigeration Cycle Apparatus

FIG. **1** is a schematic configuration diagram of a refrigeration cycle apparatus **1**. FIG. **2** is a schematic functional block configuration diagram of the refrigeration cycle apparatus **1**.

The refrigeration cycle apparatus **1** is an apparatus used for cooling and heating of a room in a building or the like by performing vapor compression refrigeration cycle operation.

The refrigeration cycle apparatus **1** includes a binary refrigerant circuit including a vapor compression primary-side refrigerant circuit **5***a* (corresponding to a first circuit) and a vapor compression secondary-side refrigerant circuit **10** (corresponding to a second circuit), and performs a binary refrigeration cycle. In the primary-side refrigerant circuit **5***a*, for example, R32 or R410A (corresponding to a first refrigerant) is sealed as a refrigerant. In the secondary-side refrigerant circuit **10**, for example, carbon dioxide (corresponding to a second refrigerant) is sealed as a refrigerant. The primary-side refrigerant circuit **5***a* and the secondary-side refrigerant circuit **10** are thermally connected via a cascade heat exchanger **35** described later.

The refrigeration cycle apparatus **1** is configured by connecting a primary-side unit **5**, a heat source unit **2**, a plurality of branch units **6***a*, **6***b*, and **6***c*, and a plurality of utilization units **3***a*, **3***b*, and **3***c* to each other via pipes. The primary-side unit **5** and the heat source unit **2** are connected by a primary-side first connection pipe **111** and a primary-side second connection pipe **112**. The heat source unit **2** and the plurality of branch units **6***a*, **6***b*, and **6***c* are connected by three connection pipes of a secondary-side second connection pipe **9**, a secondary-side first connection pipe **8**, and a secondary-side third connection pipe **7**. The plurality of branch units **6***a*, **6***b*, and **6***c* and the plurality of utilization units **3***a*, **3***b*, and **3***c* are connected by first connection pipes **15***a*, **15***b*, and **15***c* and second connection pipes **16***a*, **16***b*, and **16***c*. In the present embodiment, there is one primary-side unit **5**. In the present embodiment, there is one heat source unit **2**. In the present embodiment, the plurality of utilization units **3***a*, **3***b*, and **3***c* is three utilization units of a first utilization unit **3***a*, a second utilization unit **3***b*, and a third utilization unit **3***c*. In the present embodiment, the plurality of branch units **6***a*, **6***b*, and **6***c* is three branch units of a first branch unit **6***a*, a second branch unit **6***b*, and a third branch unit **6***c*.

In the refrigeration cycle apparatus **1**, the utilization units **3***a*, **3***b*, and **3***c* can individually perform cooling operation or heating operation, and heat can be recovered between the utilization units by sending a refrigerant from the utilization unit performing the heating operation to the utilization unit performing the cooling operation. Specifically, in the present embodiment, the heat is recovered by performing cooling main operation or heating main operation in which the cooling operation and the heating operation are simultaneously performed. In addition, the refrigeration cycle apparatus **1** is configured to balance thermal loads of the heat source unit **2** in accordance with entire thermal loads of the plurality of utilization units **3***a*, **3***b*, and **3***c* also in consideration of the heat recovery (the cooling main operation or the heating main operation).

(2) Primary-Side Refrigerant Circuit

The primary-side refrigerant circuit **5***a* includes a primary-side compressor **71** (corresponding to a first compressor), a primary-side switching mechanism **72** (corresponding to a first switching mechanism), a primary-side heat exchanger **74** (corresponding to a first heat exchanger), a primary-side first expansion valve **76**, a primary-side subcooling heat exchanger **103**, a primary-side subcooling circuit **104**, a primary-side subcooling expansion valve **104***a*, a first liquid shutoff valve **108**, the primary-side first connection pipe **111**, a second liquid shutoff valve **106**, the second refrigerant pipe **114**, a primary-side second expansion valve **102**, the cascade heat exchanger **35** shared with the secondary-side refrigerant circuit **10**, a first refrigerant pipe **113**, a second gas shutoff valve **107**, the primary-side second connection pipe **112**, a first gas shutoff valve **109**, and a primary-side accumulator **105**. This primary-side refrigerant circuit **5***a* specifically includes a primary-side flow path **35***b* (corresponding to a first portion) of the cascade heat exchanger **35**.

The primary-side compressor **71** is a device for compressing a primary-side refrigerant, and includes, for example, a scroll type or other positive-displacement compressor whose operating capacity can be varied by controlling an inverter for a compressor motor **71***a*.

The primary-side accumulator **105** is provided in the middle of a suction flow path connecting the primary-side switching mechanism **72** and a suction side of the primary-side compressor **71**.

When the cascade heat exchanger **35** is caused to function as an evaporator for the primary-side refrigerant, the primary-side switching mechanism **72** is brought into a fifth connection state where the suction side of primary-side compressor **71** and a gas side of the primary-side flow path **35***b* of the cascade heat exchanger **35** are connected (see solid lines in the primary-side switching mechanism **72** in FIG. **1**). Further, when the cascade heat exchanger **35** is caused to function as a radiator for the primary-side refrigerant, the primary-side switching mechanism **72** is brought into a sixth connection state where a discharge side of the primary-side compressor **71** and the gas side of the primary-side flow path **35***b* of the cascade heat exchanger **35** are connected (see broken lines in the primary-side switching mechanism **72** in FIG. **1**). As described above, the primary-side switching mechanism **72** is a device capable of switching a refrigerant flow path in the primary-side refrigerant circuit **5***a*, and includes, for example, a four-way switching valve. By changing a switching state of the primary-side switching mechanism **72**, the cascade heat exchanger **35** can function as an evaporator or a radiator for the primary-side refrigerant.

The cascade heat exchanger **35** is a device for exchanging heat between a refrigerant such as R32 which is a primary-side refrigerant and a refrigerant such as carbon dioxide which is a secondary-side refrigerant without being mixed with each other. The cascade heat exchanger **35** is, for example, a plate-type heat exchanger. The cascade heat exchanger **35** includes a secondary-side flow path **35***a* belonging to the secondary-side refrigerant circuit **10** and the primary-side flow path **35***b* belonging to the primary-side refrigerant circuit **5***a*. The secondary-side flow path **35***a* has a gas side connected to a secondary-side switching mechanism **22** via a third heat source pipe **25** and a liquid side connected to a heat source-side expansion valve **36** via a fourth heat source pipe **26**. The primary-side flow path **35***b* has a gas side connected to the primary-side compressor **71** via the first refrigerant pipe **113**, the second gas shutoff valve **107**, the primary-side second connection pipe **112**, the first gas shutoff valve **109**, and the primary-side switching mechanism **72**, and a liquid side connected to the second refrigerant pipe **114** provided with the primary-side second expansion valve **102**.

The primary-side heat exchanger **74** is a device for exchanging heat between the primary-side refrigerant and outdoor air. A gas side of the primary-side heat exchanger **74** is connected to a pipe extending from the primary-side switching mechanism **72**. Examples of the primary-side heat exchanger **74** include a fin-and-tube heat exchanger constituted by a plurality of heat transfer tubes and a fin.

The primary-side first expansion valve **76** is provided in a liquid pipe extending from a liquid side of the primary-side heat exchanger **74** to the primary-side subcooling heat exchanger **103**. The primary-side first expansion valve **76** is an electric expansion valve capable of adjusting an opening degree for adjusting a flow rate of the primary-side refrigerant flowing through a liquid side portion of the primary-side refrigerant circuit **5***a* and the like.

The primary-side subcooling circuit **104** branches from between the primary-side first expansion valve **76** and the primary-side subcooling heat exchanger **103**, and is connected to a portion of the suction flow path between the primary-side switching mechanism **72** and the primary-side accumulator **105**. The primary-side subcooling expansion valve **104***a* is provided on an upstream side of the primary-side subcooling heat exchanger **103** in the primary-side subcooling circuit **104**, and is an electric expansion valve capable of adjusting an opening degree for adjusting a flow rate of the primary-side refrigerant and the like.

The primary-side subcooling heat exchanger **103** is a heat exchanger that exchanges heat between the refrigerant flowing from the primary-side first expansion valve **76** toward the first liquid shutoff valve **108** and the refrigerant decompressed by the primary-side subcooling expansion valve **104***a* in the primary-side subcooling circuit **104**.

The primary-side first connection pipe **111** is a pipe that connects the first liquid shutoff valve **108** and the second liquid shutoff valve **106**, and connects the primary-side unit **5** and the heat source unit **2**.

The primary-side second connection pipe **112** is a pipe that connects the first gas shutoff valve **109** and the second gas shutoff valve **107**, and connects the primary-side unit **5** and the heat source unit **2**.

The second refrigerant pipe **114** is a pipe extending from the liquid side of the primary-side flow path **35***b* of the cascade heat exchanger **35** to the second liquid shutoff valve **106**.

The primary-side second expansion valve **102** is provided in the second refrigerant pipe **114**. The primary-side second expansion valve **102** is an electric expansion valve capable of adjusting an opening degree for adjusting a flow rate of the primary-side refrigerant flowing through the primary-side flow path **35***b* of the cascade heat exchanger **35** and the like.

The first refrigerant pipe **113** is a pipe extending from the gas side of the primary-side flow path **35***b* of the cascade heat exchanger **35** to the second gas shutoff valve **107**.

The first gas shutoff valve **109** is provided between the primary-side second connection pipe **112** and the primary-side switching mechanism **72**.

(3) Secondary-Side Refrigerant Circuit

The secondary-side refrigerant circuit **10** is configured by connecting the plurality of utilization units **3***a*, **3***b*, and **3***c*, the plurality of branch units **6***a*, **6***b*, and **6***c*, and the heat source unit **2** to each other. The utilization units **3***a*, **3***b*, and **3***c* are connected one-to-one with the corresponding branch units **6***a*, **6***b*, and **6***c*. Specifically, the utilization unit **3***a* and the branch unit **6***a* are connected via the first connection pipe **15***a* and the second connection pipe **16***a*, the utilization unit **3***b* and the branch unit **6***b* are connected via the first connection pipe **15***b* and the second connection pipe **16***b*, and the utilization unit **3***c* and the branch unit **6***c* are connected via the first connection pipe **15***c* and the second connection pipe **16***c*. Further, each of the branch units **6***a*, **6***b*, and **6***c* is connected to the heat source unit **2** via the secondary-side third connection pipe **7**, the secondary-side first connection pipe **8**, and the secondary-side second connection pipe **9**, which are three connection pipes. Specifically, each of the secondary-side third connection pipe **7**, the secondary-side first connection pipe **8**, and the secondary-side second connection pipe **9** extending from the heat source unit **2** branches into a plurality of pipes and is connected to each of the branch units **6***a*, **6***b*, and **6***c*.

Either a refrigerant in a gas-liquid two-phase state or a refrigerant in a gas state flows through the secondary-side first connection pipe **8** in accordance with an operating state. Note that depending on a type of the second refrigerant, a refrigerant in a supercritical state flows through the secondary-side first connection pipe **8** according to the operating state. Either the refrigerant in the gas-liquid two-phase state or the refrigerant in the gas state flows through the secondary-side second connection pipe **9** in accordance with the operating state. Either the refrigerant in the gas-liquid two-phase state or a refrigerant in a liquid state flows through the secondary-side third connection pipe **7** according to the operating state. Note that depending on the type of the second refrigerant, the refrigerant in the supercritical state flows in the secondary-side third connection pipe **7** according to the operating state.

The secondary-side refrigerant circuit **10** includes a heat source circuit **12**, branch circuits **14***a*, **14***b*, and **14***c*, and utilization circuits **13***a*, **13***b*, and **13***c* connected to each other.

The heat source circuit **12** mainly includes a secondary-side compressor **21** (corresponding to a second compressor), the secondary-side switching mechanism **22** (corresponding to a second switching mechanism), a first heat source pipe **28**, a second heat source pipe **29**, a suction flow path **23**, a discharge flow path **24**, the third heat source pipe **25**, the fourth heat source pipe **26**, a fifth heat source pipe **27**, the cascade heat exchanger **35**, the heat source-side expansion valve **36**, a third shutoff valve **31**, a first shutoff valve **32**, a second shutoff valve **33**, a secondary-side accumulator **30**, an oil separator **34**, an oil return circuit **40**, a secondary-side receiver **45**, a bypass circuit **46**, a bypass expansion valve **46***a*, a secondary-side subcooling heat exchanger **47**, a secondary-side subcooling circuit **48**, and a secondary-side subcooling expansion valve **48***a*. The heat source circuit **12** of the secondary-side refrigerant circuit **10** specifically includes the secondary-side flow path **35***a* (corresponding to a second portion) of the cascade heat exchanger **35**.

The secondary-side compressor **21** is a device for compressing a secondary-side refrigerant, and includes, for example, a scroll type or other positive displacement compressor whose operating capacity can be varied by controlling an inverter for a compressor motor **21***a*. Note that the secondary-side compressor **21** is controlled such that the operating capacity increases as a load increases according to the load during operation.

The secondary-side switching mechanism **22** is a mechanism capable of switching a connection state of the secondary-side refrigerant circuit **10**, particularly, a refrigerant flow path in the heat source circuit **12**. In the present embodiment, the secondary-side switching mechanism **22** includes a discharge-side connection portion **22***x*, a suction-side connection portion **22***y* (corresponding to a portion on the suction flow path side), a first switching valve **22***a* (corresponding to a four-way switching valve), and a second switching valve **22***b* (corresponding to a four-way switching valve). An end of the discharge flow path **24** on a side opposite to the secondary-side compressor **21** side is connected to the discharge-side connection portion **22***x*. An end of the suction flow path **23** on a side opposite to the secondary-side compressor **21** side is connected to the suction-side connection portion **22***y*. The first switching valve **22***a* and the second switching valve **22***b* are provided in parallel to each other between the discharge flow path **24** and the suction flow path **23** of the secondary-side compressor **21**. The first switching valve **22***a* is connected to one end of the discharge-side connection portion **22***x* and one end of the suction-side connection portion **22***y*. The second switching valve **22***b* is connected to another end of the discharge-side connection portion **22***x* and another end of the suction-side connection portion **22***y*. In the present embodiment, each of the first switching valve **22***a* and the second switching valve **22***b* includes the four-way switching valve. Each of the first switching valve **22***a* and the second switching valve **22***b* has four connection ports of a first connection port, a second connection port, a third connection port, and a fourth connection port. In the first switching valve **22***a* and the second switching valve **22***b* of the present embodiment, each of the fourth ports is closed and is a connection port not connected to the flow path of the secondary-side refrigerant circuit **10**. In the first switching valve **22***a*, the first connection port is connected to the one end of the discharge-side connection portion **22***x*, the second connection port is connected to the third heat source pipe **25** extending from the secondary-side flow path **35***a* of the cascade heat exchanger **35**, and the third connection port is connected to the one end of the suction-side connection portion **22***y*. The first switching valve **22***a* switches between a switching state in which the first connection port and the second connection port are connected and the third connection port and the fourth connection port are connected and a switching state in which the third connection port and the second connection port are connected and the first connection port and the fourth connection port are connected. The second switching valve **22***b* has the first connection port connected to the other end of the discharge-side connection portion **22***x*, the second connection port connected to the first heat source pipe **28**, and the third connection port connected to the other end of the suction-side connection portion **22***y*. The second switching valve **22***b* switches between a switching state in which the first connection port and the second connection port are connected and the third connection port and the fourth connection port are connected and a switching state in which the third connection port and the second connection port are connected and the first connection port and the fourth connection port are connected.

When sending of the secondary-side refrigerant discharged from the secondary-side compressor **21** to the secondary-side first connection pipe **8** is suppressed while the cascade heat exchanger **35** is caused to function as a radiator for the secondary-side refrigerant, the secondary-side switching mechanism **22** is switched to a first connection state in which the discharge flow path **24** and the third heat source pipe **25** are connected by the first switching valve **22***a* and the first heat source pipe **28** and the suction flow path **23** are connected by the second switching valve **22***b*. The first connection state of the secondary-side switching mechanism **22** is a connection state adopted during the cooling operation described later. Further, when the cascade heat exchanger **35** functions as an evaporator for the secondary-side refrigerant, the secondary-side switching mechanism **22** is switched to a second connection state in which the discharge flow path **24** and the first heat source pipe **28** are connected by the second switching valve **22***b* and the third heat source pipe **25** and the suction flow path **23** are connected by the first switching valve **22***a*. The second connection state of the secondary-side switching mechanism **22** is a connection state adopted during the heating operation and during the heating main operation described later. Further, when the secondary-side refrigerant discharged from the secondary-side compressor **21** is sent to the secondary-side first connection pipe **8** while the cascade heat exchanger **35** is caused to function as a radiator for the secondary-side refrigerant, the secondary-side switching mechanism **22** is switched to a third connection state in which the discharge flow path **24** and the third heat source pipe **25** are connected by the first switching valve **22***a* and the discharge flow path **24** and the first heat source pipe **28** are connected by the second switching valve **22***b*. The third connection state of the secondary-side switching mechanism **22** is a connection state adopted during the cooling main operation described later.

As described above, the cascade heat exchanger **35** is a device for exchanging heat between the refrigerant such as R32 which is the primary-side refrigerant and the refrigerant such as carbon dioxide which is the secondary-side refrigerant without being mixed with each other. Note that the cascade heat exchanger **35** includes the secondary-side flow path **35***a* through which the secondary-side refrigerant of the secondary-side refrigerant circuit **10** flows and the primary-side flow path **35***b* through which the primary-side refrigerant of the primary-side refrigerant circuit **5***a* flows, and thus is shared by the primary-side unit **5** and the heat source unit **2**. Note that in the present embodiment, as shown in FIG. **7**, the cascade heat exchanger **35** is disposed inside a heat source casing **2***x* of the heat source unit **2**. The gas side of the primary-side flow path **35***b* of the cascade heat exchanger **35** extends to the primary-side second connection pipe **112** outside the heat source casing **2***x* via the first refrigerant pipe **113** and the second gas shutoff valve **107**. The liquid side of the primary-side flow path **35***b* of the cascade heat exchanger **35** extends to the primary-side first connection pipe **111** outside the heat source casing **2***x* via the second refrigerant pipe **114** provided with the primary-side second expansion valve **102** and the second liquid shutoff valve **106**.

The heat source-side expansion valve **36** is an electric expansion valve connected to the liquid side of the cascade heat exchanger **35** and capable of adjusting an opening degree for adjusting a flow rate of the secondary-side refrigerant flowing through the cascade heat exchanger **35** and the like. The heat source-side expansion valve **36** is provided in the fourth heat source pipe **26**.

The third shutoff valve **31**, the first shutoff valve **32**, and the second shutoff valve **33** are valves provided at connecting ports with external devices and pipes (specifically, the connection pipes **7**, **8**, and **9**). Specifically, the third shutoff valve **31** is connected to the secondary-side third connection pipe **7** drawn out from the heat source unit **2**. The first shutoff valve **32** is connected to the secondary-side first connection pipe **8** drawn out from the heat source unit **2**. The second shutoff valve **33** is connected to the secondary-side second connection pipe **9** drawn out from the heat source unit **2**.

The first heat source pipe **28** is a refrigerant pipe that connects the first shutoff valve **32** and the secondary-side switching mechanism **22**. Specifically, the first heat source pipe **28** connects the first shutoff valve **32** and the second connection port of the second switching valve **22***b* of the secondary-side switching mechanism **22**.

The suction flow path **23** is a flow path that connects the secondary-side switching mechanism **22** and a suction side of the secondary-side compressor **21**. Specifically, the suction flow path **23** connects the suction-side connection portion **22***y* of the secondary-side switching mechanism **22** and the suction side of the secondary-side compressor **21**. The secondary-side accumulator **30** is provided in the middle of the suction flow path **23**.

The second heat source pipe **29** is a refrigerant pipe connecting the second shutoff valve **33** and the middle of the suction flow path **23**. Note that, in the present embodiment, the second heat source pipe **29** is connected to the suction flow path **23** at a connection point of the suction flow path **23** between the suction-side connection portion **22***y* of the secondary-side switching mechanism **22** and the secondary-side accumulator **30**.

The discharge flow path **24** is a refrigerant pipe that connects a discharge side of the secondary-side compressor **21** and the secondary-side switching mechanism **22**. Specifically, the discharge flow path **24** connects the discharge side of the secondary-side compressor **21** and the discharge-side connection portion **22***x* of the secondary-side switching mechanism **22**.

The third heat source pipe **25** is a refrigerant pipe that connects the secondary-side switching mechanism **22** and the gas side of the cascade heat exchanger **35**. Specifically, the third heat source pipe **25** connects the second connection port of the first switching valve **22***a* of the secondary-side switching mechanism **22** and a gas-side end of the secondary-side flow path **35***a* in the cascade heat exchanger **35**.

The fourth heat source pipe **26** is a refrigerant pipe that connects the liquid side (the side opposite to the gas side, the side opposite to the side on which the secondary-side switching mechanism **22** is provided) of the cascade heat exchanger **35** and the secondary-side receiver **45**. Specifically, the fourth heat source pipe **26** connects a liquid-side end (an end on a side opposite to the gas side) of the secondary-side flow path **35***a* in the cascade heat exchanger **35** and the secondary-side receiver **45**.

The secondary-side receiver **45** is a refrigerant container that stores a surplus refrigerant in the secondary-side refrigerant circuit **10**. The fourth heat source pipe **26**, the fifth heat source pipe **27**, and the bypass circuit **46** extend from the secondary-side receiver **45**.

The bypass circuit **46** is a refrigerant pipe that connects a gas phase region, which is an upper region inside the secondary-side receiver **45**, and the suction flow path **23**. Specifically, the bypass circuit **46** is connected between the secondary-side switching mechanism **22** and the secondary-side accumulator **30** in the suction flow path **23**. The bypass circuit **46** is provided with the bypass expansion valve **46***a*. The bypass expansion valve **46***a* is an electric expansion valve capable of adjusting an amount of a refrigerant guided from the inside of the secondary-side receiver **45** to the suction side of the secondary-side compressor **21** by adjusting an opening degree.

The fifth heat source pipe **27** is a refrigerant pipe connecting the secondary-side receiver **45** and the third shutoff valve **31**.

The secondary-side subcooling circuit **48** is a refrigerant pipe that connects a part of the fifth heat source pipe **27** and the suction flow path **23**. Specifically, the secondary-side subcooling circuit **48** is connected between the secondary-side switching mechanism **22** and the secondary-side accumulator **30** in the suction flow path **23**. Note that, in the present embodiment, the secondary-side subcooling circuit **48** extends so as to branch from between the secondary-side receiver **45** and the secondary-side subcooling heat exchanger **47**.

The secondary-side subcooling heat exchanger **47** is a heat exchanger for exchanging heat between a refrigerant flowing through a flow path belonging to the fifth heat source pipe **27** and a refrigerant flowing through a flow path belonging to the secondary-side subcooling circuit **48**. In the present embodiment, the secondary-side subcooling heat exchanger **47** is provided between a point where the secondary-side subcooling circuit **48** branches and the third shutoff valve **31** in the fifth heat source pipe **27**. The secondary-side subcooling expansion valve **48***a* is provided between a branching point from the fifth heat source pipe **27** in the secondary-side subcooling circuit **48** and the secondary-side subcooling heat exchanger **47**. The secondary-side subcooling expansion valve **48***a* supplies a decompressed refrigerant to the secondary-side subcooling heat exchanger **47**, and is an electric expansion valve whose opening degree is adjustable.

The secondary-side accumulator **30** is a container capable of storing the secondary-side refrigerant, and is provided on the suction side of the secondary-side compressor **21**.

The oil separator **34** is provided in the middle of the discharge flow path **24**. The oil separator **34** is a device for separating refrigerating machine oil discharged from the secondary-side compressor **21** along with the secondary-side refrigerant from the secondary-side refrigerant and returning the refrigerating machine oil to the secondary-side compressor **21**.

The oil return circuit **40** is provided to connect the oil separator **34** and the suction flow path **23**. The oil return circuit **40** includes an oil return flow path **41** extending such that a flow path extending from the oil separator **34** joins a portion of the suction flow path **23** between the secondary-side accumulator **30** and the suction side of the secondary-side compressor **21**. An oil return capillary tube **42** and an oil return on-off valve **44** are provided in the middle of the oil return flow path **41**. When the oil return on-off valve **44** is controlled to an open state, the refrigerating machine oil separated in the oil separator **34** passes through the oil return capillary tube **42** of the oil return flow path **41** and is returned to the suction side of the secondary-side compressor **21**. Here, in the present embodiment, when the secondary-side compressor **21** is in an operating state in the secondary-side refrigerant circuit **10**, the oil return on-off valve **44** repeats maintaining the open state for a predetermined time and maintaining a closed state for a predetermined time, thereby controlling an amount of refrigerating machine oil returned through the oil return circuit **40**. In the present embodiment, the oil return on-off valve **44** is an electromagnetic valve that is controlled to open and close. However, the oil return capillary tube **42** may be omitted while the oil return on-off valve is an electric expansion valve that can adjust an opening degree.

Hereinafter, the utilization circuits **13***a*, **13***b*, and **13***c* will be described. Since configurations of the utilization circuits **13***b* and **13***c* are similar to a configuration of the utilization circuit **13***a*, for the utilization circuits **13***b* and **13***c*, instead of a subscript “a” indicating each part of the utilization circuit **13***a*, a subscript “b” or “c” is added, and description of each part will be omitted.

The utilization circuit **13***a* mainly includes a utilization-side heat exchanger **52***a* (corresponding to a second heat exchanger), a first utilization pipe **57***a*, a second utilization pipe **56***a*, and a utilization-side expansion valve **51***a*.

The utilization-side heat exchanger **52***a* is a device for exchanging heat between a refrigerant and indoor air, and includes, for example, a fin-and-tube heat exchanger including a large number of heat transfer tubes and a fin. Note that the plurality of utilization-side heat exchangers **52***a*, **52***b*, and **52***c* is connected in parallel to the secondary-side switching mechanism **22**, the suction flow path **23**, and the cascade heat exchanger **35**.

One end of the second utilization pipe **56***a* is connected to a liquid side (a side opposite to a gas side) of the utilization-side heat exchanger **52***a* of the first utilization unit **3***a*. Another end of the second utilization pipe **56***a* is connected to the second connection pipe **16***a*. The utilization-side expansion valve **51***a* described above is provided in the middle of the second utilization pipe **56***a*.

The utilization-side expansion valve **51***a* is an electric expansion valve capable of adjusting an opening degree for adjusting a flow rate of a refrigerant flowing through the utilization-side heat exchanger **52***a* and the like. The utilization-side expansion valve **51***a* is provided in the second utilization pipe **56***a*.

One end of the first utilization pipe **57***a* is connected to the gas side of the utilization-side heat exchanger **52***a* of the first utilization unit **3***a*. In the present embodiment, the first utilization pipe **57***a* is connected to the utilization-side heat exchanger **52***a* on a side opposite to the utilization-side expansion valve **51***a* side. Another end of the first utilization pipe **57***a* is connected to the first connection pipe **15***a*.

Hereinafter, the branch circuits **14***a*, **14***b*, and **14***c* will be described. Since configurations of the branch circuits **14***b* and **14***c* are similar to a configuration of the branch circuit **14***a*, for the branch circuits **14***b* and **14***c*, instead of a subscript "a" indicating each part of the branch circuit **14***a*, a subscript "b" or "c" is added, and description of each part will be omitted.

The branch circuit **14***a* mainly includes a junction pipe **62***a*, a first branch pipe **63***a*, a second branch pipe **64***a*, a first control valve **66***a*, a second control valve **67***a*, a bypass pipe **69***a*, a check valve **68***a*, and a third branch pipe **61***a*.

One end of the junction pipe **62***a* is connected to the first connection pipe **15***a*. The first branch pipe **63***a* and the second branch pipe **64***a* are branched and connected to another end of the junction pipe **62***a*.

The first branch pipe **63***a* is connected to the secondary-side first connection pipe **8** on a side opposite to the junction pipe **62***a* side. The first branch pipe **63***a* is provided with the openable and closable first control valve **66***a*.

The second branch pipe **64***a* is connected to the secondary-side second connection pipe **9** on the side opposite to the junction pipe **62***a* side. The second branch pipe **64***a* is provided with the openable and closable second control valve **67***a*.

The bypass pipe **69***a* is a refrigerant pipe that connects a portion of the first branch pipe **63***a* closer to the secondary-side first connection pipe **8** side than the first control valve **66***a* and a portion of the second branch pipe **64***a* closer to the secondary-side second connection pipe **9** side than the second control valve **67***a*. The check valve **68***a* is provided in the middle of this bypass pipe **69***a*. The check valve **68***a* allows only a refrigerant flow from the second branch pipe **64***a* side toward the first branch pipe **63***a* side, and does not allow a refrigerant flow from the first branch pipe **63***a* side toward the second branch pipe **64***a* side.

One end of the third branch pipe **61***a* is connected to the second connection pipe **16***a*. Another end of the third branch pipe **61***a* is connected to the secondary-side third connection pipe **7**.

The first branch unit **6***a* can function as follows by closing the first control valve **66***a* and opening the second control valve **67***a* when performing the cooling operation to be described later. The first branch unit **6***a* sends a refrigerant flowing into the third branch pipe **61***a* through the secondary-side third connection pipe **7** to the second connection pipe **16***a*. Note that the refrigerant flowing through the second utilization pipe **56***a* of the first utilization unit **3***a* through the second connection pipe **16***a* is sent to the utilization-side heat exchanger **52***a* of the first utilization unit **3***a* through the utilization-side expansion valve **51***a*. Then, the refrigerant sent to the utilization-side heat exchanger **52***a* evaporates by heat exchange with indoor air, and then flows through the first connection pipe **15***a* via the first utilization pipe **57***a*. The refrigerant having flowed through the first connection pipe **15***a* is sent to the junction pipe **62***a* of the first branch unit **6***a*. The refrigerant having flowed through the junction pipe **62***a* does not flow toward the first branch pipe **63***a* side but flows toward the second branch pipe **64***a* side. The refrigerant flowing through the second branch pipe **64***a* passes through the second control valve **67***a*. A part of the refrigerant that has passed through the second control valve **67***a* is sent to the secondary-side second connection pipe **9**. Further, a remaining part of the refrigerant that has passed through the second control valve **67***a* flows so as to branch into the bypass pipe **69***a* provided with the check valve **68***a*, passes through a part of the first branch pipe **63***a*, and then is sent to the secondary-side first connection pipe **8**. As a result, it is possible to increase a total flow path cross-sectional area when the secondary-side gas state refrigerant evaporated in the utilization-side heat exchanger **52***a* is sent to the secondary-side compressor **21**, so that pressure loss can be reduced.

In addition, when the first utilization unit **3***a* cools a room at the time of performing the cooling main operation and the heating main operation to be described later, the first branch unit **6***a* can function as follows by closing the first control valve **66***a* and opening the second control valve **67***a*. The first branch unit **6***a* sends a refrigerant flowing into the third branch pipe **61***a* through the secondary-side third connection pipe **7** to the second connection pipe **16***a*. Note that the refrigerant flowing through the second utilization pipe **56***a* of the first utilization unit **3***a* through the second connection pipe **16***a* is sent to the utilization-side heat exchanger **52***a* of the first utilization unit **3***a* through the utilization-side expansion valve **51***a*. Then, the refrigerant sent to the utilization-side heat exchanger **52***a* evaporates by heat exchange with indoor air, and then flows through the first connection pipe **15***a* via the first utilization pipe **57***a*. The refrigerant having flowed through the first connection pipe **15***a* is sent to the junction pipe **62***a* of the first branch unit **6***a*. The refrigerant having flowed through the junction pipe **62***a* flows to the second branch pipe **64***a*, passes through the second control valve **67***a*, and then is sent to the secondary-side second connection pipe **9**.

In addition, the first branch unit **6***a* can function as follows by closing the second control valve **67***a* and opening the first control valve **66***a* when performing the heating operation to be described later. In the first branch unit **6***a*, the refrigerant flowing into the first branch pipe **63***a* through the secondary-side first connection pipe **8** passes through the first control valve **66***a* and is sent to the junction pipe **62***a*. The refrigerant having flowed through the junction pipe **62***a* flows through the first utilization pipe **57***a* of the utilization unit **3***a* via the first connection pipe **15***a* and is sent to the utilization-side heat exchanger **52***a*. Then, the refrigerant sent to the utilization-side heat exchanger **52***a* radiates heat by heat exchange with indoor air, and then passes through the utilization-side expansion valve **51***a* provided in the second utilization pipe **56***a*. The refrigerant having passed through the second utilization pipe **56***a* flows through the third branch pipe **61***a* of the first branch unit **6***a* via the second connection pipe **16***a*, and then is sent to the secondary-side third connection pipe **7**.

In addition, when the first utilization unit **3***a* heats a room at the time of performing the cooling main operation and the heating main operation to be described later, the first branch unit **6***a* can function as follows by closing the second control valve **67***a* and opening the first control valve **66***a*. In the first branch unit **6***a*, the refrigerant flowing into the first branch pipe **63***a* through the secondary-side first connection pipe **8** passes through the first control valve **66***a* and is sent to the junction pipe **62***a*. The refrigerant having flowed through the junction pipe **62***a* flows through the first utilization pipe **57***a* of the utilization unit **3***a* via the first connection pipe **15***a* and is sent to the utilization-side heat exchanger **52***a*. Then, the refrigerant sent to the utilization-side heat exchanger **52***a* radiates heat by heat exchange with indoor air, and then passes through the utilization-side expansion valve **51***a* provided in the second utilization pipe **56***a*. The refrigerant having passed through the second utilization pipe **56***a* flows through the third branch pipe **61***a* of the first branch unit **6***a* via the second connection pipe **16**a, and then is sent to the secondary-side third connection pipe **7**.

Such a function is provided not only in the first branch unit **6**a but also in the second branch unit **6**b and the third branch unit **6**c. Therefore, each of the first branch unit **6**a, the second branch unit **6**b, and the third branch unit **6**c can individually switch whether each of the utilization-side heat exchangers **52**a, **52**b, and **52**c functions as a refrigerant evaporator or a refrigerant radiator.

(4) Primary-Side Unit

The primary-side unit **5** is installed in a space, on a rooftop, or the like different from a space in which the utilization units **3**a, **3**b, and **3**c and the branch units **6**a, **6**b, and **6**c are arranged.

The primary-side unit **5** includes a part of the above-described primary-side refrigerant circuit **5**a, a primary-side fan **75**, various sensors, a primary-side control unit **70**, and a primary-side casing **5**x as shown in FIG. **7**.

The primary-side unit **5** includes, as a part of the primary-side refrigerant circuit **5**a, the primary-side compressor **71**, the primary-side switching mechanism **72**, the primary-side heat exchanger **74**, the primary-side first expansion valve **76**, the primary-side subcooling heat exchanger **103**, the primary-side subcooling circuit **104**, the primary-side subcooling expansion valve **104**a, the first liquid shutoff valve **108**, the first gas shutoff valve **109**, and the primary-side accumulator **105** in the primary-side casing **5**x.

The primary-side fan **75** is provided in the primary-side unit **5**, and generates an air flow that guides outdoor air to the primary-side heat exchanger **74**, exchanges heat with a primary-side refrigerant flowing through the primary-side heat exchanger **74**, and then discharges the air to the outside. The primary-side fan **75** is driven by a primary-side fan motor **75**a.

Further, the primary-side unit **5** is provided with various sensors. Specifically, an outdoor air temperature sensor **77** that detects temperature of outdoor air before passing through the primary-side heat exchanger **74**, a primary-side discharge pressure sensor **78** that detects pressure of the primary-side refrigerant discharged from the primary-side compressor **71**, a primary-side suction pressure sensor **79** that detects pressure of the primary-side refrigerant sucked into the primary-side compressor **71**, a primary-side suction temperature sensor **81** that detects temperature of the primary-side refrigerant sucked into the primary-side compressor **71**, and a primary-side heat-exchange temperature sensor **82** that detects temperature of a refrigerant flowing through the primary-side heat exchanger **74** are provided.

The primary-side control unit **70** controls operations of the units **71** (**71**a), **72**, **75** (**75**a), **76**, and **104**a provided in the primary-side unit **5**. The primary-side control unit **70** includes a processor such as a CPU or a microcomputer and a memory provided to control the primary-side unit **5**. The primary-side control unit can exchange control signals and the like with a remote controller (not illustrated), and exchange control signals and the like with a heat source-side control unit **20** of the heat source unit **2**, branch unit control units **60**a, **60**b, and **60**c, and utilization-side control units **50**a, **50**b, and **50**c.

(5) Heat Source Unit

The heat source unit **2** is installed in a space, on a rooftop, or the like different from the space in which the utilization units **3**a, **3**b, and **3**c and the branch units **6**a, **6**b, and **6**c are disposed.

The heat source unit **2** is connected to the branch units **6**a, **6**b, and **6**c via the connection pipes **7**, **8**, and **9**, and constitutes a part of the secondary-side refrigerant circuit **10**. Further, the heat source unit **2** is connected to the primary-side unit **5** via the primary-side first connection pipe **111** and the primary-side second connection pipe **112**, and constitutes a part of the primary-side refrigerant circuit **5**a.

The heat source unit **2** mainly includes the heat source circuit **12** described above, various sensors, the heat source-side control unit **20**, the second liquid shutoff valve **106**, the second refrigerant pipe **114**, the primary-side second expansion valve **102**, the first refrigerant pipe **113**, and the second gas shutoff valve **107** that constitute a part of the primary-side refrigerant circuit **5**a, and the heat source casing **2**x as illustrated in FIG. **7**.

The heat source unit **2** includes a secondary-side suction pressure sensor **37** that detects pressure of a secondary-side refrigerant on the suction side of the secondary-side compressor **21**, a secondary-side discharge pressure sensor **38** that detects pressure of the secondary-side refrigerant on the discharge side of the secondary-side compressor **21**, a secondary-side discharge temperature sensor **39** that detects temperature of the secondary-side refrigerant on the discharge side of the secondary-side compressor **21**, a secondary-side suction temperature sensor **88** that detects temperature of the secondary-side refrigerant on the suction side of the secondary-side compressor **21**, a secondary-side cascade temperature sensor **83** that detects temperature of the secondary-side refrigerant flowing between the secondary-side flow path **35**a of the cascade heat exchanger **35** and the heat source-side expansion valve **36**, a receiver outlet temperature sensor **84** that detects temperature of the secondary-side refrigerant flowing between the secondary-side receiver **45** and the secondary-side subcooling heat exchanger **47**, a bypass circuit temperature sensor **85** that detects temperature of the secondary-side refrigerant flowing downstream of the bypass expansion valve **46**a in the bypass circuit **46**, a subcooling outlet temperature sensor **86** that detects temperature of the secondary-side refrigerant flowing between the secondary-side subcooling heat exchanger **47** and the third shutoff valve **31**, and a subcooling circuit temperature sensor **87** that detects temperature of the secondary-side refrigerant flowing through an outlet of the secondary-side subcooling heat exchanger **47** in the secondary-side subcooling circuit **48**.

The heat source-side control unit **20** controls operations of the units **21** (**21**a), **22**, **36**, **44**, **46**a, **48**a, and **102** provided inside the heat source casing **2**x of the heat source unit **2**. The heat source-side control unit **20** includes a processor such as a CPU or a microcomputer and a memory provided to control the heat source unit **2**. The heat source control unit can exchange control signals and the like with the primary-side control unit **70** of the primary-side unit **5**, the utilization-side control units **50**a, **50**b, and **50**c of the utilization units **3**a, **3**b, and **3**c, and the branch unit control units **60**a, **60**b, and **60**c.

As described above, the heat source-side control unit **20** can control not only the units constituting the heat source circuit **12** of the secondary-side refrigerant circuit **10** but also the primary-side second expansion valve **102** constituting a part of the primary-side refrigerant circuit **5**a. Therefore, the heat source-side control unit **20** controls a valve opening degree of the primary-side second expansion valve **102** based on a condition of the heat source circuit **12** controlled by the heat source-side control unit **20**, thereby bringing the condition of the heat source circuit **12** closer to a desired condition. Specifically, it is possible to control an amount of heat received by the secondary-side refrigerant flowing through the secondary-side flow path **35**a of the cascade heat exchanger **35** in the heat source circuit **12** from the primary-side refrigerant flowing through the primary-side flow path **35***b* of the cascade heat exchanger **35** or an amount of heat given by the secondary-side refrigerant to the primary-side refrigerant.

(6) Utilization Unit

The utilization units **3***a*, **3***b*, and **3***c* are installed by being embedded, suspended, or the like on a ceiling in a room of a building or the like, or by being hung or the like on a wall surface in the room.

The utilization units **3***a*, **3***b*, and **3***c* are connected to the heat source unit **2** via the connection pipes **7**, **8**, and **9**.

The utilization units **3***a*, **3***b*, and **3***c* include the utilization circuits **13***a*, **13***b*, and **13***c* constituting a part of the secondary-side refrigerant circuit **10**.

Configurations of the utilization units **3***a*, **3***b*, and **3***c* will be described below. Note that since the configurations of the second utilization unit **3***b* and the third utilization unit **3***c* are similar to the configuration of the first utilization unit **3***a*, only the configuration of the first utilization unit **3***a* will be described here. For the configurations of the second utilization unit **3***b* and the third utilization unit **3***c*, instead of a subscript "a" indicating each part of the first utilization unit **3***a*, a subscript "b" or "c" is added, respectively, and description of each part will be omitted.

The first utilization unit **3***a* mainly includes the above-described utilization circuit **13***a*, an indoor fan **53***a*, the utilization-side control unit **50***a*, and various sensors. Note that the indoor fan **53***a* includes an indoor fan motor **54***a*.

The indoor fan **53***a* sucks indoor air into the unit, exchanges heat with a refrigerant flowing through the utilization-side heat exchanger **52***a*, and then generates an air flow to be supplied into the room as supply air. The indoor fan **53***a* is driven by then indoor fan motor **54***a*.

The utilization unit **3***a* is provided with a liquid-side temperature sensor **58***a* that detects temperature of the refrigerant on the liquid side of the utilization-side heat exchanger **52***a*. Further, the utilization unit **3***a* is provided with an indoor temperature sensor **55***a* that detects indoor temperature that is temperature of air taken in from the room and before passing through the utilization-side heat exchanger **52***a*.

The utilization-side control unit **50***a* controls operations of the units **51***a* and **53***a* (**54***a*) constituting the utilization unit **3***a*. The utilization-side control unit **50***a* includes a processor such as a CPU or a microcomputer and a memory provided to control the utilization unit **3***a*. The utilization-side control unit can exchange control signals and the like with a remote controller (not illustrated), and exchange control signals and the like with the heat source-side control unit **20** of the heat source unit **2**, the branch unit control units **60***a*, **60***b*, and **60***c*, and the primary-side control unit **70** of the primary-side unit **5**.

Note that the second utilization unit **3***b* includes the utilization circuit **13***b*, an indoor fan **53***b*, the utilization-side control unit **50***b*, and an indoor fan motor **54***b*. The third utilization unit **3***c* includes the utilization circuit **13***c*, an indoor fan **53***c*, the utilization-side control unit **50***c*, and an indoor fan motor **54***c*.

(7) Branch Unit

The branch units **6***a*, **6***b*, and **6***c* are installed in a space or the like in a ceiling cavity of a room of a building or the like.

The branch units **6***a*, **6***b*, and **6***c* are connected to the utilization units **3***a*, **3***b*, and **3***c* in one-to-one correspondence. The branch units **6***a*, **6***b*, and **6***c* are connected to the heat source unit **2** via the connection pipes **7**, **8**, and **9**.

Next, configurations of the branch units **6***a*, **6***b*, and **6***c* will be described. Note that since the configurations of the second branch unit **6***b* and the third branch unit **6***c* are similar to the configuration of the first branch unit **6***a*, only the configuration of the first branch unit **6***a* will be described here. For the configurations of the second branch unit **6***b* and the third branch unit **6***c*, instead of a subscript "a" indicating each part of the first branch unit **6***a*, a subscript "b" or "c" is added, respectively, and description of each part will be omitted.

The first branch unit **6***a* mainly includes the above-described branch circuit **14***a* and the branch unit control unit **60***a*.

The branch unit control unit **60***a* controls operations of the units **66***a* and **67***a* constituting the branch unit **6***a*. The branch unit control unit **60***a* includes a processor such as a CPU or a microcomputer and a memory provided to control the branch unit **6***a*. The branch unit control unit can exchange control signals and the like with a remote controller (not illustrated) and exchange control signals and the like with the heat source-side control unit **20** of the heat source unit **2**, the utilization units **3***a*, **3***b*, and **3***c*, and the primary-side control unit **70** of the primary-side unit **5**.

Note that the second branch unit **6***b* includes the branch circuit **14***b* and the branch unit control unit **60***b*. The third branch unit **6***c* includes the branch circuit **14***c* and the branch unit control unit **60***c*.

(8) Control Unit

In the refrigeration cycle apparatus **1**, the heat source-side control unit **20**, the utilization-side control units **50***a*, **50***b*, and **50***c*, the branch unit control units **60***a*, **60***b*, and **60***c*, and the primary-side control unit **70** described above are communicably connected to each other in a wired or wireless manner to constitute a control unit **80**. Therefore, this control unit **80** controls operations of the units **21** (**21***a*), **22**, **36**, **44**, **46***a*, **48***a*, **51***a*, **51***b*, **51***c*, **53***a*, **53***b*, **53***c* (**54***a*, **54***b*, **54***c*), **66***a*, **66***b*, **66***c*, **67***a*, **67***b*, **67***c*, **71** (**71***a*), **72**, **75** (**75***a*), **76**, **104***a* on the basis of detection information of the various sensors **37**, **38**, **39**, **83**, **84**, **85**, **86**, **87**, **88**, **77**, **78**, **79**, **81**, **82**, **58***a*, **58***b*, **58***c*, and the like, and instruction information received from a remote controller (not illustrated) and the like.

(9) Operation of Refrigeration Cycle Apparatus

Next, an operation of the refrigeration cycle apparatus **1** will be described with reference to FIGS. **3** to **6**.

Refrigeration cycle operation of the refrigeration cycle apparatus **1** can be mainly divided into cooling operation, heating operation, cooling main operation, and heating main operation.

Here, the cooling operation is refrigeration cycle operation in which only the utilization unit in which the utilization-side heat exchanger functions as a refrigerant evaporator exists, and the cascade heat exchanger **35** functions as a radiator for the secondary-side refrigerant with respect to an evaporation load of the entire utilization unit.

The heating operation is refrigeration cycle operation in which only the utilization unit in which the utilization-side heat exchanger functions as a refrigerant radiator exists, and the cascade heat exchanger **35** functions as an evaporator for the secondary-side refrigerant with respect to a heat radiation load of the entire utilization unit.

The cooling main operation is operation in which the utilization unit in which the utilization-side heat exchanger functions as a refrigerant evaporator and the utilization unit in which the utilization-side heat exchanger functions as a refrigerant radiator are mixed. The cooling main operation is refrigeration cycle operation in which, when an evaporation load is a main thermal load of the entire utilization unit, the cascade heat exchanger **35** functions as a radiator for the secondary-side refrigerant in order to process the evaporation load of the entire utilization unit.

The heating main operation is operation in which the utilization unit in which the utilization-side heat exchanger functions as a refrigerant evaporator and the utilization unit in which the utilization-side heat exchanger functions as a refrigerant radiator are mixed. The heating main operation is refrigeration cycle operation in which, when a heat radiation load is a main heat load of the entire utilization unit, the cascade heat exchanger **35** functions as an evaporator for the secondary-side refrigerant in order to process the heat radiation load of the entire utilization unit.

Note that the operation of the refrigeration cycle apparatus **1** including the refrigeration cycle operation is performed by the above-described control unit **80**.

(9-1) Cooling Operation

In the cooling operation, for example, all of the utilization-side heat exchangers **52***a*, **52***b*, and **52***c* of the utilization units **3***a*, **3***b*, and **3***c* operate to function as refrigerant evaporators, and the cascade heat exchanger **35** operates to function as a radiator for the secondary-side refrigerant. In this cooling operation, the primary-side refrigerant circuit **5***a* and the secondary-side refrigerant circuit **10** of the refrigeration cycle apparatus **1** are configured as illustrated in FIG. **3**. Note that arrows attached to the primary-side refrigerant circuit **5***a* and arrows attached to the secondary-side refrigerant circuit **10** in FIG. **3** indicate flows of the refrigerant during the cooling operation.

Specifically, in the primary-side unit **5**, the cascade heat exchanger **35** is caused to function as an evaporator for a primary-side refrigerant by switching the primary-side switching mechanism **72** to the fifth connection state. The fifth connection state of the primary-side switching mechanism **72** is a connection state indicated by solid lines in the primary-side switching mechanism **72** of FIG. **3**. As a result, in the primary-side unit **5**, the primary-side refrigerant discharged from the primary-side compressor **71** passes through the primary-side switching mechanism **72**, and is condensed by exchanging heat with outdoor air supplied from the primary-side fan **75** in the primary-side heat exchanger **74**. The primary-side refrigerant condensed in the primary-side heat exchanger **74** passes through the primary-side first expansion valve **76** controlled to a fully open state. A part of the refrigerant flows toward the first liquid shutoff valve **108** through the primary-side subcooling heat exchanger **103**, and another part of the refrigerant branches and flows into the primary-side subcooling circuit **104**. The refrigerant flowing through the primary-side subcooling circuit **104** is decompressed when passing through the primary-side subcooling expansion valve **104***a*. The refrigerant flowing from the primary-side first expansion valve **76** toward the first liquid shutoff valve **108** exchanges heat with the refrigerant decompressed by the primary-side subcooling expansion valve **104***a* and flowing through the primary-side subcooling circuit **104** in the primary-side subcooling heat exchanger **103**, and is cooled until reaching a subcooled state. The refrigerant in the subcooled state flows through the primary-side first connection pipe **111**, the second liquid shutoff valve **106**, and the second refrigerant pipe **114** in this order, and is decompressed when passing through the primary-side second expansion valve **102**. Here, a valve opening degree of the primary-side second expansion valve **102** is controlled such that a degree of superheating of the primary-side refrigerant sucked into the primary-side compressor **71** satisfies a predetermined condition. When flowing through the primary-side flow path **35***b* of the cascade heat exchanger **35**, the primary-side refrigerant decompressed by the primary-side second expansion valve **102** evaporates by exchanging heat with the secondary-side refrigerant flowing through the secondary-side flow path **35***a*, and flows toward the second gas shutoff valve **107** through the first refrigerant pipe **113**. The refrigerant having passed through the second gas shutoff valve **107** passes through the primary-side second connection pipe **112** and the first gas shutoff valve **109**, and then reaches the primary-side switching mechanism **72**. The refrigerant that has passed through the primary-side switching mechanism **72** joins the refrigerant that has flowed through the primary-side subcooling circuit **104**, and is then sucked into the primary-side compressor **71** via the primary-side accumulator **105**.

Further, in the heat source unit **2**, by switching the secondary-side switching mechanism **22** to the first connection state, the cascade heat exchanger **35** functions as a radiator for the secondary-side refrigerant. Note that, in the first connection state of the secondary-side switching mechanism **22**, the discharge flow path **24** and the third heat source pipe **25** are connected by the first switching valve **22***a*, and the first heat source pipe **28** and the suction flow path **23** are connected by the second switching valve **22***b*. Here, an opening degree of the heat source-side expansion valve **36** is adjusted. In the first to third branch units **3***a*, **3***b*, **3***c*, the second control valves **67***a*, **67***b*, **67***c* are controlled to open states. As a result, all of the utilization-side heat exchangers **52***a*, **52***b*, and **52***c* of the utilization units **3***a*, **3***b*, and **3***c* function as refrigerant evaporators. Further, all of the utilization-side heat exchangers **52***a*, **52***b*, and **52***c* of the utilization units **3***a*, **3***b*, and **3***c* and the suction side of the secondary-side compressor **21** of the heat source unit **2** are connected via the first utilization pipes **57***a*, **57***b*, and **57***c*, the first connection pipes **15***a*, **15***b*, and **15***c*, the junction pipes **62***a*, **62***b*, and **62***c*, the second branch pipes **64***a*, **64***b*, and **64***c*, the bypass pipes **69***a*, **69***b*, and **69***c*, parts of the first branch pipes **63***a*, **63***b*, and **63***c*, the secondary-side first connection pipe **8**, and the secondary-side second connection pipe **9**. In addition, an opening degree of the secondary-side subcooling expansion valve **48***a* is controlled such that a degree of subcooling of the secondary-side refrigerant flowing through the outlet of the secondary-side subcooling heat exchanger **47** toward the secondary-side third connection pipe **7** satisfies a predetermined condition. The bypass expansion valve **46***a* is controlled to a closed state. In the utilization units **3***a*, **3***b*, and **3***c*, opening degrees of the utilization-side expansion valves **51***a*, **51***b*, and **51***c* are adjusted.

In such a secondary-side refrigerant circuit **10**, a high-pressure secondary-side refrigerant compressed and discharged by the secondary-side compressor **21** is sent to the secondary-side flow path **35***a* of the cascade heat exchanger **35** through the first switching valve **22***a* of the secondary-side switching mechanism **22**. In the cascade heat exchanger **35**, the high-pressure secondary-side refrigerant flowing through the secondary-side flow path **35***a* radiates heat, and the primary-side refrigerant flowing through the primary-side flow path **35***b* of the cascade heat exchanger **35** evaporates. The secondary-side refrigerant having radiated heat in the cascade heat exchanger **35** passes through the heat source-side expansion valve **36** whose opening degree is adjusted, and then flows into the secondary-side receiver **45**. A part of the refrigerant that has flowed out of the secondary-side receiver **45** branches and flows into the secondary-side subcooling circuit **48**, is decompressed by the secondary-side subcooling expansion valve **48***a*, and then joins the suction flow path **23**. In the secondary-side subcooling heat exchanger **47**, another part of the refrigerant that has flowed out of the secondary-side receiver **45** is cooled by the refrigerant flowing through the secondary-side subcooling circuit **48**, and then is sent to the secondary-side third connection pipe **7** through the third shutoff valve **31**.

Then, the refrigerant sent to the secondary-side third connection pipe **7** is branched into three and passes through the third branch pipes **61***a*, **61***b*, and **61***c* of the first to third branch units **6***a*, **6***b*, and **6***c*. Thereafter, the refrigerant having flowed through the second connection pipes **16***a*, **16***b*, and **16***c* is sent to the second utilization pipes **56***a*, **56***b*, and **56***c* of the first to third utilization units **3***a*, **3***b*, and **3***c*, respectively. The refrigerant sent to the second utilization pipes **56***a*, **56***b*, and **56***c* is sent to the utilization-side expansion valves **51***a*, **51***b*, and **51***c* of the utilization units **3***a*, **3***b*, and **3***c*.

Then, the refrigerant having passed through the utilization-side expansion valves **51***a*, **51***b*, and **51***c* whose opening degrees are adjusted exchanges heat with indoor air supplied by the indoor fans **53***a*, **53***b*, and **53***c* in the utilization-side heat exchangers **52***a*, **52***b*, and **52***c*. As a result, the refrigerant flowing through the utilization-side heat exchangers **52***a*, **52***b*, and **52***c* evaporates and becomes a low-pressure gas refrigerant. The indoor air is cooled and is supplied into the room. As a result, an indoor space is cooled. The low-pressure gas refrigerant evaporated in the utilization-side heat exchangers **52***a*, **52***b*, and **52***c* flows through the first utilization pipes **57***a*, **57***b*, and **57***c*, flows through the first connection pipes **15***a*, **15***b*, and **15***c*, and then is sent to the junction pipes **62***a*, **62***b*, and **62***c* of the first to third branch units **6***a*, **6***b*, and **6***c*.

Then, the low-pressure gas refrigerant sent to the junction pipes **62***a*, **62***b*, and **62***c* flows to the second branch pipes **64***a*, **64***b*, and **64***c*. A part of the refrigerant that has passed through the second control valves **67***a*, **67***b*, and **67***c* in the second branch pipes **64***a*, **64***b*, and **64***c* is sent to the secondary-side second connection pipe **9**. A remaining part of the refrigerant that has passed through the second control valves **67***a*, **67***b*, and **67***c* passes through the bypass pipes **69***a*, **69***b*, and **69***c*, flows through a part of the first branch pipes **63***a*, **63***b*, and **63***c*, and then is sent to the secondary-side first connection pipe **8**.

Then, the low-pressure gas refrigerant sent to the secondary-side first connection pipe **8** and the secondary-side second connection pipe **9** is returned to the suction side of the secondary-side compressor **21** through the first shutoff valve **32**, the second shutoff valve **33**, the first heat source pipe **28**, the second heat source pipe **29**, the second switching valve **22***b* of the secondary-side switching mechanism **22**, the suction flow path **23**, and the secondary-side accumulator **30**.

Note that, in this cooling operation, the secondary-side refrigerant circuit **10** controls capacity, for example, by controlling the secondary-side compressor **21** so that evaporation temperature of the secondary-side refrigerant in the utilization-side heat exchangers **52***a*, **52***b*, and **52***c* becomes predetermined secondary-side evaporation target temperature. The primary-side refrigerant circuit **5***a* controls capacity, for example, by controlling the primary-side compressor **71** such that evaporation temperature of the primary-side refrigerant in the primary-side flow path **35***b* of the cascade heat exchanger **35** becomes predetermined primary-side evaporation target temperature. Here, the primary-side evaporation target temperature is changed such that a carbon dioxide refrigerant flowing through the secondary-side flow path **35***a* of the cascade heat exchanger **35** does not exceed a critical point when an operation condition is not a predetermined operation condition in which the carbon dioxide refrigerant exceeds the critical point. Also, the primary-side evaporation target temperature is changed such that the carbon dioxide refrigerant exceeds the critical point by more than a predetermined amount when the operation condition is the predetermined operation condition in which the carbon dioxide refrigerant exceeds the critical point.

In this manner, the operation in the cooling operation is performed.

(9-2) Heating Operation

In the heating operation, for example, all of the utilization-side heat exchangers **52***a*, **52***b*, and **52***c* of the utilization units **3***a*, **3***b*, and **3***c* operate to function as refrigerant radiators. Further, in the heating operation, the cascade heat exchanger **35** operates to function as an evaporator for the secondary-side refrigerant. In the heating operation, the primary-side refrigerant circuit **5***a* and the secondary-side refrigerant circuit **10** of the refrigeration cycle apparatus **1** are configured as illustrated in FIG. **4**. Arrows attached to the primary-side refrigerant circuit **5***a* and arrows attached to the secondary-side refrigerant circuit **10** in FIG. **4** indicate flows of the refrigerant during the heating operation.

Specifically, in the primary-side unit **5**, by switching the primary-side switching mechanism **72** to the sixth connection state, the cascade heat exchanger **35** functions as a radiator for the primary-side refrigerant. The sixth connection state of the primary-side switching mechanism **72** is a connection state indicated by broken lines in the primary-side switching mechanism **72** in FIG. **4**. As a result, in the primary-side unit **5**, the primary-side refrigerant discharged from the primary-side compressor **71**, passed through the primary-side switching mechanism **72**, and passed through the first gas shutoff valve **109** passes through the primary-side second connection pipe **112** and the second gas shutoff valve **107**, and is sent to the primary-side flow path **35***b* of the cascade heat exchanger **35**. The refrigerant flowing through the primary-side flow path **35***b* of the cascade heat exchanger **35** is condensed by exchanging heat with the secondary-side refrigerant flowing through the secondary-side flow path **35***a*. When flowing through the second refrigerant pipe **114**, the primary-side refrigerant condensed in the cascade heat exchanger **35** passes through the primary-side second expansion valve **102** controlled to a fully open state. The refrigerant that has passed through the primary-side second expansion valve **102** flows through the second liquid shutoff valve **106**, the primary-side first connection pipe **111**, the first liquid shutoff valve **108**, and the primary-side subcooling heat exchanger **103** in this order, and is decompressed by the primary-side first expansion valve **76**. Note that, during the heating operation, the primary-side subcooling expansion valve **104***a* is controlled to a closed state, so that the refrigerant does not flow into the primary-side subcooling circuit **104**. Therefore, heat is not exchanged in the primary-side subcooling heat exchanger **103** either. Note that a valve opening degree of the primary-side first expansion valve **76** is controlled such that, for example, a degree of superheating of the refrigerant sucked into the primary-side compressor **71** satisfies a predetermined condition. The refrigerant decompressed by the primary-side first expansion valve **76** evaporates by exchanging heat with outdoor air supplied from the primary-side fan **75** in the primary-side heat exchanger **74**, passes through the primary-side switching mechanism **72** and the primary-side accumulator **105**, and is sucked into the primary-side compressor **71**.

Further, in the heat source unit **2**, the secondary-side switching mechanism **22** is switched to the second connection state. The cascade heat exchanger **35** thus functions as an evaporator for the secondary-side refrigerant. In the second connection state of the secondary-side switching mechanism **22**, the discharge flow path **24** and the first heat source pipe **28** are connected by the second switching valve **22***b*, and the third heat source pipe **25** and the suction flow path **23** are connected by the first switching valve **22***a*. Further, an opening degree of the heat source-side expansion valve **36** is adjusted. In the first to third branch units **6***a*, **6***b*, and **6***c*, the first control valves **66***a*, **66***b*, and **66***c* are controlled to open states, and the second control valves **67***a*, **67***b*, and **67***c* are controlled to closed states. As a result, all of the utilization-side heat exchangers **52***a*, **52***b*, and **52***c* of the utilization units **3***a*, **3***b*, and **3***c* function as refrigerant radiators. The utilization-side heat exchangers **52***a*, **52***b*, and **52***c* of the utilization units **3***a*, **3***b*, and **3***c* and the discharge side of the secondary-side compressor **21** of the heat source unit **2** are connected via the discharge flow path **24**, the first heat source pipe **28**, the secondary-side first connection pipe **8**, the first branch pipes **63***a*, **63***b*, and **63***c*, the junction pipes **62***a*, **62***b*, and **62***c*, the first connection pipes **15***a*, **15***b*, and **15***c*, and the first utilization pipes **57***a*, **57***b*, and **57***c*. Further, the secondary-side subcooling expansion valve **48***a* and the bypass expansion valve **46***a* are controlled to closed states. In the utilization units **3***a*, **3***b*, and **3***c*, opening degrees of the utilization-side expansion valves **51***a*, **51***b*, and **51***c* are adjusted.

In such a secondary-side refrigerant circuit **10**, the high-pressure refrigerant compressed and discharged by the secondary-side compressor **21** is sent to the first heat source pipe **28** through the second switching valve **22***b* of the secondary-side switching mechanism **22**. The refrigerant sent to the first heat source pipe **28** is sent to the secondary-side first connection pipe **8** through the first shutoff valve **32**.

Then, the high-pressure refrigerant sent to the secondary-side first connection pipe **8** is branched into three and is sent to the first branch pipes **63***a*, **63***b*, and **63***c* of the utilization units **3***a*, **3***b*, and **3***c*, which are the utilization units in operation. The high-pressure refrigerant sent to the first branch pipes **63***a*, **63***b*, and **63***c* passes through the first control valves **66***a*, **66***b*, and **66***c*, and flows through the junction pipes **62***a*, **62***b*, and **62***c*. Thereafter, the refrigerant having flowed through the first connection pipes **15***a*, **15***b*, and **15***c* and the first utilization pipes **57***a*, **57***b*, and **57***c* is sent to the utilization-side heat exchangers **52***a*, **52***b*, and **52***c*.

Then, the high-pressure refrigerant sent to the utilization-side heat exchangers **52***a*, **52***b*, and **52***c* exchanges heat with indoor air supplied by the indoor fans **53***a*, **53***b*, and **53***c* in the utilization-side heat exchangers **52***a*, **52***b*, and **52***c*. As a result, the refrigerant flowing through the utilization-side heat exchangers **52***a*, **52***b*, and **52***c* dissipates heat. The indoor air is heated and is supplied into the room. As a result, an indoor space is heated. The refrigerant having dissipated heat in the utilization-side heat exchangers **52***a*, **52***b*, and **52***c* flows through the second utilization pipes **56***a*, **56***b*, and **56***c*, and passes through the utilization-side expansion valves **51***a*, **51***b*, and **51***c* whose opening degrees are adjusted. Thereafter, the refrigerant having flowed through the second connection pipes **16***a*, **16***b*, and **16***c* flows through the third branch pipes **61***a*, **61***b*, and **61***c* of the branch units **6***a*, **6***b*, and **6***c*, respectively.

Then, the refrigerant sent to the third branch pipes **61***a*, **61***b*, and **61***c* is sent to the secondary-side third connection pipe **7** and joins.

Then, the refrigerant sent to the secondary-side third connection pipe **7** is sent to the heat source-side expansion valve **36** through the third shutoff valve **31**. A flow rate of the refrigerant sent to the heat source-side expansion valve **36** is adjusted by the heat source-side expansion valve **36** and then sent to the cascade heat exchanger **35**. In the cascade heat exchanger **35**, the secondary-side refrigerant flowing through the secondary-side flow path **35***a* evaporates to become a low-pressure gas refrigerant and is sent to the secondary-side switching mechanism **22**. The primary-side refrigerant flowing through the primary-side flow path **35***b* of the cascade heat exchanger **35** condenses. Then, the secondary-side low-pressure gas refrigerant sent to the first switching valve **22***a* of the secondary-side switching mechanism **22** is returned to the suction side of the secondary-side compressor **21** through the suction flow path **23** and the secondary-side accumulator **30**.

Note that, in this heating operation, the secondary-side refrigerant circuit **10** controls capacity, for example, by controlling the secondary-side compressor **21** so as to process loads in the utilization-side heat exchanger **52***a*, **52***b*, and **52***c*. The primary-side refrigerant circuit **5***a* controls capacity, for example, by controlling the primary-side compressor **71** such that condensation temperature of the primary-side refrigerant in the primary-side flow path **35***b* of the cascade heat exchanger **35** becomes predetermined primary-side condensation target temperature.

In this manner, the operation in the heating operation is performed.

(9-3) Cooling Main Operation

In the cooling main operation, for example, the utilization-side heat exchangers **52***a* and **52***b* of the utilization units **3***a* and **3***b* function as refrigerant evaporators, and the utilization-side heat exchanger **52***c* of the utilization unit **3***c* functions as a refrigerant radiator. In the cooling main operation, the cascade heat exchanger **35** functions as a radiator for the secondary-side refrigerant. In the cooling main operation, the primary-side refrigerant circuit **5***a* and the secondary-side refrigerant circuit **10** of the refrigeration cycle apparatus **1** are configured as illustrated in FIG. **5**. Arrows attached to the primary-side refrigerant circuit **5***a* and arrows attached to the secondary-side refrigerant circuit **10** in FIG. **5** indicate flows of the refrigerant during the cooling main operation.

Specifically, in the primary-side unit **5**, the primary-side switching mechanism **72** is switched to the fifth connection state (state indicated by solid lines in the primary-side switching mechanism **72** in FIG. **5**), so that the cascade heat exchanger **35** functions as an evaporator for the primary-side refrigerant. As a result, in the primary-side unit **5**, the primary-side refrigerant discharged from the primary-side compressor **71** passes through the primary-side switching mechanism **72**, and is condensed by exchanging heat with outdoor air supplied from the primary-side fan **75** in the primary-side heat exchanger **74**. The primary-side refrigerant condensed in the primary-side heat exchanger **74** passes through the primary-side first expansion valve **76** controlled to a fully open state. A part of the refrigerant flows toward the first liquid shutoff valve **108** through the primary-side subcooling heat exchanger **103**, and another part of the refrigerant branches and flows into the primary-side subcooling circuit **104**. The refrigerant flowing through the primary-side subcooling circuit **104** is decompressed when passing through the primary-side subcooling expansion valve **104***a*. The refrigerant flowing from the primary-side first expansion valve **76** toward the first liquid shutoff valve **108** exchanges heat with the refrigerant decompressed by the primary-side subcooling expansion valve **104***a* and flowing through the primary-side subcooling circuit **104** in the primary-side subcooling heat exchanger **103**, and is cooled until reaching a subcooled state. The refrigerant in the subcooled state flows through the primary-side first connection pipe **111**, the second liquid shutoff valve **106**, and the second refrigerant pipe **114** in this order, and is decompressed by the primary-side second expansion valve **102**. At this time, for example, a valve opening degree of the primary-side second expansion valve **102** is controlled such that a degree of superheating of the refrigerant sucked into the primary-side compressor **71** satisfies a predetermined condition. When flowing through the primary-side flow path **35***b* of the cascade heat exchanger **35**, the primary-side refrigerant decompressed by the primary-side second expansion valve **102** evaporates by exchanging heat with the secondary-side refrigerant flowing through the secondary-side flow path **35***a*, and flows toward the second gas shutoff valve **107** through the first refrigerant pipe **113**. The refrigerant having passed through the second gas shutoff valve **107** passes through the primary-side second connection pipe **112** and the first gas shutoff valve **109**, and then reaches the primary-side switching mechanism **72**. The refrigerant that has passed through the primary-side switching mechanism **72** joins the refrigerant that has flowed through the primary-side subcooling circuit **104**, and is then sucked into the primary-side compressor **71** via the primary-side accumulator **105**.

Further, in the heat source unit **2**, the secondary-side switching mechanism **22** is switched to the third connection state in which the discharge flow path **24** and the third heat source pipe **25** are connected by the first switching valve **22***a* and the discharge flow path **24** and the first heat source pipe **28** are connected by the second switching valve **22***b*, thereby causing the cascade heat exchanger **35** to function as a radiator for the secondary-side refrigerant. Further, an opening degree of the heat source-side expansion valve **36** is adjusted. In the first to third branch units **6***a*, **6***b*, and **6***c*, the first control valve **66***c* and the second control valves **67***a* and **67***b* are controlled to open states, and the first control valves **66***a* and **66***b* and the second control valve **67***c* are controlled to closed states. Accordingly, the utilization-side heat exchangers **52***a* and **52***b* of the utilization units **3***a* and **3***b* function as refrigerant evaporators, and the utilization-side heat exchanger **52***c* of the utilization unit **3***c* functions as a refrigerant radiator. Further, the utilization-side heat exchangers **52***a* and **52***b* of the utilization units **3***a* and **3***b* and the suction side of the secondary-side compressor **21** of the heat source unit **2** are connected via the secondary-side second connection pipe **9**, and the utilization-side heat exchanger **52***c* of the utilization unit **3***c* and the discharge side of the secondary-side compressor **21** of the heat source unit **2** are connected via the secondary-side first connection pipe **8**. In addition, an opening degree of the secondary-side subcooling expansion valve **48***a* is controlled such that a degree of subcooling of the secondary-side refrigerant flowing through the outlet of the secondary-side subcooling heat exchanger **47** toward the secondary-side third connection pipe **7** satisfies a predetermined condition. The bypass expansion valve **46***a* is controlled to a closed state. In the utilization units **3***a*, **3***b*, and **3***c*, opening degrees of the utilization-side expansion valves **51***a*, **51***b*, and **51***c* are adjusted.

In such a secondary-side refrigerant circuit **10**, a part of the secondary-side high-pressure refrigerant compressed and discharged by the secondary-side compressor **21** is sent to the secondary-side first connection pipe **8** through the second switching valve **22***b* of the secondary-side switching mechanism **22**, the first heat source pipe **28**, and the first shutoff valve **32**, and the rest is sent to the secondary-side flow path **35***a* of the cascade heat exchanger **35** through the first switching valve **22***a* of the secondary-side switching mechanism **22** and the third heat source pipe **25**.

Then, the high-pressure refrigerant sent to the secondary-side first connection pipe **8** is sent to the first branch pipe **63***c*. The high-pressure refrigerant sent to the first branch pipe **63***c* is sent to the utilization-side heat exchanger **52***c* of the utilization unit **3***c* via the first control valve **66***c* and the junction pipe **62***c*.

Then, the high-pressure refrigerant sent to the utilization-side heat exchanger **52***c* exchanges heat with indoor air supplied by the indoor fan **53***c* in the utilization-side heat exchanger **52***c*. As a result, the refrigerant flowing through the utilization-side heat exchanger **52***c* dissipates heat. The indoor air is heated and supplied into the room, and the heating operation of the utilization unit **3***c* is performed. The refrigerant having dissipated heat in the utilization-side heat exchanger **52***c* flows through the second utilization pipe **56***c*, and a flow rate of the refrigerant is adjusted in the utilization-side expansion valve **51***c*. Thereafter, the refrigerant flowing through the second connection pipe **16***c* is sent to the third branch pipe **61***c* of the branch unit **6***c*.

Then, the refrigerant sent to the third branch pipe **61***c* is sent to the secondary-side third connection pipe **7**.

Further, the high-pressure refrigerant sent to the secondary-side flow path **35***a* of the cascade heat exchanger **35** radiates heat by exchanging heat with the primary-side refrigerant flowing through the primary-side flow path **35***b* in the cascade heat exchanger **35**. The secondary-side refrigerant that has dissipated heat in the cascade heat exchanger **35** flows into the secondary-side receiver **45** after a flow rate of the refrigerant is adjusted in the heat source-side expansion valve **36**. A part of the refrigerant that has flowed out of the secondary-side receiver **45** branches and flows into the secondary-side subcooling circuit **48**, is decompressed by the secondary-side subcooling expansion valve **48***a*, and then joins the suction flow path **23**. In the secondary-side subcooling heat exchanger **47**, another part of the refrigerant that has flowed out of the secondary-side receiver **45** is cooled by the refrigerant flowing through the secondary-side subcooling circuit **48**, and then is sent to the secondary-side third connection pipe **7** through the third shutoff valve **31** to join the refrigerant having radiated heat in the utilization-side heat exchanger **52***c*.

Then, the refrigerant joined at the secondary-side third connection pipe **7** branches into two and is sent to the third branch pipes **61***a* and **61***b* of the branch units **6***a* and **6***b*. Thereafter, the refrigerant having flowed through the second connection pipes **16***a* and **16***b* is sent to the second utilization pipes **56***a* and **56***b* of the first and second utilization units **3***a* and **3***b*. The refrigerant flowing through the second utilization pipes **56***a* and **56***b* passes through the utilization-side expansion valves **51***a* and **51***b* of the utilization units **3***a* and **3***b*.

Then, the refrigerant having passed through the utilization-side expansion valves **51***a* and **51***b* whose opening degrees are adjusted exchanges heat with indoor air supplied by the indoor fans **53***a* and **53***b* in the utilization-side heat exchangers **52***a* and **52***b*. As a result, the refrigerant flowing through the utilization-side heat exchangers **52***a* and **52***b* evaporates and becomes a low-pressure gas refrigerant. The indoor air is cooled and is supplied into the room. As a result, an indoor space is cooled. The low-pressure gas refrigerant evaporated in the utilization-side heat exchangers **52***a* and **52***b* is sent to the junction pipes **62***a* and **62***b* of the first and second branch units **6***a* and **6***b*.

Then, the low-pressure gas refrigerant sent to the junction pipes **62***a* and **62***b* is sent to the secondary-side second connection pipe **9** through the second control valves **67***a* and **67***b* and the second branch pipes **64***a* and **64***b* to join.

Then, the low-pressure gas refrigerant sent to the secondary-side second connection pipe **9** is returned to the suction side of the secondary-side compressor **21** through the second shutoff valve **33**, the second heat source pipe **29**, the suction flow path **23**, and the secondary-side accumulator **30**.

Note that, in this cooling main operation, the secondary-side refrigerant circuit **10** controls capacity, for example, by controlling the secondary-side compressor **21** such that evaporation temperature in a heat exchanger functioning as an evaporator for the secondary-side refrigerant among the utilization-side heat exchanger **52***a*, **52***b*, and **52***c* becomes predetermined secondary-side evaporation target temperature. The primary-side refrigerant circuit **5***a* controls capacity, for example, by controlling the primary-side compressor **71** such that evaporation temperature of the primary-side refrigerant in the primary-side flow path **35***b* of the cascade heat exchanger **35** becomes predetermined primary-side evaporation target temperature. Here, the primary-side evaporation target temperature is changed such that a carbon dioxide refrigerant flowing through the secondary-side flow path **35***a* of the cascade heat exchanger **35** does not exceed a critical point when an operation condition is not a predetermined operation condition in which the carbon dioxide refrigerant exceeds the critical point. Also, the primary-side evaporation target temperature is changed such that the carbon dioxide refrigerant exceeds the critical point by more than a predetermined amount when the operation condition is the predetermined operation condition in which the carbon dioxide refrigerant exceeds the critical point.

In this manner, the operation in the cooling main operation is performed.

(9-4) Heating Main Operation

In the heating main operation, for example, the utilization-side heat exchangers **52***a* and **52***b* of the utilization units **3***a* and **3***b* function as refrigerant radiators, and the utilization-side heat exchanger **52***c* functions as a refrigerant evaporator. In the heating main operation, the cascade heat exchanger **35** functions as an evaporator for the secondary-side refrigerant. In the heating main operation, the primary-side refrigerant circuit **5***a* and the secondary-side refrigerant circuit **10** of the refrigeration cycle apparatus **1** are configured as illustrated in FIG. **6**. Arrows attached to the primary-side refrigerant circuit **5***a* and arrows attached to the secondary-side refrigerant circuit **10** in FIG. **6** indicate flows of the refrigerant during the heating main operation.

Specifically, in the primary-side unit **5**, by switching the primary-side switching mechanism **72** to the sixth connection state, the cascade heat exchanger **35** functions as a radiator for the primary-side refrigerant. The sixth connection state of the primary-side switching mechanism **72** is a connection state indicated by broken lines in the primary-side switching mechanism **72** in FIG. **6**. As a result, in the primary-side unit **5**, the primary-side refrigerant discharged from the primary-side compressor **71**, passed through the primary-side switching mechanism **72**, and passed through the first gas shutoff valve **109** passes through the primary-side second connection pipe **112** and the second gas shutoff valve **107**, and is sent to the primary-side flow path **35***b* of the cascade heat exchanger **35**. The refrigerant flowing through the primary-side flow path **35***b* of the cascade heat exchanger **35** is condensed by exchanging heat with the secondary-side refrigerant flowing through the secondary-side flow path **35***a*. When flowing through the second refrigerant pipe **114**, the primary-side refrigerant condensed in the cascade heat exchanger **35** passes through the primary-side second expansion valve **102** controlled to a fully open state. Then, the primary-side refrigerant flows through the second liquid shutoff valve **106**, the primary-side first connection pipe **111**, the first liquid shutoff valve **108**, and the primary-side subcooling heat exchanger **103** in this order, and is decompressed by the primary-side first expansion valve **76**. Note that, during the heating main operation, the primary-side subcooling expansion valve **104***a* is controlled to a closed state, so that the refrigerant does not flow into the primary-side subcooling circuit **104**. Therefore, heat is not exchanged in the primary-side subcooling heat exchanger **103** either. Note that a valve opening degree of the primary-side first expansion valve **76** is controlled such that, for example, a degree of superheating of the refrigerant sucked into the primary-side compressor **71** satisfies a predetermined condition. The refrigerant decompressed by the primary-side first expansion valve **76** evaporates by exchanging heat with outdoor air supplied from the primary-side fan **75** in the primary-side heat exchanger **74**, passes through the primary-side switching mechanism **72** and the primary-side accumulator **105**, and is sucked into the primary-side compressor **71**.

In the heat source unit **2**, the secondary-side switching mechanism **22** is switched to the second connection state. In the second connection state of the secondary-side switching mechanism **22**, the discharge flow path **24** and the first heat source pipe **28** are connected by the second switching valve **22***b*, and the third heat source pipe **25** and the suction flow path **23** are connected by the first switching valve **22***a*. The cascade heat exchanger **35** thus functions as an evaporator for the second-side refrigerant. Further, an opening degree of the heat source-side expansion valve **36** is adjusted. In the first to third branch units **6***a*, **6***b*, and **6***c*, the first control valves **66***a* and **66***b* and the second control valve **67***c* are controlled to open states, and the first control valve **66***c* and the second control valves **67***a* and **67***b* are controlled to closed states. Accordingly, the utilization-side heat exchangers **52***a* and **52***b* of the utilization units **3***a* and **3***b* function as refrigerant radiators, and the utilization-side heat exchanger **52***c* of the utilization unit **3***c* functions as a refrigerant evaporator. The utilization-side heat exchanger **52***c* of the utilization unit **3***c* and the suction side of the secondary-side compressor **21** of the heat source unit **2** are connected via the first utilization pipe **57***c*, the first connection pipe **15***c*, the junction pipe **62***c*, the second branch pipe **64***c*, and the secondary-side second connection pipe **9**. Further, the utilization-side heat exchangers **52***a* and **52***b* of the utilization units **3***a* and **3***b* and the discharge side of the secondary-side compressor **21** of the heat source unit **2** are connected via the discharge flow path **24**, the first heat source pipe **28**, the secondary-side first connection pipe **8**, the first branch pipes **63***a* and **63***b*, the junction pipes **62***a* and **62***b*, the first connection pipes **15***a* and **15***b*, and the first utilization pipes **57***a* and **57***b*. Further, the secondary-side subcooling expansion valve **48***a* and the bypass expansion valve **46***a* are controlled to closed states. In the utilization units **3***a*, **3***b*, and **3***c*, opening degrees of the utilization-side expansion valves **51***a*, **51***b*, and **51***c* are adjusted.

In such a secondary-side refrigerant circuit **10**, the high-pressure secondary-side refrigerant compressed and discharged by the secondary-side compressor **21** is sent to the secondary-side first connection pipe **8** through the second switching valve **22***b* of the secondary-side switching mechanism **22**, the first heat source pipe **28**, and the first shutoff valve **32**.

Then, the high-pressure refrigerant sent to the secondary-side first connection pipe **8** is branched into two and sent to the first branch pipes **63***a* and **63***b* of the first branch unit **6***a* and the second branch unit **6***b* respectively connected to the first utilization unit **3***a* and the second utilization unit **3***b*, which are the utilization units in operation. The high-pressure refrigerant sent to the first branch pipes **63***a* and **63***b* is sent to the utilization-side heat exchangers **52***a* and **52***b* of the first utilization unit **3***a* and the second utilization unit **3***b* through the first control valves **66***a* and **66***b*, the junction pipes **62***a* and **62***b*, and the first connection pipes **15***a* and **15***b*.

Then, the high-pressure refrigerant sent to the utilization-side heat exchangers **52***a* and **52***b* exchange heat with indoor air supplied by the indoor fans **53***a* and **53***b* in the utilization-side heat exchangers **52***a* and **52***b*. As a result, the refrigerant flowing through the utilization-side heat exchangers **52***a* and **52***b* dissipates heat. The indoor air is heated and is supplied into the room. As a result, an indoor space is heated. The refrigerant having dissipated heat in the utilization-side heat exchangers **52***a* and **52***b* flows through the second utilization pipes **56***a* and **56***b* and passes through the utilization-side expansion valves **51***a* and **51***b* whose opening degrees are adjusted. Thereafter, the refrigerant having flowed through the second connection pipes **16***a* and **16***b* is sent to the secondary-side third connection pipe **7** via the third branch pipes **61***a* and **61***b* of the branch units **6***a* and **6***b*.

Then, a part of the refrigerant sent to the secondary-side third connection pipe **7** is sent to the third branch pipe **61***c* of the branch unit **6***c*, and the rest is sent to the heat source-side expansion valve **36** through the third shutoff valve **31**.

Then, the refrigerant sent to the third branch pipe **61***c* flows through the second utilization pipe **56***c* of the utilization unit **3***c* via the second connection pipe **16***c*, and is sent to the utilization-side expansion valve **51***c*.

Then, the refrigerant having passed through the utilization-side expansion valve **51***c* whose opening degree is adjusted exchanges heat with indoor air supplied by the indoor fan **53***c* in the utilization-side heat exchanger **52***c*. As a result, the refrigerant flowing through the utilization-side heat exchanger **52***c* evaporates and becomes a low-pressure gas refrigerant. The indoor air is cooled and is supplied into the room. As a result, an indoor space is cooled. The low-pressure gas refrigerant evaporated in the utilization-side heat exchanger **52***c* passes through the first utilization pipe **57***c* and the first connection pipe **15***c*, and is sent to the junction pipe **62***c*.

Then, the low-pressure gas refrigerant sent to the junction pipe **62***c* is sent to the secondary-side second connection pipe **9** through the second control valve **67***c* and the second branch pipe **64***c*.

Then, the low-pressure gas refrigerant sent to the secondary-side second connection pipe **9** is returned to the suction side of the secondary-side compressor **21** through the second shutoff valve **33**, the second heat source pipe **29**, the suction flow path **23**, and the secondary-side accumulator **30**.

Further, the refrigerant sent to the heat source-side expansion valve **36** passes through the heat source-side expansion valve **36** whose opening degree is adjusted, and then exchanges heat with the primary-side refrigerant flowing through the primary-side flow path **35***b* in the secondary-side flow path **35***a* of the cascade heat exchanger **35**. As a result, the refrigerant flowing through the secondary-side flow path **35***a* of the cascade heat exchanger **35** evaporates to become a low-pressure gas refrigerant, and is sent to the first switching valve **22***a* of the secondary-side switching mechanism **22**. The low-pressure gas refrigerant sent to the first switching valve **22***a* of the secondary-side switching mechanism **22** joins the low-pressure gas refrigerant evaporated in the utilization-side heat exchanger **52***c* in the suction flow path **23**. The joined refrigerant is returned to the suction side of the secondary-side compressor **21** via the secondary-side accumulator **30**.

Note that, in this heating main operation, the secondary-side refrigerant circuit **10** controls capacity, for example, by controlling the secondary-side compressor **21** so as to process a load in a heat exchanger functioning as a radiator for the secondary-side refrigerant among the utilization-side heat exchangers **52***a*, **52***b*, and **52***c*. The primary-side refrigerant circuit **5***a* controls capacity, for example, by controlling the primary-side compressor **71** such that condensation temperature of the primary-side refrigerant in the primary-side flow path **35***b* of the cascade heat exchanger **35** becomes predetermined primary-side condensation target temperature.

In this manner, the operation in the heating main operation is performed.

(10) Structure of Primary-Side Unit and Heat Source Unit

FIG. **7** is a schematic external view illustrating a state in which the primary-side unit **5** and the heat source unit **2** are connected.

The primary-side unit **5** has the primary-side casing **5***x* having a substantially rectangular parallelepiped shape configured to have a plurality of surfaces. The primary-side casing **5***x* accommodates, as a part of the primary-side refrigerant circuit **5***a*, the primary-side compressor **71**, the primary-side switching mechanism **72**, the primary-side heat exchanger **74**, the primary-side first expansion valve **76**, the primary-side subcooling heat exchanger **103**, the primary-side subcooling circuit **104**, the primary-side subcooling expansion valve **104***a*, the first liquid shutoff valve **108**, the first gas shutoff valve **109**, and the primary-side accumulator **105**. The primary-side first connection pipe **111** and the primary-side second connection pipe **112**, which are parts of the primary-side refrigerant circuit **5***a*, extend from the primary-side casing **5***x*.

The heat source unit **2** includes the heat source casing **2***x* having a substantially rectangular parallelepiped shape. A part of the secondary-side refrigerant circuit **10** and a part of the primary-side refrigerant circuit **5***a* are accommodated in the heat source casing **2***x*. A part of the secondary-side refrigerant circuit **10** accommodated in the heat source casing **2***x* is the heat source circuit **12** including the secondary-side compressor **21**, the secondary-side switching mechanism **22**, the first heat source pipe **28**, the second heat source pipe **29**, the suction flow path **23**, the discharge flow path **24**, the third heat source pipe **25**, the fourth heat source pipe **26**, the fifth heat source pipe **27**, the secondary-side flow path **35***a* of the cascade heat exchanger **35**, the heat source-side expansion valve **36**, the third shutoff valve **31**, the first shutoff valve **32**, the second shutoff valve **33**, the secondary-side accumulator **30**, the oil separator **34**, the oil return circuit **40**, the secondary-side receiver **45**, the bypass circuit **46**, the bypass expansion valve **46***a*, the secondary-side subcooling heat exchanger **47**, the secondary-side subcooling circuit **48**, and the secondary-side subcooling expansion valve **48***a*. A part of the primary-side refrigerant circuit **5***a* accommodated in the heat source casing **2***x* includes the second liquid shutoff valve **106**, the second refrigerant pipe **114**, the primary-side second expansion valve **102**, the primary-side flow path **35***b* of the cascade heat exchanger **35**, the first refrigerant pipe **113**, and the second gas shutoff valve **107**. The secondary-side third connection pipe **7**, the secondary-side first connection pipe **8**, and the secondary-side second connection pipe **9**, which are parts of the secondary-side refrigerant circuit **10**, extend from the heat source casing **2***x*. Further, the primary-side first connection pipe **111** and the primary-side second connection pipe **112**, which are parts of the primary-side refrigerant circuit **5***a*, extend from the heat source casing **2***x*.

The heat source casing **2***x* has a plurality of surfaces including a top surface **120***b*, a first side surface **120***a*, a second side surface **120***c*, a bottom surface **120***d*, a third side surface (not illustrated), and a fourth side surface (not illustrated). Among them, an opening **120***x* is provided in the first side surface **120***a*. The primary-side first connection pipe **111** and the primary-side second connection pipe **112** pass through the opening **120***x*. The cascade heat exchanger **35** is placed on the bottom surface **120***d*.

Note that the second liquid shutoff valve **106** to which the primary-side first connection pipe **111** is connected and the second gas shutoff valve **107** to which the primary-side second connection pipe **112** is connected are located inside the opening **120***x* of the heat source casing **2***x*.

(11) Characteristics of Embodiment

In the refrigeration cycle apparatus **1** according to the present embodiment, the secondary-side refrigerant flowing through the secondary-side flow path **35***a* of the cascade heat exchanger **35** used as the heat source of the secondary-side refrigerant circuit **10** does not exchange heat with outdoor air, but exchanges heat with the primary-side refrigerant flowing through the primary-side refrigerant circuit **5***a*. Since temperature of the outdoor air changes naturally, it cannot be controlled. On the other hand, in the primary-side refrigerant circuit **5***a*, the primary-side compressor **71** or the like can control capacity. For this reason, even if the temperature of the outdoor air changes, the capacity is controlled in the primary-side refrigerant circuit **5***a*, so that it is easy to secure an amount of heat exchange required in the secondary-side flow path **35***a* of the cascade heat exchanger **35** of the secondary-side refrigerant circuit **10**. As a result, even if the temperature of the outdoor air changes, the amount of heat exchange in the secondary-side flow path **35***a* of the cascade heat exchanger **35** can be controlled so as to cope with load processing required in the secondary-side refrigerant circuit **10**.

In particular, in the present embodiment, the carbon dioxide refrigerant is used as the secondary-side refrigerant in the secondary-side refrigerant circuit **10**. This carbon dioxide refrigerant can exceed a critical point when used in a refrigeration cycle. On the other hand, in the refrigeration cycle apparatus **1** according to the present embodiment, the carbon dioxide refrigerant flowing through the secondary-side flow path **35***a* of the cascade heat exchanger **35** does not exchange heat with the outdoor air whose temperature cannot be controlled, but exchanges heat with the primary-side refrigerant whose temperature can be controlled flowing through the primary-side refrigerant circuit **5***a*. Therefore, not only the secondary-side compressor **21** or the like in the secondary-side refrigerant circuit **10** is controlled, but also the temperature and the flow rate of the primary-side refrigerant sent to the primary-side flow path **35***b* of the cascade heat exchanger **35** are controlled, whereby the carbon dioxide refrigerant flowing through the secondary-side flow path **35***a* of the cascade heat exchanger **35** can be prevented from exceeding the critical point. Since behavior of the carbon dioxide refrigerant in the vicinity of the critical point becomes unstable, when an operation condition of the refrigeration cycle apparatus **1** is an operation condition in which the carbon dioxide refrigerant in the secondary-side refrigerant circuit **10** is in the vicinity of the critical point, it is possible to stabilize the refrigeration cycle by controlling the secondary-side refrigerant circuit **10** and the primary-side refrigerant circuit **5***a* so that the carbon dioxide refrigerant greatly exceeds the critical point.

Further, in the refrigeration cycle apparatus **1** of the present embodiment, the binary refrigeration cycle is adopted, so that the secondary-side refrigerant circuit **10** can provide sufficient capacity.

Additionally, in the refrigeration cycle apparatus **1** according to the present embodiment, the secondary-side switching mechanism **22** that switches the flow path of the secondary-side refrigerant circuit **10** is provided on the discharge side of the secondary-side compressor **21**. During the cooling operation, the flow path is switched such that the secondary-side switching mechanism **22** is brought into the first connection state, whereby the refrigerant discharged from the secondary-side compressor **21** is sent to the secondary-side flow path **35***a* of the cascade heat exchanger **35** via the first switching valve **22***a* of the secondary-side switching mechanism **22**. At this time, in the second switching valve **22***b* of the secondary-side switching mechanism **22**, the discharge side of the secondary-side compressor **21** is connected to the closed fourth connection port. Therefore, during the cooling operation, the flow of the refrigerant discharged from the secondary-side compressor **21** is stopped at the second switching valve **22***b* of the secondary-side switching mechanism **22**, and does not flow to the first heat source pipe **28** and the secondary-side first connection pipe **8**. This can suppress accumulation of the secondary-side refrigerant and the refrigerating machine oil in the first heat source pipe **28** and the secondary-side first connection pipe **8** during the cooling operation. In particular, in the present embodiment, the first heat source pipe **28** and the secondary-side first connection pipe **8** are connected to the suction side of the secondary-side compressor **21** during the cooling operation, so that accumulation of the secondary-side refrigerant and the refrigerating machine oil in the first heat source pipe **28** and the secondary-side first connection pipe **8** is sufficiently suppressed.

This can suppress shortage of the secondary-side refrigerant in the secondary-side refrigerant circuit **10** during the cooling operation.

In addition, a filling amount of the secondary-side refrigerant filled in the secondary-side refrigerant circuit **10** can be reduced. In particular, in the present embodiment, carbon dioxide is used as the secondary-side refrigerant to be filled in the secondary-side refrigerant circuit **10**. When a refrigeration cycle is performed in a refrigerant circuit using this carbon dioxide refrigerant, the refrigerant circuit is required to be filled with the carbon dioxide refrigerant at high density. Even when the carbon dioxide refrigerant required to be filled at high density is used, the refrigeration cycle apparatus **1** according to the present embodiment can reduce the filling amount. In addition, since the filling amount of the carbon dioxide refrigerant can be reduced, safety is easily secured even if the carbon dioxide refrigerant leaks from the secondary-side refrigerant circuit **10**.

In the refrigeration cycle apparatus **1** according to the present embodiment, the primary-side refrigerant used in the primary-side refrigerant circuit **5***a* is different from the secondary-side refrigerant used in the secondary-side refrigerant circuit **10**. For this reason, as the refrigerant of the secondary-side refrigerant circuit **10** flowing through the utilization-side heat exchangers **52***a*, **52***b*, and **52***c* provided in the indoor in which a user stays, a refrigerant having lower flammability than the refrigerant used in the primary-side refrigerant circuit **5***a* can be selected.

Furthermore, in the refrigeration cycle apparatus **1** according to the present embodiment described above, the carbon dioxide refrigerant is used as the refrigerant in the secondary-side refrigerant circuit **10**. As compared with a case where the refrigerant such as R32 or R410A is used in all of the primary-side refrigerant circuit **5***a* and the secondary-side refrigerant circuit **10**, global warming potential (GWP) and ozone depletion potential (ODP) can be kept low. In addition, even if a refrigerant leak occurs on the utilization side, the refrigerant does not contain chlorofluorocarbon, and thus the chlorofluorocarbon does not flow out on the utilization side.

(12) Other Embodiments

(12-1) Another Embodiment A

In the above embodiment, a case where the first control valves **66***a*, **66***b*, and **66***c* are controlled to the closed states and the second control valves **67***a*, **67***b*, and **67***c* are controlled to the open states during the cooling operation has been described as an example.

On the other hand, as illustrated in FIG. **8**, while the secondary-side refrigerant circuit is a refrigerant circuit in which the bypass pipes **69***a*, **69***b*, and **69***c* provided with the check valves **68***a*, **68***b*, and **68***c* are not provided, both the first control valves **66***a*, **66***b*, and **66***c* and the second control valves **67***a*, **67***b*, and **67***c* may be controlled to open states during the cooling operation. This also allows the secondary-side refrigerant to be returned to the suction side of the secondary-side compressor **21** by using both the flow paths including the second branch pipes **64***a*, **64***b*, and **64***c*, the secondary-side second connection pipe **9**, and the second heat source pipe **29**, and the flow paths including the first branch pipes **63***a*, **63***b*, and **63***c*, the secondary-side first connection pipe **8**, and the first heat source pipe **28**. As a result, it is possible to increase a total flow path cross-sectional area when the secondary-side gas state refrigerant evaporated in the utilization-side heat exchangers **52***a*, **52***b*, and **52***c* is sent to the secondary-side compressor **21**, so that pressure loss can be reduced.

Note that, when the pressure loss of the secondary-side refrigerant is unlikely to cause a problem, the first control valves **66***a*, **66***b*, and **66***c* may be controlled to closed states during the cooling operation by the above circuit, and the secondary-side refrigerant may be returned to the secondary-side compressor **21** using only the flow paths formed by the second branch pipes **64***a*, **64***b*, and **64***c*, the secondary-side second connection pipe **9**, and the second heat source pipe **29**.

(12-2) Another Embodiment B

In the above embodiment, a case where the secondary-side switching mechanism **22** includes the first switching valve **22***a* and the second switching valve **22***b*, which are two four-way switching valves, has been described as an example.

On the other hand, at least one or both of the first switching valve **22***a* and the second switching valve **22***b* of the secondary-side switching mechanism **22** may include a three-way valve having a first connection port, a second connection port, and a third connection port. For example, as illustrated in FIG. **9**, the secondary-side switching mechanism **22** may include a first three-way valve **122***a* and a second three-way valve **122***b*. Here, a first connection port, a second connection port, and a third connection port of the first three-way valve **122***a* correspond to the first connection port, the second connection port, and the third connection port of the first switching valve **22***a* of the above embodiment. Further, a first connection port, a second connection port, and a third connection port of the second three-way valve **122***b* correspond to the first connection port, the second connection port, and the third connection port of the second switching valve **22***b* of the above embodiment.

This configuration also produces similar advantageous effects to those of the foregoing embodiment.

(12-3) Another Embodiment C

In the above embodiment, a case where the secondary-side switching mechanism **22** includes the first switching valve **22***a* and the second switching valve **22***b*, which are two four-way switching valves, has been described as an example.

On the other hand, as illustrated in FIG. **10**, for example, the secondary-side switching mechanism **22** may be configured by a circular flow path with four on-off valves **222***a*, **222***b*, **222***c*, and **222***d*, which are two-way valves, provided in a row of four.

Specifically, the secondary-side switching mechanism **22** according to another embodiment C includes a first on-off valve **222***a* provided in a flow path connecting the discharge flow path **24** and the third heat source pipe **25**, a second on-off valve **222***b* provided in a flow path connecting the discharge flow path **24** and the first heat source pipe **28**, a third on-off valve **222***c* provided in a flow path connecting the suction flow path **23** and the third heat source pipe **25**, and a fourth on-off valve **222***d* provided in a flow path connecting the suction flow path **23** and the first heat source pipe **28**. Each of the first on-off valve **222***a*, the second on-off valve **222***b*, the third on-off valve **222***c*, and the fourth on-off valve **222***d* is an electromagnetic valve that is switched between an open state and a closed state.

When performing the cooling operation for preventing the secondary-side refrigerant discharged from the secondary-side compressor **21** from being sent to the secondary-side first connection pipe **8** while causing the cascade heat exchanger **35** to function as a radiator for the secondary-side refrigerant, the secondary-side switching mechanism **22** according to the other embodiment C is switched to the first connection state by closing the third on-off valve **222***c* while opening the first on-off valve **222***a* to connect the discharge flow path **24** and the third heat source pipe **25**, and by opening or closing the fourth on-off valve **222***d* while closing the second on-off valve **222***b*. Further, when the cascade heat exchanger **35** functions as an evaporator for the secondary-side refrigerant to perform the heating operation or the heating main operation, the secondary-side switching mechanism **22** is switched to the second connection state by closing the first on-off valve **222***a* while opening the third on-off valve **222***c* to connect the suction flow path **23** and the third heat source pipe **25**, and by closing the fourth on-off valve **222***d* while opening the second on-off valve **222***b* to connect the discharge flow path **24** and the first heat source pipe **28**. In addition, when performing the cooling main operation by sending the secondary-side refrigerant discharged from the secondary-side compressor **21** to the secondary-side first connection pipe **8** while causing the cascade heat exchanger **35** to function as a radiator for the secondary-side refrigerant, the secondary-side switching mechanism **22** is switched to the third connection state by closing the third on-off valve **222**c while opening the first on-off valve **222**a to connect the discharge flow path **24** and the third heat source pipe **25**, and by closing the fourth on-off valve **222**d while opening the second on-off valve **222**b to connect the discharge flow path **24** and the first heat source pipe **28**.

This configuration also produces similar advantageous effects to those of the foregoing embodiment.

(12-4) Another Embodiment D

In the above embodiment, the secondary-side refrigerant circuit **10** in which the second heat source pipe **29** connected to the secondary-side second connection pipe **9** is connected to the suction flow path **23** has been described as an example.

On the other hand, as the secondary-side refrigerant circuit **10**, for example, as illustrated in FIG. **11**, the second heat source pipe **29** connected to the secondary-side second connection pipe **9** may be connected to a suction-side connection portion **22**y of the secondary-side switching mechanism **22** instead of the suction flow path **23**.

This configuration also produces similar advantageous effects to those of the foregoing embodiment.

(12-5) Another Embodiment E

In the above embodiment, the description has been given by exemplifying the secondary-side refrigerant circuit **10** that includes electromagnetic valves that can only be opened and closed are used as the first control valves **66**a, **66**b, and **66**c and the second control valves **67**a, **67**b, and **67**c, and the bypass pipes **69**a, **69**b, and **69**c provided with the check valves **68**a, **68**b, and **68**c and connecting the first branch pipe **63**a, **63**b, and **63**c and the second branch pipe **64**a, **64**b, and **64**c.

On the other hand, as shown in FIG. **12**, as the secondary-side refrigerant circuit **10**, instead of the first control valves **66**a, **66**b, and **66**c and the second control valves **67**a, **67**b, and **67**c of the above embodiment, first control valves **166**a, **166**b, and **166**c and second control valves **167**a, **167**b, and **167**c that are electric expansion valves each capable of adjusting an opening degree may be used. Further, in the secondary-side refrigerant circuit **10**, the bypass pipes **69**a, **69**b, and **69**c provided with the check valves **68**a, **68**b, and **68**c may be omitted.

This configuration also produces similar advantageous effects to those of the foregoing embodiment.

Note that, in the circuit in which the bypass pipes **69**a, **69**b, and **69**c are omitted, during the cooling operation, both the first control valves **166**a, **166**b, and **166**c and the second control valves **167**a, **167**b, and **167**c may be controlled to open states. Alternatively, the first control valves **166**a, **166**b, and **166**c may be controlled to closed states, and the second control valves **167**a, **167**b, and **167**c may be controlled to open states.

(12-6) Another Embodiment F

In the above embodiment, R32 or R410A is exemplified as the refrigerant used in the primary-side refrigerant circuit **5**a, and carbon dioxide is exemplified as the refrigerant used in the secondary-side refrigerant circuit **10**.

On the other hand, the refrigerant used in the primary-side refrigerant circuit **5**a is not limited, and an HFC-32, an HFO refrigerant, a mixed refrigerant of the HFC-32 and the HFO refrigerant, carbon dioxide, ammonia, propane, or the like can be used.

Further, the refrigerant used in the secondary-side refrigerant circuit **10** is not limited, and an HFC-32, an HFO refrigerant, a mixed refrigerant of the HFC-32 and the HFO refrigerant, carbon dioxide, ammonia, propane, or the like can be used.

Note that, as the HFO refrigerant, for example, HFO-1234yf, HFO-1234ze, or the like can be used.

Further, the same refrigerant or different refrigerants may be used in the primary-side refrigerant circuit **5**a and the secondary-side refrigerant circuit **10**. Preferably, the refrigerant used in the secondary-side refrigerant circuit **10** has at least one of lower global warming potential (GWP), lower ozone depletion potential (ODP), lower flammability, and lower toxicity than the refrigerant used in the primary-side refrigerant circuit **5**a. In particular, when an overall content volume of the secondary-side refrigerant circuit **10** is larger than an overall content volume of the primary-side refrigerant circuit **5**a, by using the refrigerant lower than the refrigerant in the primary-side refrigerant circuit **5**a in at least one of the global warming potential (GWP), the ozone depletion potential (ODP), the flammability, and the toxicity in the secondary-side refrigerant circuit **10**, adverse effects when a leak occurs can be reduced.

(12-7) Another Embodiment G

In the above embodiment, the refrigeration cycle apparatus **1** in which one heat source unit **2** is connected to one primary-side unit **5** has been described as an example.

On the other hand, as shown in FIG. **13**, for example, by connecting a first heat source unit **2**a, a second heat source unit **2**b, and a third heat source unit **2**c, which are a plurality of heat source units, in parallel to one primary-side unit **5**, the refrigeration cycle apparatus **1** may include a first secondary-side refrigerant circuit **10**a including a first heat source circuit **12**a, a second secondary-side refrigerant circuit **10**b including a second heat source circuit **12**b, and a third secondary-side refrigerant circuit **10**c including a third heat source circuit **12**c. Note that, in FIG. **13**, an internal structure of each of the first heat source unit **2**a, the second heat source unit **2**b, and the third heat source unit **2**c is similar to that of the heat source unit **2** according to the above embodiment, and thus only a part of each heat source unit is illustrated.

Although not illustrated, each of the first heat source unit **2**a, the second heat source unit **2**b, and the third heat source unit **2**c is connected with the plurality of branch units **6**a, **6**b, and **6**c and the plurality of utilization units **3**a, **3**b, and **3**c as in the above embodiment. Specifically, the first heat source unit **2**a is connected with a plurality of branch units and utilization units via a secondary-side third connection pipe **7**a, a secondary-side first connection pipe **8**a, and a secondary-side second connection pipe **9**a. The second heat source unit **2**b is connected, via a secondary-side third connection pipe **7**b, a secondary-side first connection pipe **8**b, and a secondary-side second connection pipe **9**b, with a plurality of branch units and utilization units different from those connected with the first heat source unit **2**a. The third heat source unit **2**c is connected, via a secondary-side third connection pipe **7**c, a secondary-side first connection pipe **8**c, and a secondary-side second connection pipe **9**c, with another plurality of branch units and utilization units different from those connected to the first heat source unit **2***a* and different from those connected to the second heat source unit **2***b*.

Here, the primary-side unit **5** and the first heat source unit **2***a* are connected via a primary-side first connection pipe **111***a* via a primary-side second connection pipe **112***a*. The primary-side unit **5** and the second heat source unit **2***b* are connected via a primary-side first connection pipe **111***b* branched from the primary-side first connection pipe **111***a* and a primary-side second connection pipe **112***b* branched from the primary-side second connection pipe **112***a*. The primary-side unit **5** and the third heat source unit **2***c* are connected via a primary-side first connection pipe **111***c* branched from the primary-side first connection pipe **111***a* and a primary-side second connection pipe **112***c* branched from the primary-side second connection pipe **112***a*.

Here, each of the first heat source unit **2***a*, the second heat source unit **2***b*, and the third heat source unit **2***c* includes a primary-side second expansion valve **102** whose opening degree is controlled by the first heat source unit **2***a*, the second heat source unit **2***b*, and the third heat source unit **2***c*. Further, a first heat source-side control unit **20***a* included in the first heat source unit **2***a*, a second heat source-side control unit **20***b* included in the second heat source unit **2***b*, and a third heat source-side control unit **20***c* included in the third heat source unit **2***c* control the opening degree of the corresponding primary-side second expansion valve **102**. Similarly to the above embodiment, each of the first heat source-side control unit **20***a*, the second heat source-side control unit **20***b*, and the third heat source-side control unit **20***c* controls the valve opening degree of the corresponding primary-side second expansion valve **102** on the basis of conditions of the first heat source circuit **12***a*, the second heat source circuit **12***b*, and the third heat source circuit **12***c* controlled by the first heat source-side control unit **20***a*, the second heat source-side control unit **20***b*, and the third heat source-side control unit **20***c*. As a result, the primary-side refrigerant flowing through the primary-side refrigerant circuit **5***a* is controlled to have a flow rate of the primary-side refrigerant in the primary-side first connection pipe **111***a* and the primary-side second connection pipe **112***a*, a flow rate of the primary-side refrigerant in the primary-side first connection pipe **111***b* and the primary-side second connection pipe **112***b*, and a flow rate of the primary-side refrigerant in the primary-side first connection pipe **111***c* and the primary-side second connection pipe **112***c* so as to correspond to a difference in loads in the first secondary-side refrigerant circuit **10***a*, the second secondary-side refrigerant circuit **10***b*, and the third secondary-side refrigerant circuit **10***c*.

(12-8) Others

Note that, in the first operation, all of the plurality of second heat exchangers may function as evaporators for the second refrigerant. Alternatively, the second heat exchanger functioning as an evaporator for the second refrigerant and the second heat exchanger in an operation stop state or a state in which the second refrigerant does not flow may coexist in the plurality of second heat exchangers.

Note that the refrigeration cycle apparatus may include a control unit capable of switching the second switching mechanism and controlling the first operation.

Note that, in the second operation, all of the plurality of second heat exchangers may function as radiators for the second refrigerant. Alternatively, the second heat exchanger functioning as a radiator for the second refrigerant and the second heat exchanger in an operation stop state or a state in which the second refrigerant does not flow may coexist in the plurality of second heat exchangers.

Note that the refrigeration cycle apparatus may include a control unit capable of switching the second switching mechanism and controlling the second operation.

Note that the refrigeration cycle apparatus may include a control unit capable of switching the second switching mechanism and controlling the third operation.

Note that the refrigeration cycle apparatus may include a control unit capable of switching the second switching mechanism and controlling the fourth operation.

Note that the on-off valve only needs to be a valve capable of at least being in an open state and a closed state, and may be a valve capable of switching between two states of the open state and the closed state, or may be a valve capable of controlling a valve opening degree in stages.

Note that the first refrigerant is preferably a refrigerant having higher capacity than the second refrigerant.

Further, the flammability can be compared according to classifications related to ASHRAE 34 flammability, for example.

Note that the toxicity can be compared, for example, according to classifications related to ASHRAE 34 safety grade.

Supplementary Note

Although the embodiments of the present disclosure have been described above, it will be understood that various changes in form and details can be made without departing from the spirit and scope of the present disclosure described in claims.

REFERENCE SIGNS LIST

1: refrigeration cycle apparatus.
2: heat source unit
2*x*: heat source casing
3*a*: first utilization unit
3*b*: second utilization unit
3*c*: third utilization unit
5: primary-side unit
5*a*: primary-side refrigerant circuit (first circuit)
5*x*: primary-side casing
7: secondary-side third connection pipe (third connection flow path)
8: secondary-side first connection pipe (first connection flow path)
9: secondary-side second connection pipe (second connection flow path)
10: secondary-side refrigerant circuit (second circuit)
12: heat source circuit
13*a*, **13***b*, **13***c*: utilization circuit
15*a*, **15***b*, **15***c*: first connection pipe (first connection flow path and second connection flow path)
16*a*, **16***b*, **16***c*: second connection pipe (third connection flow path)
20: heat source-side control unit
21: secondary-side compressor (second compressor)
21*a*: compressor motor
22: secondary-side switching mechanism (second switching mechanism)
22*a*: first switching valve (four-way switching valve)
22*b*: second switching valve (four-way switching valve)
22*x*: discharge-side connection portion
22*y*: suction-side connection portion (portion on suction flow path side)
23: suction flow path

24: discharge flow path
25: third heat source pipe
26: fourth heat source pipe (third connection flow path)
27: fifth heat source pipe (third connection flow path)
28: first heat source pipe (first connection flow path)
29: second heat source pipe (second connection flow path)
30: secondary-side accumulator
34: oil separator
35: cascade heat exchanger
35*a*: secondary-side flow path (second portion)
35*b*: primary-side flow path (first portion)
36: heat source-side expansion valve
37: secondary-side suction pressure sensor
38: secondary-side discharge pressure sensor
39: secondary-side discharge temperature sensor
40: oil return circuit
41: oil return flow path
42: oil return capillary tube
44: oil return on-off valve
45: secondary-side receiver
46: bypass circuit
46*a*: bypass expansion valve
47: secondary-side subcooling heat exchanger
48: secondary-side subcooling circuit
48*a*: secondary-side subcooling expansion valve
50*a-c*: utilization-side control unit
51*a-c*: utilization-side expansion valve
52*a-c*: utilization-side heat exchanger (second heat exchanger)
53*a-c*: indoor fan
56*a*, **56***b*, **56***c*: second utilization pipe (third connection flow path)
57*a*, **57***b*, **57***c*: first utilization pipe (first connection flow path and second connection flow path)
58*a*, **58***b*, **58***c*: liquid-side temperature sensor
60*a*, **60***b*, **60***c*: branch unit control unit
61*a*, **61***b*, **61***c*: third branch pipe (third connection flow path)
62*a*, **62***b*, **62***c*: junction pipe (first connection flow path and second connection flow path)
63*a*, **63***b*, **63***c*: first branch pipe (first connection flow path)
64*a*, **64***b*, **64***c*: second branch pipe (second connection flow path)
66*a*, **66***b*, **66***c*: first control valve
67*a*, **67***b*, **67***c*: second control valve
68*a*, **68***b*, **68***c*: check valve
69*a*, **69***b*, **69***c*: bypass pipe
70: primary-side control unit
71: primary-side compressor (first compressor)
72: primary-side switching mechanism (first switching mechanism)
74: primary-side heat exchanger (first heat exchanger)
76: primary-side first expansion valve
77: outdoor air temperature sensor
78: primary-side discharge pressure sensor
79: primary-side suction pressure sensor
81: primary-side suction temperature sensor
82: primary-side heat-exchange temperature sensor
83: secondary-side cascade temperature sensor
84: receiver outlet temperature sensor
85: bypass circuit temperature sensor
86: subcooling outlet temperature sensor
87: subcooling circuit temperature sensor
88: secondary-side suction temperature sensor
80: control unit
102: primary-side second expansion valve
103: primary-side subcooling heat exchanger
104: primary-side subcooling circuit
104*a*: primary-side subcooling expansion valve
105: primary-side accumulator
111: primary-side first connection pipe
112: primary-side second connection pipe
113: first refrigerant pipe
114: second refrigerant pipe
166*a*, **166***b*, **166***c*: first control valve
167*a*, **167***b*, **167***c*: second control valve
122*a*: first three-way valve (three-way valve)
122*b*: second three-way valve (three-way valve)
222*a*: first on-off valve (on-off valve)
222*b*: second on-off valve (on-off valve)
222*c*: third on-off valve (on-off valve)
222*d*: fourth on-off valve (on-off valve)

CITATION LIST

Patent Literature

Patent Literature 1: WO 2018/235832 A

The invention claimed is:

1. A refrigeration cycle apparatus comprising:

a processor,

a first circuit, in which a first refrigerant circulates, including a first compressor, a first portion of a cascade heat exchanger, a first heat exchanger, and a first switching mechanism located between the first compressor and the first heat exchanger and switching a flow path; and

a second circuit, in which a second refrigerant circulates, including a second compressor, a discharge flow path extending from a discharge side of the second compressor, a suction flow path extending from a suction side of the second compressor, a second portion of the cascade heat exchanger, a second switching mechanism, a plurality of second heat exchangers, a first connection flow path, a second connection flow path, and a third connection flow path,

wherein

the first connection flow path connects the second switching mechanism and the plurality of second heat exchangers,

the second connection flow path connects the plurality of second heat exchangers and the suction flow path or a portion of the second switching mechanism on a suction flow path side,

the third connection flow path connects the plurality of second heat exchangers and the second portion of the cascade heat exchanger,

the second switching mechanism is connected with the discharge flow path, the suction flow path, a flow path extending from the second portion of the cascade heat exchanger, and the first connection flow path, and switches a flow of the second refrigerant within the second circuit,

the second refrigerant is a carbon oxide, and

the processor is configured to control the first compressor so that the second refrigerant flowing through the second portion of the cascade heat exchanger does not exceed a critical point.

2. The refrigeration cycle apparatus according to claim **1**, wherein

a first operation of causing the cascade heat exchanger to function as a radiator for the second refrigerant and causing the plurality of second heat exchangers to function as evaporators for the second refrigerant is possible, and

in the second switching mechanism, the flow of the second refrigerant within the second circuit is switched during the first operation such that the discharge flow path and the flow path extending from the second portion of the cascade heat exchanger are connected and the discharge flow path and the first connection flow path are not connected.

3. The refrigeration cycle apparatus according to claim **1**, wherein

a second operation of causing the cascade heat exchanger to function as an evaporator for the second refrigerant and causing the plurality of second heat exchangers to function as radiators for the second refrigerant is possible, and

in the second switching mechanism, the flow of the second refrigerant within the second circuit is switched during the second operation such that the discharge flow path and the flow path extending from the second portion of the cascade heat exchanger are not connected and the discharge flow path and the first connection flow path are connected.

4. The refrigeration cycle apparatus according to claim **1**, wherein

a third operation in which the cascade heat exchanger is caused to function as a radiator for the second refrigerant and the plurality of second heat exchangers includes both the second heat exchanger functioning as a radiator for the second refrigerant and the second heat exchanger functioning as an evaporator for the second refrigerant is possible, and

in the second switching mechanism, the flow of the second refrigerant within the second circuit is switched during the third operation such that the discharge flow path and the flow path extending from the second portion of the cascade heat exchanger are connected and the discharge flow path and the first connection flow path are connected.

5. The refrigeration cycle apparatus according to claim **1**, wherein

a fourth operation in which the cascade heat exchanger is caused to function as an evaporator for the second refrigerant and the plurality of second heat exchangers includes both the second heat exchanger functioning as a radiator for the second refrigerant and the second heat exchanger functioning as an evaporator for the second refrigerant is possible, and

in the second switching mechanism, the flow of the second refrigerant within the second circuit is switched during the fourth operation such that the discharge flow path and the flow path extending from the second portion of the cascade heat exchanger are not connected and the discharge flow path and the first connection flow path are connected.

6. The refrigeration cycle apparatus according to claim **1**, wherein

the first heat exchanger exchanges heat between the first refrigerant and outdoor air.

7. The refrigeration cycle apparatus according to claim **6**, wherein

at least either heat absorbing capacity or heat releasing capacity of the first refrigerant in the first portion of the cascade heat exchanger is adjustable by controlling a state of a refrigeration cycle of the first refrigerant in the first circuit.

8. The refrigeration cycle apparatus according to claim **1**, wherein

the second switching mechanism includes any of

two four-way switching valves provided in parallel on the discharge side of the second compressor,

two three-way valves provided in parallel on the discharge side of the second compressor, or

two on-off valves provided in parallel on the discharge side of the second compressor and two on-off valves provided in parallel on the suction side of the second compressor.

9. The refrigeration cycle apparatus according to claim **1**, wherein

the first refrigerant and the second refrigerant are different in refrigerant type.

10. The refrigeration cycle apparatus according to claim **9**, wherein

the second refrigerant has at least one of lower global warming potential, lower ozone depletion potential, lower flammability, and lower toxicity than the first refrigerant.

11. The refrigeration cycle apparatus according to claim **2**, wherein

a second operation of causing the cascade heat exchanger to function as an evaporator for the second refrigerant and causing the plurality of second heat exchangers to function as radiators for the second refrigerant is possible, and

in the second switching mechanism, the flow of the second refrigerant within the second circuit is switched during the second operation such that the discharge flow path and the flow path extending from the second portion of the cascade heat exchanger are not connected and the discharge flow path and the first connection flow path are connected.

12. The refrigeration cycle apparatus according to claim **2**, wherein

a third operation in which the cascade heat exchanger is caused to function as a radiator for the second refrigerant and the plurality of second heat exchangers includes both the second heat exchanger functioning as a radiator for the second refrigerant and the second heat exchanger functioning as an evaporator for the second refrigerant is possible, and

in the second switching mechanism, the flow of the second refrigerant within the second circuit is switched during the third operation such that the discharge flow path and the flow path extending from the second portion of the cascade heat exchanger are connected and the discharge flow path and the first connection flow path are connected.

13. The refrigeration cycle apparatus according to claim **3**, wherein

a third operation in which the cascade heat exchanger is caused to function as a radiator for the second refrigerant and the plurality of second heat exchangers includes both the second heat exchanger functioning as a radiator for the second refrigerant and the second heat exchanger functioning as an evaporator for the second refrigerant is possible, and

in the second switching mechanism, the flow of the second refrigerant within the second circuit is switched during the third operation such that the discharge flow path and the flow path extending from the second portion of the cascade heat exchanger are connected and the discharge flow path and the first connection flow path are connected.

14. The refrigeration cycle apparatus according to claim **2**, wherein

a fourth operation in which the cascade heat exchanger is caused to function as an evaporator for the second refrigerant and the plurality of second heat exchangers includes both the second heat exchanger functioning as a radiator for the second refrigerant and the second heat exchanger functioning as an evaporator for the second refrigerant is possible, and

in the second switching mechanism, the flow of the second refrigerant within the second circuit is switched during the fourth operation such that the discharge flow path and the flow path extending from the second portion of the cascade heat exchanger are not connected and the discharge flow path and the first connection flow path are connected.

15. The refrigeration cycle apparatus according to claim **3**, wherein

a fourth operation in which the cascade heat exchanger is caused to function as an evaporator for the second refrigerant and the plurality of second heat exchangers includes both the second heat exchanger functioning as a radiator for the second refrigerant and the second heat exchanger functioning as an evaporator for the second refrigerant is possible, and

in the second switching mechanism, the flow of the second refrigerant within the second circuit is switched during the fourth operation such that the discharge flow path and the flow path extending from the second portion of the cascade heat exchanger are not connected and the discharge flow path and the first connection flow path are connected.

16. The refrigeration cycle apparatus according to claim **4**, wherein

a fourth operation in which the cascade heat exchanger is caused to function as an evaporator for the second refrigerant and the plurality of second heat exchangers includes both the second heat exchanger functioning as a radiator for the second refrigerant and the second heat exchanger functioning as an evaporator for the second refrigerant is possible, and

in the second switching mechanism, the flow of the second refrigerant within the second circuit is switched during the fourth operation such that the discharge flow path and the flow path extending from the second portion of the cascade heat exchanger are not connected and the discharge flow path and the first connection flow path are connected.

17. The refrigeration cycle apparatus according to claim **2**, wherein

the first heat exchanger exchanges heat between the first refrigerant and outdoor air.

18. The refrigeration cycle apparatus according to claim **3**, wherein

the first heat exchanger exchanges heat between the first refrigerant and outdoor air.

19. The refrigeration cycle apparatus according to claim **4**, wherein

the first heat exchanger exchanges heat between the first refrigerant and outdoor air.

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