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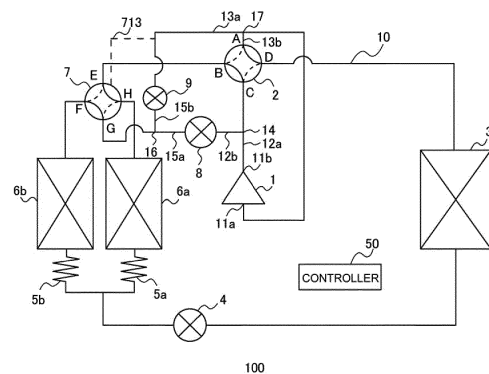
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(54) **AIR-CONDITIONING DEVICE**

(57) An air-conditioning apparatus includes a refrigerant circuit including: a compressor; a high-pressure pipe for high-pressure refrigerant discharged from the compressor; a low-pressure pipe for low-pressure refrigerant to be sucked into the compressor; a first flow switching valve; an indoor heat exchanger; an expansion valve; a first outdoor heat exchanger; a second outdoor heat exchanger; and a second flow switching valve. The second flow switching valve switches flow passages for refrigerant flowing to the first outdoor heat exchanger and the second outdoor heat exchanger. The second flow switching valve includes a first chamber, a second chamber, and a slide valve that is moved by a differential pressure between the first and second chambers. At least one of the first and second chambers is connected with the high-pressure pipe or the low-pressure pipe.

FIG. 1



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Description

Technical Field

[0001] The present disclosure relates to an air conditioning apparatus capable of performing a simultaneous heating and defrosting operation.

Background Art

[0002] In the past, air-conditioning apparatuses capable of performing a heating operation and a defrosting operation at the same time have been known. Patent Literature 1 discloses an air-conditioning apparatus in which a first heat exchange unit and a second heat exchange unit provided in an outdoor heat exchanger are alternately defrosted, whereby the outdoor heat exchanger can be defrosted without stopping a heating operation.

Citation List

Patent Literature

[0003] Patent Literature 1: International Publication No. 2019/003291

Summary of Invention

Technical Problem

[0004] An existing air-conditioning apparatus uses a differential pressure drive type of flow switching valve that switches a flow passage between a flow passage to a first heat exchange unit and a flow passage to a second heat exchange unit. In this case, in an operation in which high-pressure refrigerant flows in the entire region of the flow switching valve as in a cooling operation or low-pressure refrigerant flows in the entire region of the flow switching valve as in a heating operation, it is not possible to ensure a sufficient differential pressure necessary for the flow switching valve to switch the flow passage and to be fixed.

[0005] The present disclosure is applied to solve the above problem, and an object according to the present disclosure is to ensure a differential pressure in a flow switching valve in an air-conditioning apparatus capable of performing a simultaneous heating and defrosting operation.

Solution to Problem

[0006] An air-conditioning apparatus according to an embodiment of the present disclosure includes a refrigerant circuit that includes a compressor, a high-pressure pipe through which high-pressure refrigerant discharged from the compressor flows, a low-pressure pipe through which low-pressure refrigerant to be sucked into the com-

pressor flows, a first flow switching valve, an indoor heat exchanger, an expansion valve, a first outdoor heat exchanger, a second outdoor heat exchanger, and a second flow switching valve. The second flow switching valve switches flow passages for refrigerant flowing to the first outdoor heat exchanger and the second outdoor heat exchanger. The second flow switching valve includes a first chamber, a second chamber, and a slide valve configured to be moved by a differential pressure between the first chamber and the second chamber. At least one of the first chamber and the second chamber is connected with the high-pressure pipe or the low-pressure pipe.

15 Advantageous Effects of Invention

[0007] According to the present disclosure, one of the first chamber and the second chamber, between which a differential pressure is generated in the second flow switching valve, is connected with the high-pressure pipe or the low-pressure pipe, whereby it is possible to ensure a sufficient differential pressure for switching and fixation of the second flow switching valve.

25 Brief Description of Drawings

[0008]

[Fig. 1] Fig. 1 is a refrigerant circuit diagram illustrating a configuration of an air-conditioning apparatus according to Embodiment 1.

[Fig. 2] Fig. 2 is an explanatory view for explanation of how the air-conditioning apparatus according to Embodiment 1 is operated when the air-conditioning apparatus 100 is in a cooling operation.

[Fig. 3] Fig. 3 is an explanatory view for explanation of how the air-conditioning apparatus 100 according to Embodiment 1 is operated when the air-conditioning apparatus 100 is in a heating operation.

[Fig. 4] Fig. 4 is an explanatory view for explanation of how the air-conditioning apparatus according to Embodiment 1 is operated when the air-conditioning apparatus is in a first operation of a simultaneous heating and defrosting operation.

[Fig. 5] Fig. 5 is an explanatory view for explanation of how the air-conditioning apparatus according to Embodiment 1 is operated when the air-conditioning apparatus is in a second operation of the simultaneous heating and defrosting operation.

[Fig. 6] Fig. 6 is a sectional view schematically illustrating a configuration of a second flow switching valve according to Embodiment 1.

[Fig. 7] Fig. 7 is a p-h diagram of the air-conditioning apparatus according to Embodiment 1.

[Fig. 8] Fig. 8 is a sectional view schematically illustrating a configuration of a second flow switching valve according to Embodiment 2.

[Fig. 9] Fig. 9 is a sectional view schematically illus-

trating a configuration of a second flow switching valve according to Embodiment 3.

[Fig. 10] Fig. 10 is a sectional view schematically illustrating a configuration of a second flow switching valve according to Embodiment 4.

[Fig. 11] Fig. 11 is a refrigerant circuit diagram illustrating a configuration of an air-conditioning apparatus according to Embodiment 5.

Description of Embodiments

Embodiment 1

[0009] An air-conditioning apparatus 100 according to Embodiment 1 will be described. The air-conditioning apparatus 100 is a room air conditioner installed at a wall in an air-conditioning target space or an all-in-on air-conditioning system installed at a ceiling located above the air-conditioning target space. The air-conditioning apparatus 100 is capable of performing a cooling operation, a heating operation, a reverse cycle defrosting operation (hereinafter simply referred to as "defrosting operation"), and a simultaneous heating and defrosting operation.

(Configuration of Air-Conditioning Apparatus)

[0010] Fig. 1 is a refrigerant circuit diagram illustrating a configuration of the air-conditioning apparatus 100 according to Embodiment 1. As illustrated in Fig. 1, the air-conditioning apparatus 100 includes a refrigerant circuit 10 and a controller 50 that controls the refrigerant circuit 10. The refrigerant circuit 10 includes a compressor 1, a first flow switching valve 2, an indoor heat exchanger 3, an expansion valve 4, a first pressure reducing device 5a, a second pressure reducing device 5b, a first outdoor heat exchanger 6a, a second outdoor heat exchanger 6b, a second flow switching valve 7, a first valve 8, and a second valve 9.

[0011] The compressor 1 is a fluid machine that sucks low-pressure gas refrigerant, compresses the low-pressure gas refrigerant to change it into high-pressure gas refrigerant, and discharges the high-pressure gas refrigerant. The compressor 1 is an inverter drive compressor whose operating frequency can be adjusted. The operating frequency of the compressor 1 is controlled by the controller 50. The compressor 1 has a suction inlet 11a through which refrigerant is sucked and a discharge outlet through which compressed refrigerant is discharged. The suction inlet 11a is kept at a suction pressure, that is, a low pressure, and the discharge outlet 11b is kept at a discharge pressure, that is, a high pressure.

[0012] The first flow switching valve 2 is a four-way valve that switches a flow passage for refrigerant discharged from the compressor 1 between a plurality of flow passages. The first flow switching valve 2 has a first port A, a second port B, a third port C, and a fourth port D. The first port A is a low-pressure port that is kept at a low pressure whichever of the cooling operation, the

heating operation, the defrosting operation, and the simultaneous heating and defrosting operation is performed. The third port C is a high-pressure port that is kept at a high pressure whichever of the cooling operation, the heating operation, the defrosting operation, and the simultaneous heating and defrosting operation is performed. The first flow switching valve 2 can enter a first state indicated by solid lines in Fig. 1 and a second state indicated by broken lines in Fig. 1. When the first flow switching valve 2 is in the first state, the first port A and the fourth port D communicate with each other and the second port B and the third port C communicate with each other. When the first flow switching valve 2 is in the second state, the first port A and the second port B communicate with each other and the third port C and the fourth port D communicate with each other. In the cooling operation or the defrosting operation, the controller 50 sets the state of the first flow switching valve 2 to the first state, and in the heating operation or the simultaneous heating and defrosting operation, the controller 50 sets the state of the first flow switching valve 2 to the second state.

[0013] The indoor heat exchanger 3 is a heat exchanger that transfers heat between refrigerant that flows in the indoor heat exchanger 3 and air sent by an indoor fan (not illustrated) provided in an indoor unit. The indoor heat exchanger 3 operates as a condenser in the heating operation and operates as an evaporator in the cooling operation.

[0014] The expansion valve 4 is an electronic expansion valve that reduces the pressure of the refrigerant. The opening degree of the expansion valve 4 is adjusted by the controller 50.

[0015] The first pressure reducing device 5a and the second pressure reducing device 5b are respective capillary tubes that reduce the pressure of refrigerant flowing between the expansion valve 4 and the first outdoor heat exchanger 6a and the pressure of refrigerant flowing between the expansion valve 4 and the second outdoor heat exchanger 6b. The first pressure reducing device 5a is provided at the first outdoor heat exchanger 6a on an outflow side for the refrigerant in the cooling operation, and the second pressure reducing device 5b is provided at the second outdoor heat exchanger 6b on an outflow side for the refrigerant in the cooling operation.

[0016] The first outdoor heat exchanger 6a and the second outdoor heat exchanger 6b are each a heat exchanger that transfers heat between refrigerant flowing in the heat exchanger and air sent by an outdoor fan (not illustrated) provided in an outdoor unit. Each of the first outdoor heat exchanger 6a and the second outdoor heat exchanger 6b operates as an evaporator in the heating operation and operates as a condenser in the cooling operation. The first outdoor heat exchanger 6a and the second outdoor heat exchanger 6b are connected in parallel with each other in the refrigerant circuit 10. The first outdoor heat exchanger 6a and the second outdoor heat exchanger 6b are outdoor heat exchangers into which,

for example, a single heat exchanger is divided, and which are arranged one above the other. For example, the first outdoor heat exchanger 6a is located on a lower side, and the second outdoor heat exchanger 6b is located on an upper side. In this case, the first outdoor heat exchanger 6a and the second outdoor heat exchanger 6b are also arranged in parallel with each other for the flow of air.

[0017] The second flow switching valve 7 switches the flow passage for the refrigerant between a flow passage through which the refrigerant flows to the first outdoor heat exchanger 6a and a flow passage through which the refrigerant flows to the second outdoor heat exchanger 6b. The second flow switching valve 7 is a differential pressure drive type of four-way valve that is operated by a differential pressure. The second flow switching valve 7 has a first port E, a second port F, a third port G, and a fourth port H. The second flow switching valve 7 can enter a first state indicated by solid lines in Fig. 1 and a second state indicated by broken lines in Fig. 1. When the second flow switching valve 7 is in the first state, the first port E and the fourth port H communicate with each other and the second port F and the third port G communicate with each other. When the second flow switching valve 7 is in the second state, the first port E and the second port F communicate with each other and the third port G and the fourth port H communicate with each other. In the simultaneous heating and defrosting operation, the controller 50 sets the state of the second flow switching valve 7 to the first state or the second state.

[0018] The first valve 8 is a solenoid valve or an electronic expansion valve that adjusts the flow rate of refrigerant that flows from the discharge outlet 11b of the compressor 1 to the third port G of the second flow switching valve 7. The opening degree of the first valve 8 is adjusted by the controller 50.

[0019] The second valve 9 is a solenoid valve or an electronic expansion valve that adjusts the flow rate of refrigerant that flows from the third port G of the second flow switching valve 7 to the suction inlet 11a of the compressor 1. The opening degree of the second valve 9 is adjusted by the controller 50.

[0020] The discharge outlet 11b of the compressor 1 is connected with the third port C of the first flow switching valve 2 by a first high-pressure pipe 12a. In the first high-pressure pipe 12a, high-pressure refrigerant discharged from the discharge outlet 11b of the compressor 1 flows whichever of the cooling operation, the heating operation, the defrosting operation, and the simultaneous heating and defrosting operation is performed.

[0021] A branch portion 14 provided at an intermediate portion of the first high-pressure pipe 12a is connected with the first valve 8 by a second high-pressure pipe 12b. Also, in the second high-pressure pipe 12b, the high-pressure refrigerant discharged from the discharge outlet 11b of the compressor 1 flows whichever of the cooling operation, the heating operation, the defrosting operation, and the simultaneous heating and defrosting oper-

ation is performed. The first valve 8 is connected with the third port G of the second flow switching valve 7 by a first pipe 15a. That is, the third port G of the second flow switching valve 7 is connected with the discharge outlet 11b of the compressor 1 by the first pipe 15a, the first valve 8, the second high-pressure pipe 12b, and the first high-pressure pipe 12a. A branch portion 16 provided at an intermediate portion of the first pipe 15a is connected with the second valve 9 by a second pipe 15b.

[0022] The suction inlet 11a of the compressor 1 is connected with the second valve 9 by a first low-pressure pipe 13a. In the first low-pressure pipe 13a, low-pressure refrigerant that is to be sucked from the suction inlet 11a of the compressor 1 flows whichever of the cooling operation, the heating operation, the defrosting operation, and the simultaneous heating and defrosting operation is performed. Furthermore, to the first low-pressure pipe 13a, a pilot pipe 713 of the second flow switching valve 7 is connected. A branch portion 17 provided at an intermediate portion of the first low-pressure pipe 13a is connected with the first port A of the first flow switching valve 2 by a second low-pressure pipe 13b.

[0023] The fourth port D of the first flow switching valve 2 is connected with one port of the indoor heat exchanger 3 by a refrigerant pipe, and the other port of the indoor heat exchanger 3 is connected with one port of the expansion valve 4 by a refrigerant pipe.

[0024] The other port of the expansion valve 4 is connected with the first pressure reducing device 5a and the second pressure reducing device 5b by respective refrigerant pipes. The first pressure reducing device 5a and the second pressure reducing device 5b are connected with the first outdoor heat exchanger 6a and the second outdoor heat exchanger 6b, respectively. That is, the other port of the expansion valve 4 is connected with one port of the first outdoor heat exchanger 6a and one port of the second outdoor heat exchanger 6b via the refrigerant pipes and the first pressure reducing device 5a and the second pressure reducing device 5b. Furthermore, the one port of the first outdoor heat exchanger 6a is connected with the one port of the second outdoor heat exchanger 6b by a refrigerant pipe.

[0025] The other port of the first outdoor heat exchanger 6a is connected with the fourth port H of the second flow switching valve 7 by a refrigerant pipe. The other port of the second outdoor heat exchanger 6b is connected with the second port F of the second flow switching valve 7 by a refrigerant pipe. The first port E of the second flow switching valve 7 is connected with the second port B of the first flow switching valve 2 by a refrigerant pipe.

[0026] The controller 50 includes a microcomputer provided with a CPU, a ROM, a RAM, an I/O port, etc. The controller 50 controls components of the air-conditioning apparatus 100 to cause any of the cooling operation, the heating operation, the defrosting operation, and the simultaneous heating and defrosting operation to be performed, based on detection signals sent from various sensors (not illustrated) provided in the air-conditioning

apparatus 100 and set information input from the remote controller. To be more specific, the controller 50 controls the operating frequency of the compressor 1, switching of the state of each of the first flow switching valve 2 and the second flow switching valve 7, the opening degree of each of the expansion valve 4, the first valve 8, and the second valve, and the rotating speed of each of the fans. The various sensors provided in the air-conditioning apparatus 100 are an indoor temperature sensor that detects the temperature of the air-conditioning target space, an outside air temperature sensor that detects an outside air temperature, sensors that detect the temperatures or pressures of refrigerant flowing in the respective heat exchangers, a sensor that detects presence or absence of a person or persons in the air-conditioning target space, etc.

(Operation of Air-Conditioning Apparatus)

(Cooling Operation)

[0027] It will be described how the air-conditioning apparatus 100 is operated when the air-conditioning apparatus 100 is in the cooling operation. Fig. 2 is an explanatory view for explanation of how the air-conditioning apparatus 100 according to Embodiment 1 is operated when the air-conditioning apparatus 100 is in the cooling operation. As illustrated in Fig. 2, in the cooling operation, the first flow switching valve 2 and the second flow switching valve 7 are both set in the first state. Furthermore, the first valve 8 is opened to a predetermined opening degree, and the second valve 9 is closed.

[0028] At the branch portion 14 of the first high-pressure pipe 12a, high-pressure gas refrigerant discharged from the compressor 1 branches into gas refrigerant that flows into the third port C of the first flow switching valve 2 and gas refrigerant that flows into the second high-pressure pipe 12b. The gas refrigerant that has flowed into the third port C of the first flow switching valve 2 passes through the second port B of the first flow switching valve 2 and the first port E and the fourth port H of the second flow switching valve 7, and flows into the first outdoor heat exchanger 6a. The gas refrigerant that has flowed into the second high-pressure pipe 12b passes through the first valve 8, the first pipe 15a, and the third port G and the second port F of the second flow switching valve 7, and flows into the second outdoor heat exchanger 6b. In the cooling operation, the first outdoor heat exchanger 6a and the second outdoor heat exchanger 6b both operate as condensers. The gas refrigerant that has flowed into the first outdoor heat exchanger 6a and the gas refrigerant that has flowed into the second outdoor heat exchanger 6b condense to change into liquid refrigerant.

[0029] The liquid refrigerant that has flowed out of the first outdoor heat exchanger 6a is reduced in pressure at the first pressure reducing device 5a and flows into the expansion valve 4. The liquid refrigerant that has

flowed out of the second outdoor heat exchanger 6b is reduced in pressure at the second pressure reducing device 5b, joins the liquid refrigerant that has flowed out of the first outdoor heat exchanger 6a, and then flows into the expansion valve 4. The liquid refrigerant that has flowed into the expansion valve 4 is reduced in pressure to change into low-pressure two-phase refrigerant. The two-phase refrigerant that has flowed out of the expansion valve 4 flows into the indoor heat exchanger 3. In the cooling operation, the indoor heat exchanger 3 operates as an evaporator. That is, at the indoor heat exchanger 3, the refrigerant that flows in the indoor heat exchanger 3 receives heat from indoor air as evaporation heat. As a result, the two-phase refrigerant that has flowed into the indoor heat exchanger 3 evaporates to change into low-pressure gas refrigerant. On the other hand, the indoor air sent by the indoor fan transfers heat to the refrigerant and is thus cooled. The gas refrigerant that has flowed out of the indoor heat exchanger 3 passes through the fourth port D and the first port A of the first flow switching valve 2, the second low-pressure pipe 13b, and the first low-pressure pipe 13a, and is sucked into the compressor 1. The gas refrigerant that has sucked into the compressor 1 is compressed to change into high-pressure gas refrigerant. In the cooling operation, the above cycle is continuously repeated.

(Heating Operation)

[0030] It will be described how the air-conditioning apparatus 100 is operated when the air-conditioning apparatus 100 is in the heating operation. Fig. 3 is an explanatory view for explanation of how the air-conditioning apparatus 100 according to Embodiment 1 is operated when the air-conditioning apparatus 100 is in the heating operation. As illustrated in Fig. 3, in the heating operation, the first flow switching valve 2 is set in the second state, and the second flow switching valve 7 is set in the first state. Furthermore, the second valve 9 is opened to a predetermined opening degree, and the first valve 8 is closed.

[0031] High-pressure gas refrigerant discharged from the compressor 1 passes through the first high-pressure pipe 12a and the third port C and the fourth port D of the first flow switching valve 2, and flows into the indoor heat exchanger 3. In the heating operation, the indoor heat exchanger 3 operates as a condenser. That is, at the indoor heat exchanger 3, the refrigerant that flows in the indoor heat exchanger 3 exchanges heat with indoor air sent by the indoor fan, and transfers heat to the indoor air as condensation heat. As a result, the gas refrigerant that has flowed into the indoor heat exchanger 3 condenses to change into high-pressure liquid refrigerant. The indoor air sent by the indoor fan is heated by the heat transferred from the refrigerant.

[0032] The liquid refrigerant that flowed out of the indoor heat exchanger 3 flows into the expansion valve 4. The liquid refrigerant that has flowed into the expansion

valve 4 is reduced in pressure to change into low-pressure two-phase refrigerant. The two-phase refrigerant that has flowed out of the expansion valve 4 branch into two-phase refrigerant that flows into the first pressure reducing device 5a and two-phase refrigerant that flows into the second pressure reducing device 5b. The two-phase refrigerant that has flowed into the first pressure reducing device 5a is further reduced in pressure and flows into the first outdoor heat exchanger 6a. The two-phase refrigerant that has flowed into the second pressure reducing device 5b is further reduced in pressure and flows into the second outdoor heat exchanger 6b.

[0033] In the heating operation, the first outdoor heat exchanger 6a and the second outdoor heat exchanger 6b both operate as condensers. At each of the first outdoor heat exchanger 6a and the second outdoor heat exchanger 6b, refrigerant that flows in the outdoor heat exchanger exchanges heat with outdoor air sent by the outdoor fan and receives heat from the outdoor air as evaporation heat. As a result, the two-phase refrigerant that has flowed into each of the first outdoor heat exchanger 6a and the second outdoor heat exchanger 6b evaporates to change into low-pressure gas refrigerant.

[0034] The gas refrigerant that has flowed out of the first outdoor heat exchanger 6a passes through the fourth port H and the first port E of the second flow switching valve 7, the second port B and the first port A of the first flow switching valve 2, the second low-pressure pipe 13b, and the first low-pressure pipe 13a, and is sucked into the compressor 1. The gas refrigerant that has flowed out of the second outdoor heat exchanger 6b passes through the second port F and the third port G of the second flow switching valve 7, the first pipe 15a, the second pipe 15b, and the second valve 9, joins the gas refrigerant that has flowed out of the first outdoor heat exchanger 6a, in the first low-pressure pipe 13a, and is sucked into the compressor 1. The gas refrigerant that has sucked into the compressor 1 is compressed to change into high-pressure gas refrigerant. In the heating operation, the above cycle is continuously repeated.

(Simultaneous Heating and Defrosting Operation)

[0035] It will be described how the air-conditioning apparatus 100 is operated when the air-conditioning apparatus 100 is in the simultaneous heating and defrosting operation. The simultaneous heating and defrosting operation includes a first operation and a second operation. In the first operation, the first outdoor heat exchanger 6a and the indoor heat exchanger 3 operate as condensers, and the second outdoor heat exchanger 6b operates as an evaporator. As a result, the first outdoor heat exchanger 6a is defrosted while heating is being continued. In the second operation, the second outdoor heat exchanger 6b and the indoor heat exchanger 3 operate as condensers, and the first outdoor heat exchanger 6a operates as an evaporator. As a result, the second outdoor heat exchanger 6b is defrosted while heating is being continued.

[0036] In the case where the heating operation is performed, when a requirement for a start of the simultaneous heating and defrosting operation is satisfied, the controller 50 causes the simultaneous heating and defrosting operation to be performed. As the requirement for the start of the simultaneous heating and defrosting operation, for example, the following conditions are present: time that elapses from the start of the heating operation exceeds a threshold time, or the temperature of each of the first outdoor heat exchanger 6a and the second outdoor heat exchanger 6b reaches a threshold temperature or less. When the requirement for the start of the simultaneous heating and defrosting operation is satisfied, the controller 50 first causes the first operation to be performed, and then when elapsed time reaches predetermined time, or when the temperature of the first outdoor heat exchanger 6a exceeds the threshold temperature, the controller 50 causes the second operation to be performed.

[0037] Fig. 4 is an explanatory view for explanation of how the air-conditioning apparatus 100 according to Embodiment 1 is operated when the air-conditioning apparatus 100 is in the first operation of the simultaneous heating and defrosting operation. As illustrated in Fig. 4, in the first operation, the first flow switching valve 2 and the second flow switching valve 7 are both set in the second state. Furthermore, the first valve 8 is opened to a predetermined opening degree, and the second valve 9 is closed.

[0038] High-pressure gas discharged from the compressor 1 branches into gas refrigerant that flows into the third port C of the first flow switching valve 2 and gas refrigerant that flows into the second high-pressure pipe 12b. The gas refrigerant that has flowed into the second high-pressure pipe 12b passes through the first valve 8, the first pipe 15a, and the third port G and the fourth port H of the second flow switching valve 7, and flows into the first outdoor heat exchanger 6a. At the first outdoor heat exchanger 6a, frost adhering to the first outdoor heat exchanger 6a is molten by heat transferred from the refrigerant that flows in the first outdoor heat exchanger 6a. Thus, the first outdoor heat exchanger 6a is defrosted. The gas refrigerant that has flowed into the first outdoor heat exchanger 6a condenses to change into intermediate-pressure liquid refrigerant or two-phase refrigerant, flows out of the first outdoor heat exchanger 6a, and is reduced in pressure at the first pressure reducing device 5a.

[0039] Of the high-pressure gas refrigerant discharged from the compressor 1, the gas refrigerant that has flowed into the third port C of the first flow switching valve 2 passes through the fourth port D of the first flow switching valve 2 and flows into the indoor heat exchanger 3. At the indoor heat exchanger 3, the refrigerant that flows in the indoor heat exchanger 3 exchanges heat with indoor air sent by the indoor fan, and transfers heat to the indoor air as condensation heat. As a result, the gas refrigerant that has flowed into the indoor heat exchanger 3 con-

condenses to change into high-pressure liquid refrigerant. On the other hand, the indoor air sent by the indoor fan is heated by heat transferred from the refrigerant.

[0040] The liquid refrigerant that has flowed out of the indoor heat exchanger 3 flows into the expansion valve 4. The liquid refrigerant that has flowed into the expansion valve 4 is reduced in pressure to change into low-pressure two-phase refrigerant. The two-phase refrigerant that has flowed out of the expansion valve 4 joins the liquid refrigerant or two-phase refrigerant that has been reduced in pressure at the first pressure reducing device 5a, is further reduced in pressure at the second pressure reducing device 5b, and flows into the second outdoor heat exchanger 6b. At the second outdoor heat exchanger 6b, the refrigerant that flows in the second outdoor heat exchanger 6b exchanges heat with outdoor air sent by the outdoor fan, and receives heat from the outdoor air as evaporation heat. As a result, the two-phase refrigerant that has flowed into the second outdoor heat exchanger 6b evaporates to change into low-pressure gas refrigerant. The gas refrigerant that has flowed out of the second outdoor heat exchanger 6b passes through the second port F and the first port E of the second flow switching valve 7, the second port B and the first port A of the first flow switching valve 2, the second low-pressure pipe 13b, and the first low-pressure pipe 13a, and is sucked into the compressor 1. The gas refrigerant that has been sucked into the compressor 1 is compressed to change into high-pressure gas refrigerant. In the first operation of the simultaneous heating and defrosting operation, the above cycle is continuously repeated, whereby the first outdoor heat exchanger 6a is defrosted while heating is being continued.

[0041] Fig. 5 is an explanatory view for explanation of how the air-conditioning apparatus 100 according to Embodiment 1 is operated when the air-conditioning apparatus 100 is in the second operation of the simultaneous heating and defrosting operation. As illustrated in Fig. 5, in the second operation of the simultaneous heating and defrosting operation, the first flow switching valve 2 is set in the second state, and the second flow switching valve 7 is set in the first state. Furthermore, the first valve 8 is opened to a predetermined opening degree, and the second valve 9 is closed.

[0042] High-pressure gas refrigerant discharged from the compressor 1 branches, at the branch portion 14 of the first high-pressure pipe 12a, into gas refrigerant that flows into the third port C of the first flow switching valve 2 and gas refrigerant that flows into the second high-pressure pipe 12b. The gas refrigerant that has flowed into the second high-pressure pipe 12b passes through the first valve 8, the first pipe 15a, and the third port G and the second port F of the second flow switching valve 7, and flows into the second outdoor heat exchanger 6b. At the second outdoor heat exchanger 6b, frost adhering to the second outdoor heat exchanger 6b is molten by heat transferred from the refrigerant that flows in the second outdoor heat exchanger 6b. As a result, the second

outdoor heat exchanger 6b is defrosted. The gas refrigerant that has flowed into the second outdoor heat exchanger 6b condenses to change into intermediate-pressure liquid refrigerant or two-phase refrigerant, flows out of the second outdoor heat exchanger 6b as the intermediate-pressure liquid refrigerant or two-phase refrigerant, and is reduced in pressure at the second pressure reducing device 5b.

[0043] Of the high-pressure gas refrigerant discharged from the compressor 1, the gas refrigerant that has flowed into the third port C of the first flow switching valve 2 passes through the fourth port D of the first flow switching valve 2 and flows into the indoor heat exchanger 3. At the indoor heat exchanger 3, the refrigerant that flows in the indoor heat exchanger 3 exchanges heat with indoor air sent by the indoor fan, and transfers heat to the indoor air as condensation heat. As a result, the gas refrigerant that has flowed into the indoor heat exchanger 3 condenses to change into high-pressure liquid refrigerant. Furthermore, the indoor air sent by the indoor fan is heated by the heat transferred from the refrigerant.

[0044] The liquid refrigerant that has flowed out of the indoor heat exchanger 3 flows into the expansion valve 4. The liquid refrigerant that has flowed into the expansion valve 4 is reduced in pressure to change into low-pressure two-phase refrigerant. The two-phase refrigerant that has flowed out of the expansion valve 4 joins the liquid refrigerant or two-phase refrigerant that has been reduced in pressure at the second pressure reducing device 5b, is further reduced in pressure at the first pressure reducing device 5a, and flows into the first outdoor heat exchanger 6a. At the first outdoor heat exchanger 6a, the refrigerant that flows in the first outdoor heat exchanger 6a exchanges heat with outdoor air sent by the outdoor fan, and receives heat from the outdoor fan as evaporation heat. As a result, the two-phase refrigerant that has flowed into the first outdoor heat exchanger 6a evaporates to change into low-pressure gas refrigerant. The gas refrigerant that has flowed out of the first outdoor heat exchanger 6a passes through the fourth port H and the first port E of the second flow switching valve 7, the second port B and the first port A of the first flow switching valve 2, the second low-pressure pipe 13b, and the first low-pressure pipe 13a, and is sucked into the compressor 1. The gas refrigerant that has been sucked into the compressor 1 is compressed to change into high-pressure gas refrigerant. In the second operation of the simultaneous heating and defrosting operation, the above cycle is continuously repeated, whereby the second outdoor heat exchanger 6b is defrosted while heating is being continued.

(Defrosting Operation)

[0045] It will be described how the air-conditioning apparatus 100 is operated when the air-conditioning apparatus 100 is in the defrosting operation. In the case where the heating operation is operated, when a requirement

for a start of the defrosting operation is satisfied, the controller 50 causes the defrosting operation to be performed. As the requirement for the start of the defrosting operation, for example, the following conditions are present: a condition in which the heating load is low or no person is present in the air-conditioning target space, in addition to a condition in which the requirement for the start of the simultaneous heating and defrosting operation is satisfied. The operation of the air-conditioning apparatus 100 in the defrosting operation is the same as that in the cooling operation, which is illustrated in Fig. 2. In the defrosting operation, the first outdoor heat exchanger 6a and the second outdoor heat exchanger 6b both operate as condensers. That is, at each of the first outdoor heat exchanger 6a and the second outdoor heat exchanger 6b, frost adhering to the outdoor heat exchanger is molten by heat transferred by the refrigerant that flows in the outdoor heat exchanger. As a result, the first outdoor heat exchanger 6a and the second outdoor heat exchanger 6b are defrosted.

(Configuration of Second Flow Switching Valve)

[0046] A configuration of the second flow switching valve 7 according to Embodiment 1 will be described. Fig. 6 is a sectional view schematically illustrating a configuration of the second flow switching valve 7 according to Embodiment 1. As illustrated in Fig. 6, the second flow switching valve 7 includes a main valve 70 and a pilot valve 71.

[0047] The main valve 70 includes a cylinder 701, a slide rack 702 provided at part of an inner wall of the cylinder 701, and a slide valve 703 that is slid over the slide rack 702 along a central axis of the cylinder 701. At a central portion of the slide rack 702 in a direction along the central axis of the cylinder 701, the first port E is provided. The second port F and the fourth port H are located opposite to each other with respect to the first port E in the direction along the central axis of the cylinder 701. The third port G is located opposite to the first port E with respect to the central axis of the cylinder 701.

[0048] The slide valve 703 is formed in the shape of a dome having an opening that faces a side where the slide rack 702 is located. On one end side of the slide valve 703, a piston 704 is provided such that the piston 704 is coupled to the slide valve 703. Between one end of the cylinder 701 and the piston 704, a first chamber 706 is provided. On the other end side of the slide valve 703 in the direction along the central axis of the cylinder 701, a piston 705 is provided such that the piston 705 is coupled to the slide valve 703. Between the other end of the cylinder 701 and the piston 705, a second chamber 707 is provided. The pistons 704 and 705 are provided such that the pistons 704 and 705 are slidable along an inner wall surface of the cylinder 701. The pistons 704 and 705 are moved together with the slide valve 703 in the direction along the central axis of the cylinder 701.

[0049] The pilot valve 71 includes four pilot pipes 710,

711, 712, and 713. The pilot pipe 710 is connected with the third port G of the main valve 70; the pilot pipe 711 is connected with the first chamber 706 of the main valve 70; the pilot pipe 712 is connected with the second chamber 707 of the main valve 70; and the pilot pipe 713 is connected with the first low-pressure pipe 13a.

[0050] The state of the pilot valve 71 is switched by the controller 50 between a first state and a second state. In the first state of the pilot valve 71, the pilot pipe 710 and the pilot pipe 711 communicate with each other in the pilot valve 71, and the pilot pipe 713 and the pilot pipe 712 communicate with each other in the pilot valve 71. Thus, in the first state, the third port G and the first chamber 706 communicate with each other, whereby the pressure in the first chamber 706 is substantially equalized to that in the third port G. Furthermore, the first low-pressure pipe 13a and the second chamber 707 communicate with each other, whereby the pressure in the second chamber 707 is substantially equalized to that in the first low-pressure pipe 13a. The slide valve 703 is moved by a differential pressure between the first chamber 706 and the second chamber 707. In the first state, the slide valve 703 is moved toward the second chamber 707, which is lower in pressure than the first chamber 706. As a result, the first port E and the fourth port H communicate with each other, the third port G and the second port F communicate with each other, and the state of the second flow switching valve 7 is switched to the first state.

[0051] In the second state, the pilot pipe 710 and the pilot pipe 712 communicate with each other in the pilot valve 71, and the pilot pipe 711 and the pilot pipe 713 communicate with each other in the pilot valve 71. Thus, in the first state, the third port G and the second chamber 707 communicate with each other, whereby the pressure in the second chamber 707 is substantially equalized to that in the third port G. Furthermore, the first low-pressure pipe 13a and the first chamber 706 communicate with each other, whereby the pressure in the first chamber 706 is substantially equalized to that in the first low-pressure pipe 13a. In the second state, the slide valve 703 is moved toward the first chamber 706, which is lower in pressure than the second chamber 707. As a result, the first port E and the second port F communicate with each other, the third port G and the fourth port H communicate with each other, and the state of the second flow switching valve 7 is switched to the second state.

[0052] Fig. 7 is a p-h diagram of the air-conditioning apparatus 100 according to Embodiment 1. In an existing differential pressure drive type of four-way valve, the pilot pipe 713 of the pilot valve 71 is connected with the first port E of the main valve 70. In this case, especially in the cooling operation, high-pressure refrigerant flows into the third port G and the first port E, and as indicated in Fig. 7, a differential pressure D_{p0} between the third port G and the first port E is thus a pressure loss in the second flow switching valve 7 and decreases. Consequently, it is not possible to ensure a sufficient differential pressure for movement and fixation of the slide valve 703. Thus,

for example, the following failure may occur: the state of the slide valve 703 cannot be switched, or the position of the slide valve 703 is shifted during the operation.

[0053] By contrast, in Embodiment 1, the pilot pipe 713 of the second flow switching valve 7 is connected with the first low-pressure pipe 13a, whereby in the cooling operation also, it is possible to obtain a great differential pressure D_{p1} between the third port G and the first low-pressure pipe 13a. As a result, it is possible to ensure a differential pressure between the first chamber 706 and the second chamber 707 and reliably move and fix the slide valve 703.

[0054] As described above, according to Embodiment 1, the first chamber 706 or the second chamber 707 of the second flow switching valve 7 is connected with the first low-pressure pipe 13a in which low-pressure refrigerant flows, via the pilot valve 71, whereby it is possible to ensure a minimum operating differential pressure in the second flow switching valve 7. As a result, the second flow switching valve 7 can be normally operated.

Embodiment 2

[0055] An air-conditioning apparatus 100 according to Embodiment 2 will be described. In the air-conditioning apparatus 100 according to Embodiment 2, the configuration of the second flow switching valve 7 is different from that in Embodiment 1. The other configurations and controls in the air-conditioning apparatus 100 according to Embodiment 2 are the same as those in Embodiment 1.

[0056] Fig. 8 is a sectional view schematically illustrating a configuration of a second flow switching valve 7A according to Embodiment 2. As illustrated in Fig. 8, in Embodiment 2, the pilot pipe 713 of the second flow switching valve 7A is connected with the first port E; and the second chamber 707 of the main valve 70 of the second flow switching valve 7A is connected with the first low-pressure pipe 13a by a pipe 721 and a third valve 722. That is, in Embodiment 2, the second chamber 707 of the second flow switching valve 7A is connected with the first low-pressure pipe 13a without communicating with the pilot valve 71.

[0057] The third valve 722 is a solenoid valve or an electronic expansion valve that adjusts the flow rate of refrigerant flowing from the first low-pressure pipe 13a to the second chamber 707, and the opening degree of the third valve 722 is controlled by the controller 50. When the third valve 722 is opened by the controller 50, the first low-pressure pipe 13a and the second chamber 707 communicate with each other, and as a result, the pressure in the second chamber 707 is substantially equalized to that in the first low-pressure pipe 13a. As a result, the slide valve 703 is moved by a differential pressure between the first chamber 706 and the second chamber 707, and the state of the second flow switching valve 7A is switched.

[0058] In Embodiment 2, the second chamber 707 is connected with the first low-pressure pipe 13a without

communicating with the pilot valve 71. In this case also, it is possible to ensure a minimum operating differential pressure in the second flow switching valve 7A, and reliably move and fix the slide valve 703. Thus, the second flow switching valve 7A can be normally operated.

[0059] It should be noted that although Fig. 8 illustrates an example in which the second chamber 707 is connected with the first low-pressure pipe 13a without communicating with the pilot valve 71, this illustration is not limiting. The first chamber 706 may be connected with the first low-pressure pipe 13a without communicating with the pilot valve 71, or each of the first chamber 706 and the second chamber 707 may be connected with the first low-pressure pipe 13a without communicating with the pilot valve 71.

Embodiment 3

[0060] An air-conditioning apparatus 100 according to Embodiment 3 will be described. In the air-conditioning apparatus 100 according to Embodiment 3, the configuration of the second flow switching valve 7 is different from that in Embodiment 1. The other configurations and controls in the air-conditioning apparatus 100 according to Embodiment 3 are the same as those in Embodiment 1.

[0061] Fig. 9 is a sectional view schematically illustrating a configuration of a second flow switching valve 7B according to Embodiment 3. As illustrated in Fig. 9, in Embodiment 3, the pilot pipe 713 of the second flow switching valve 7B is connected with the first port E, and the pilot pipe 710 of the second flow switching valve 7B is connected with the second high-pressure pipe 12b of the refrigerant circuit 10.

[0062] In the heating operation of the air-conditioning apparatus 100, low-pressure refrigerant flows into both the third port G and the first port E. In the existing differential pressure drive type of four-way valve, the pilot pipe 710 of the pilot valve 71 is connected with the third port G of the main valve 70. In this case, the differential pressure between the third port G and the first port E is only the differential pressure loss in the second flow switching valve 7 and it may be impossible to ensure a sufficient differential pressure for movement and fixation of the slide valve 703.

[0063] By contrast, in Embodiment 3, the first chamber 706 or the second chamber 707 of the second flow switching valve 7B is connected with the first low-pressure pipe 13a via the pilot valve 71, whereby in the heating operation also, it is possible to ensure a great differential pressure between the first port E and the second high-pressure pipe 12b. Thus, it is possible to ensure a differential pressure between the first chamber 706 and the second chamber 707, and reliably move and fix the slide valve 703. As a result, the second flow switching valve 7B can be normally operated.

Embodiment 4

[0064] An air-conditioning apparatus 100 according to Embodiment 4 will be described. In the air-conditioning apparatus 100 according to Embodiment 4, the configuration of the second flow switching valve 7 is different from that in Embodiment 1. In Embodiment 4, the other configurations and controls in the air-conditioning apparatus 100 are the same as those in Embodiment 1.

[0065] Fig. 10 is a sectional view schematically illustrating a configuration of a second flow switching valve 7C according to Embodiment 4. As illustrated in Fig. 10, in Embodiment 4, in the second flow switching valve 7C, the pilot pipe 710 is connected with the third port G, and the pilot pipe 713 is connected with the first port E. Also, in the second flow switching valve 7C, the first chamber 706 of the main valve 70 is connected with the second high-pressure pipe 12b by a pipe 731 and a fourth valve 732. That is, in Embodiment 4, the first chamber 706 of the second flow switching valve 7C is connected with the second high-pressure pipe 12b without communicating with a pilot valve 41.

[0066] The fourth valve 732 is a solenoid valve or an electronic expansion valve that adjusts the flow rate of refrigerant flowing from the second high-pressure pipe 12b into the first chamber 706, and the opening degree of the fourth valve 732 is controlled by the controller 50. When the fourth valve 732 is opened by the controller 50, the second high-pressure pipe 12b and the first chamber 706 communicate with each other, and as a result, the pressure in the first chamber 706 is substantially equalized to that in the second high-pressure pipe 12b. Thus, the slide valve 703 is moved by the differential pressure between the first chamber 706 and the second chamber 707, and the state of the second flow switching valve 7C is switched.

[0067] In Embodiment 4, the first chamber 706 is connected with the second high-pressure pipe 12b without communicating with the pilot valve 71. In this case also, it is possible to ensure a minimum operating differential pressure in the second flow switching valve 7C, and reliably move and fix the slide valve 703. As a result, the second flow switching valve 7C can be normally operated.

[0068] It should be noted that although Fig. 9 illustrates an example in which the first chamber 706 of the second flow switching valve 7C is connected with the second high-pressure pipe 12b without communicating with the pilot valve 71, this illustration is not limiting. The second chamber 707 may be connected with the second high-pressure pipe 12b without communicating with the pilot valve 71, or each of the first chamber 706 and the second chamber 707 may be connected with the second high-pressure pipe 12b without communicating with the pilot valve 71.

Embodiment 5

[0069] An air-conditioning apparatus 100A according to Embodiment 5 will be described. In the air-conditioning apparatus 100A according to Embodiment 5, the configuration of the second flow switching valve 7 is different from that in Embodiment 1. The other configurations and controls of the air-conditioning apparatus 100A according to Embodiment 5 are the same as those in Embodiment 1.

[0070] Fig. 11 is a refrigerant circuit diagram illustrating a configuration of the air-conditioning apparatus 100A according to Embodiment 5. As illustrated in Fig. 11, the air-conditioning apparatus 100A of Embodiment 5 does not include the second valve 9. Furthermore, the suction inlet 11a of the compressor 1 and the first port A of the first flow switching valve 2 are connected with each other by the first low-pressure pipe 13a. In addition, the air-conditioning apparatus 100A includes a second flow switching valve 7D that switches a flow passage for the refrigerant between a flow passage through the refrigerant flows to the first outdoor heat exchanger 6a and a flow passage through the refrigerant flows to the second outdoor heat exchanger 6b.

[0071] The second flow switching valve 7D is a differential pressure drive type of four-way valve that is operated by a differential pressure as in the second flow switching valve according to each of Embodiments 1 to 4. The second flow switching valve 7D has a first port E, a second port F, a third port G, and a fourth port H. The second flow switching valve 7D of Embodiment 5 can enter a first state, a second state, and a third state. In the first state, the first port E, the second port F, and the fourth port H communicate with each other, and the third port G is closed. In the second state, the first port E and the second port F communicate with each other, and the third port G and the fourth port H communicate with each other. In the third state, the second port F and the third port G communicate with each other, and the first port E and the fourth port H communicate with each other.

[0072] In each of the cooling operation, the defrosting operation, and the heating operation, the second flow switching valve 7D is set in the first state; in the first operation of the simultaneous heating and defrosting operation, the second flow switching valve 7D is set in the second state; and in the second operation of the simultaneous heating and defrosting operation, the second flow switching valve 7D is set in the third state.

[0073] In the second flow switching valve 7D, at least one of the first chamber 706 and the second chamber 707, between which a differential pressure is generated, is connected with the first low-pressure pipe 13a or the second high-pressure pipe 12b. To be more specific, the pilot pipe 713 of the second flow switching valve 7D is connected with the first low-pressure pipe 13a, or the second chamber 707 of the second flow switching valve 7D is connected with the first low-pressure pipe 13a. Alternatively, the pilot pipe 710 of the second flow switching

valve 7D is connected with the second high-pressure pipe 12b, or the first chamber 706 of the second flow switching valve 7D is connected with the second high-pressure pipe 12b.

[0074] Also, in the case where the second flow switching valve 7D can enter three states as in Embodiment 5, by connecting at least one of the first chamber 706 and the second chamber 707 with the first low-pressure pipe 13a or the second high-pressure pipe 12b, it is possible to ensure a minimum operating differential pressure in the second flow switching valve 7D. As a result, the second flow switching valve 7D can be normally operated.

[0075] The above descriptions are made with respect to the embodiments, but they are not limiting. Various modifications can be made or the embodiments can be variously combined, without departing from the gist of the present disclosure. For example, regarding connection of the pilot pipe 713 of Embodiment 1 and the second chamber 707 of Embodiment 2, it suffices that the pilot pipe 713 of Embodiment 1 and the second chamber 707 of Embodiment 2 are each connected to a low-pressure portion whichever of the operations is performed in the refrigerant circuit 10, and the pilot pipe 713 of Embodiment 1 and the second chamber 707 of Embodiment 2 may be each connected with the second low-pressure pipe 13b or any of the other low-pressure pipes, instead of with the first low-pressure pipe 13a. Also, regarding connection of the pilot pipe 710 of Embodiment 3 and the first chamber 706 of Embodiment 4, it suffices that the pilot pipe 710 of Embodiment 3 and the first chamber 706 of Embodiment 4 are each connected to a low-pressure portion whichever of the operations is performed in the refrigerant circuit 10, and the pilot pipe 710 of Embodiment 3 and the first chamber 706 of Embodiment 4 may be connected with the first high-pressure pipe 12a or any of the other high-pressure pipes, instead of with the second high-pressure pipe 12b.

[0076] Embodiments 1 to 5 can be combined arbitrarily. To be more specific, the second flow switching valve 7 may be configured such that the pilot pipe 713 is connected with the first low-pressure pipe 13a and the pilot pipe 710 is connected with the second high-pressure pipe 12b. Alternatively, the second flow switching valve 7 may be configured such the second chamber 707 is connected with the first low-pressure pipe 13a and the first chamber 706 is connected with the second high-pressure pipe 12b. Alternatively, the second flow switching valve 7 may be configured such that the pilot pipe 713 is connected with the first low-pressure pipe 13a and the first chamber 706 is connected with the second high-pressure pipe 12b. Alternatively, the second flow switching valve 7 may be configured such that the second chamber 707 is connected with the first low-pressure pipe 13a and the pilot pipe 710 is connected with the second high-pressure pipe 12b. That is, it suffices that part of the second flow switching valve 7 that is other than the ports is connected to any one of the low-pressure pipes and the high-pressure pipes in the refrigerant circuit 10.

Reference Signs List

[0077] 1: compressor, 2: first flow switching valve, 3: indoor heat exchanger, 4: expansion valve, 5a: first pressure reducing device, 5b: second pressure reducing device, 6a: first outdoor heat exchanger, 6b: second outdoor heat exchanger, 7, 7A, 7B, 7C, 7D: second flow switching valve, 8: first valve, 9: second valve, 10: refrigerant circuit, 11a: suction inlet, 11b: discharge outlet, 12a: first high-pressure pipe, 12b: second high-pressure pipe, 13a: first low-pressure pipe, 13b: second low-pressure pipe, 14: branch portion, 15a: first pipe, 15b: second pipe, 16: branch portion, 17: branch portion, 50: controller, 70: main valve, 71: pilot valve, 100, 100A: air-conditioning apparatus, 701: cylinder, 702: slide rack, 703: slide valve, 704: piston, 705: piston, 706: first chamber, 707: second chamber, 710, 711, 712, 713: pilot pipe, 721, 731: pipe, 722: third valve, 732: fourth valve

Claims

1. An air-conditioning apparatus comprising:

a refrigerant circuit including a compressor, a high-pressure pipe through which high-pressure refrigerant discharged from the compressor flows, a low-pressure pipe through which low-pressure refrigerant to be sucked into the compressor flows, a first flow switching valve, an indoor heat exchanger, an expansion valve, a first outdoor heat exchanger, a second outdoor heat exchanger, and a second flow switching valve, wherein the second flow switching valve is configured to switch flow passages for refrigerant flowing to the first outdoor heat exchanger and the second outdoor heat exchanger, wherein the second flow switching valve includes a first chamber, a second chamber, and a slide valve configured to be moved by a differential pressure between the first chamber and the second chamber, and wherein at least one of the first chamber and the second chamber is connected with the high-pressure pipe or the low-pressure pipe.

2. The air-conditioning apparatus of claim 1,

wherein the second flow switching valve includes a main valve and a pilot valve, and wherein at least one of the first chamber and the second chamber is connected with the high-pressure pipe or the low-pressure pipe via the pilot valve.

3. The air-conditioning apparatus of claim 1,

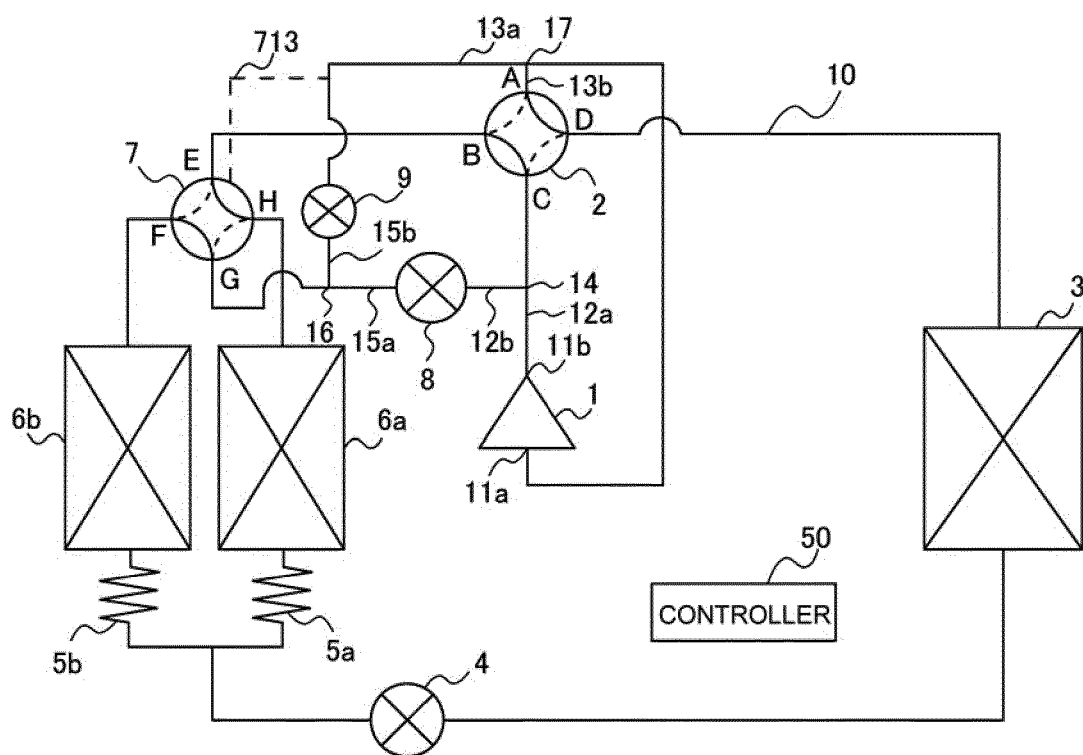
wherein the second flow switching valve in-

- cludes a main valve and a pilot valve, and wherein at least one of the first chamber and the second chamber is connected with the high-pressure pipe or the low-pressure pipe without communicating with the pilot valve. 5
4. The air-conditioning apparatus of claim 3, further comprising:
- a pipe connecting at least one of the first chamber and the second chamber with the high-pressure pipe or the low-pressure pipe; and a valve provided at the pipe. 10
5. The air-conditioning apparatus of any one of claims 1 to 4, wherein the second flow switching valve includes
- a first port connected with the first flow switching valve, 20
- a second port connected with the second outdoor heat exchanger,
- a third port connected with a discharge outlet of the compressor, and
- a fourth port connected with the first outdoor heat exchanger. 25
6. The air-conditioning apparatus of claim 5, further comprising a controller configured to switch a state of the second flow switching valve between a first state in which the first port and the fourth port communicate with each other and the second port and the third port communicate with each other and a second state in which the first port and the second port communicate with each other and the third port and the fourth port communicate with each other. 30 35
7. The air-conditioning apparatus of claim 5, further comprising a controller configured to switch a state of the second flow switching valve between a first state in which the first port, the second port, and the fourth port communicate with each other and the third port G is closed, a second state in which the first port and the second port communicate with each other and the third port and the fourth port communicate with each other, and a third state in which the second port and the third port communicate with each other and the first port and the fourth port communicate with each other. 40 45 50
8. The air-conditioning apparatus of claim 6 or 7, wherein
- the controller is configured to perform a cooling operation in which the first outdoor heat exchanger and the second outdoor heat exchanger operate as condensers and the indoor heat exchanger operates as an evaporator, 55

a heating operation in which the first outdoor heat exchanger and the second outdoor heat exchanger operate as the evaporators and the indoor heat exchanger operates as the condenser, and

a simultaneous heating and defrosting operation in which one of the first outdoor heat exchanger and the second outdoor heat exchanger operates as the evaporator and the other of the first outdoor heat exchanger and the second outdoor heat exchanger and the indoor heat exchanger operate as the condensers.

FIG. 1



100

FIG. 2

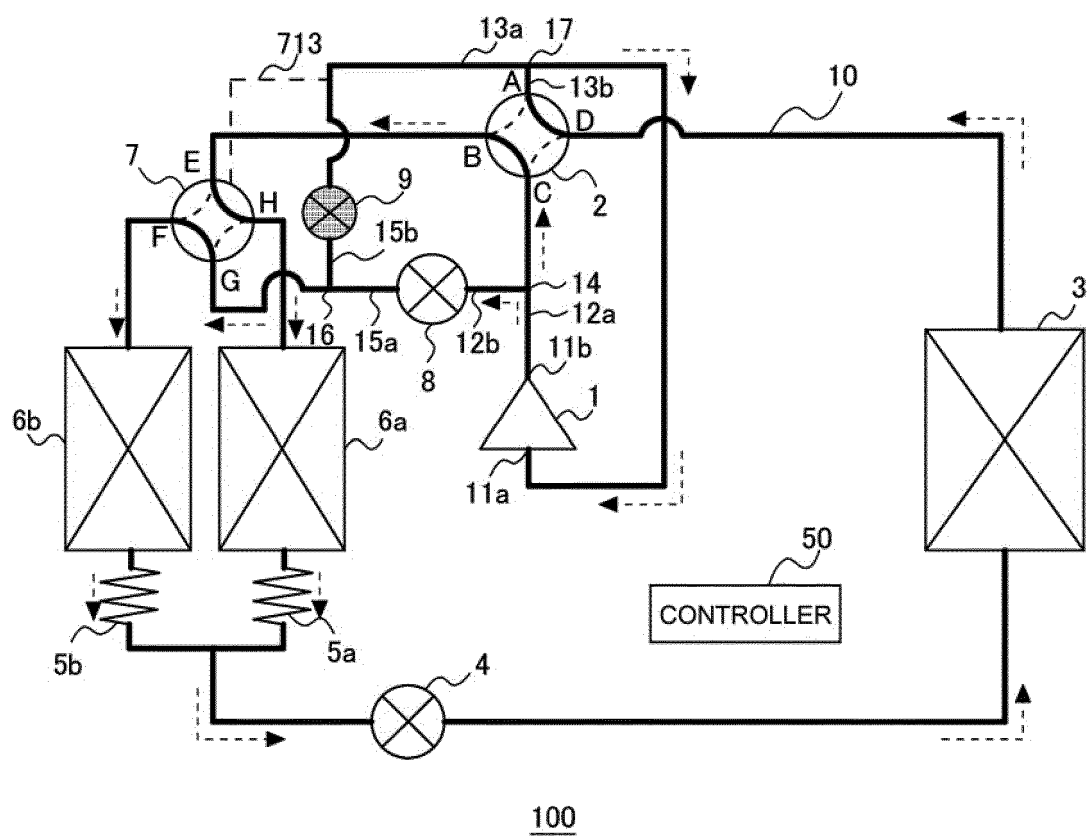


FIG. 3

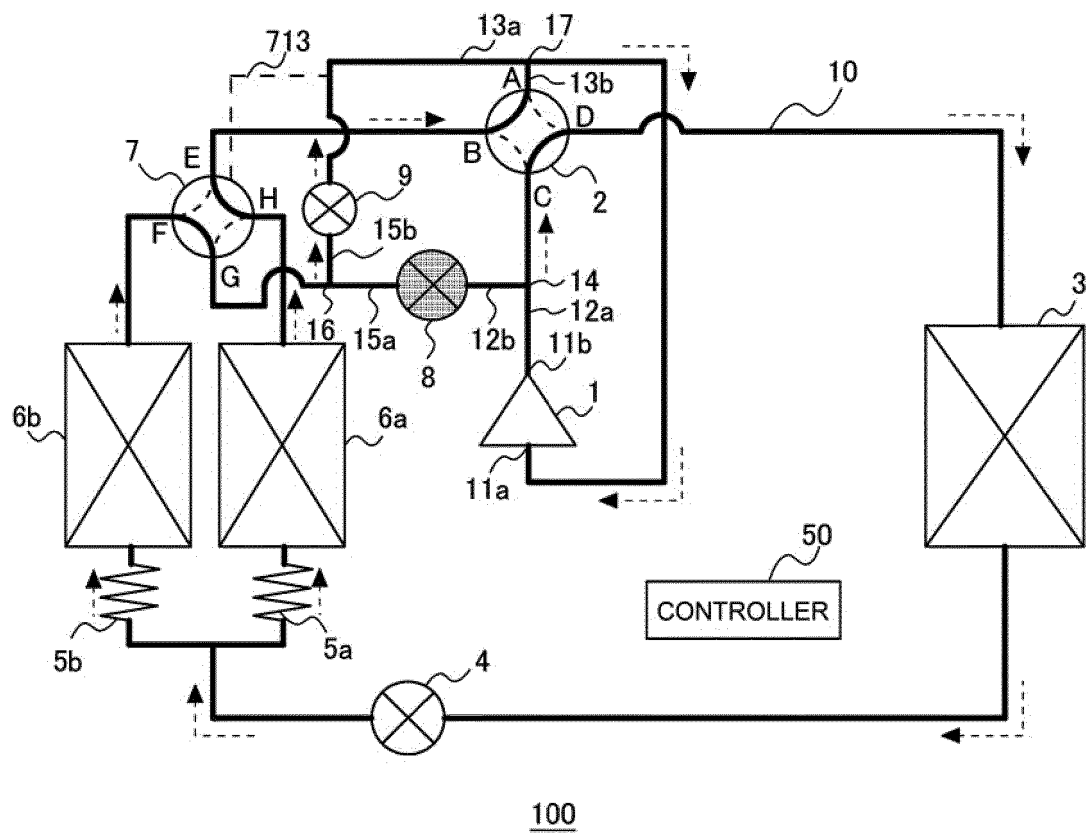


FIG. 4

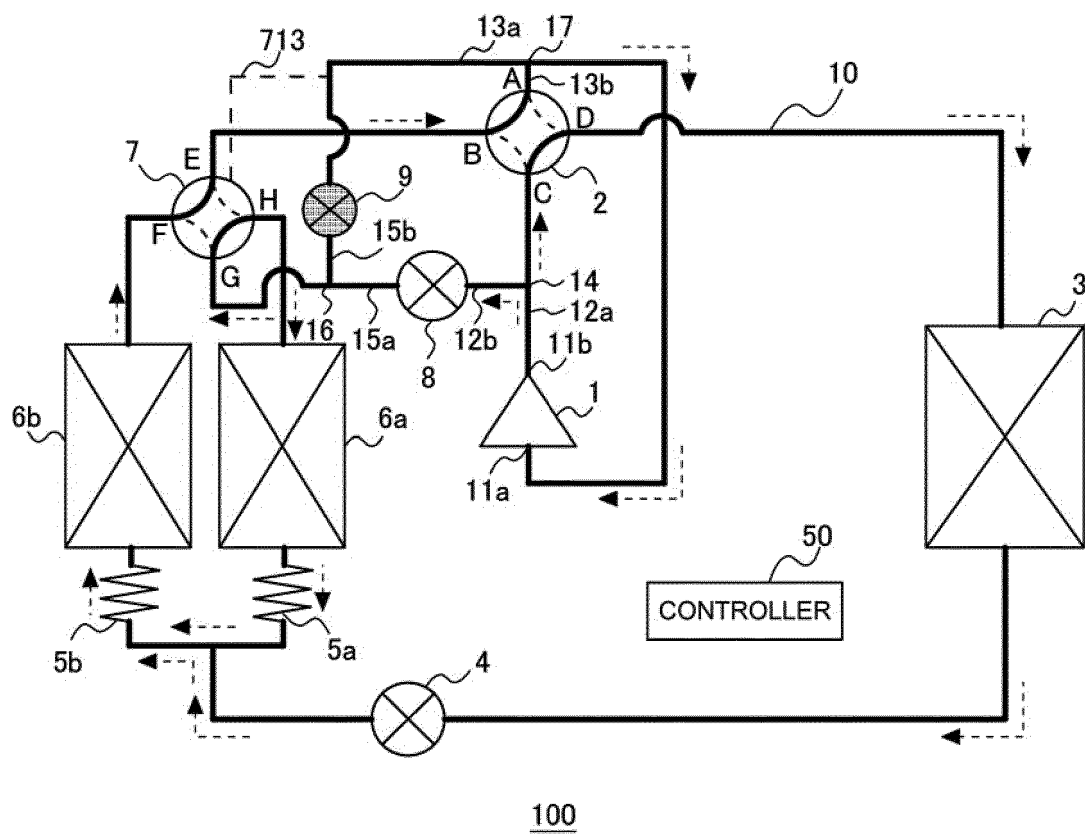


FIG. 5

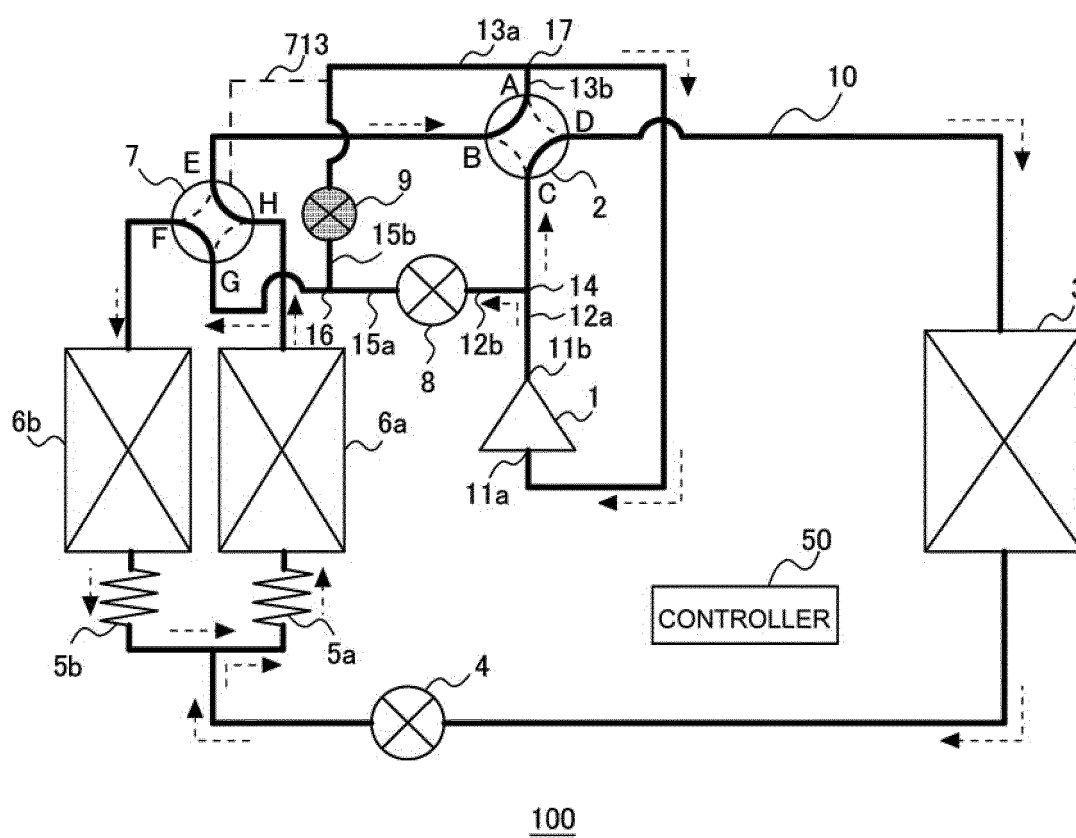


FIG. 6

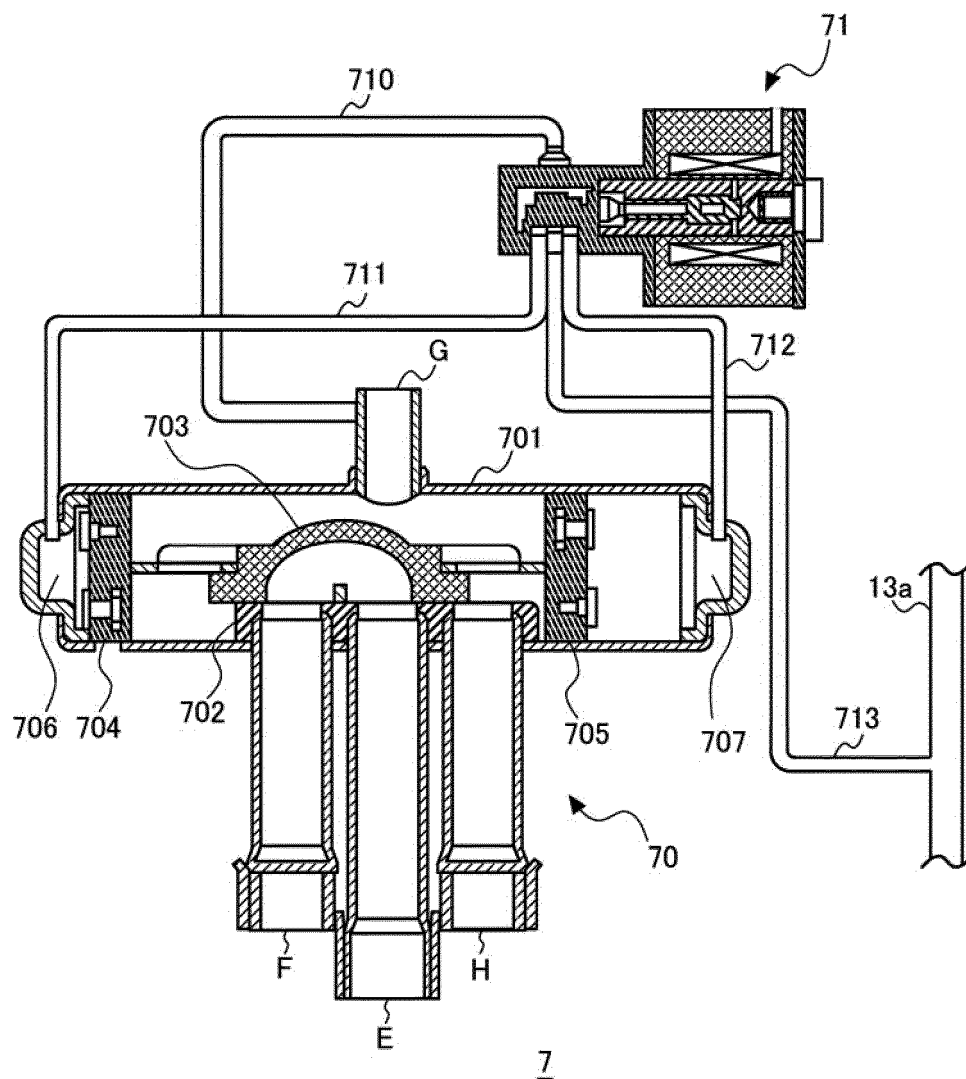


FIG. 7

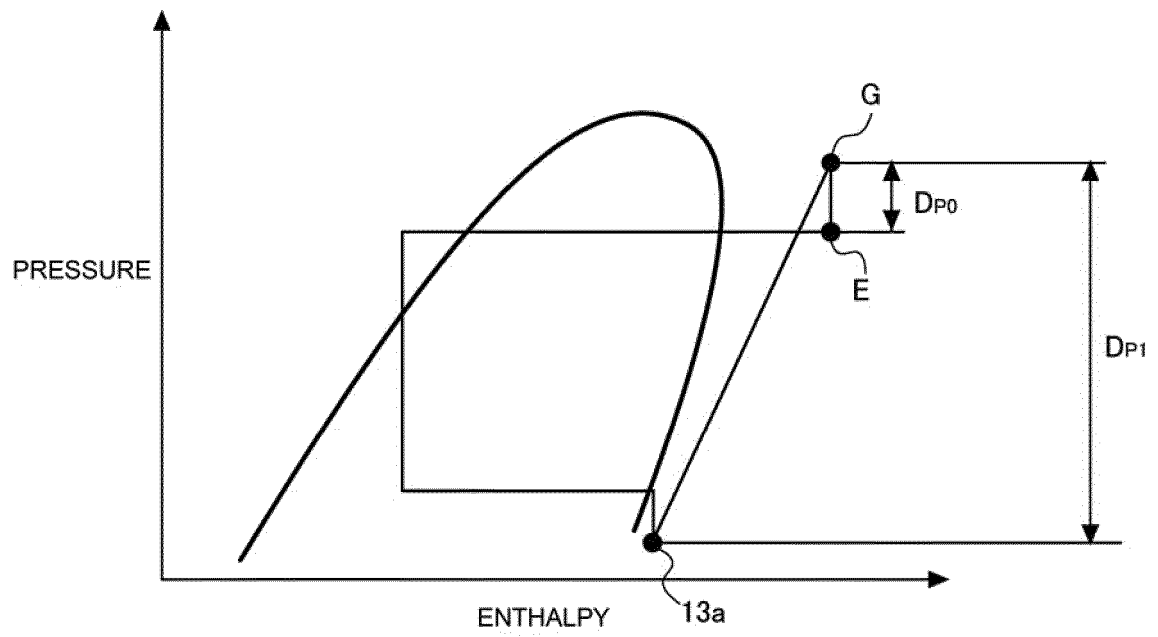


FIG. 8

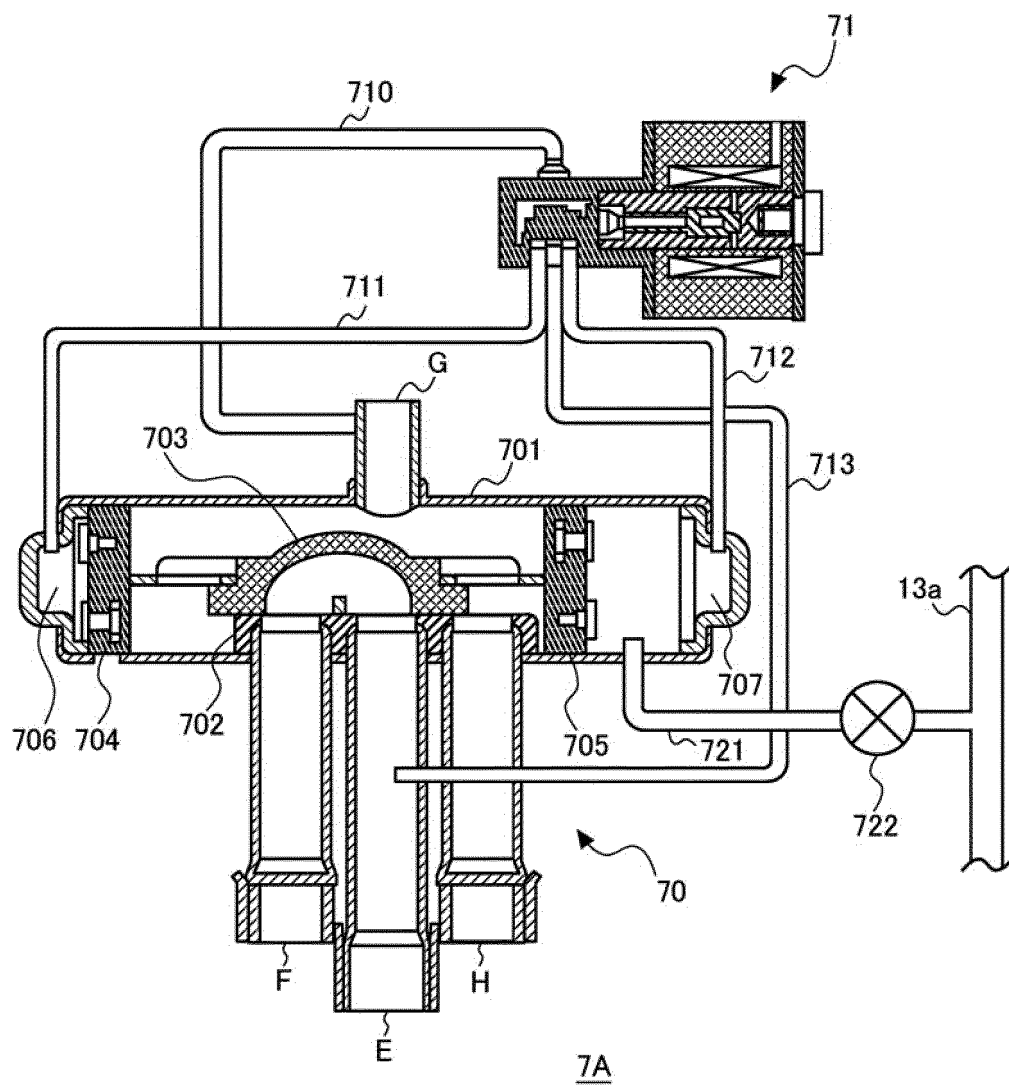


FIG. 9

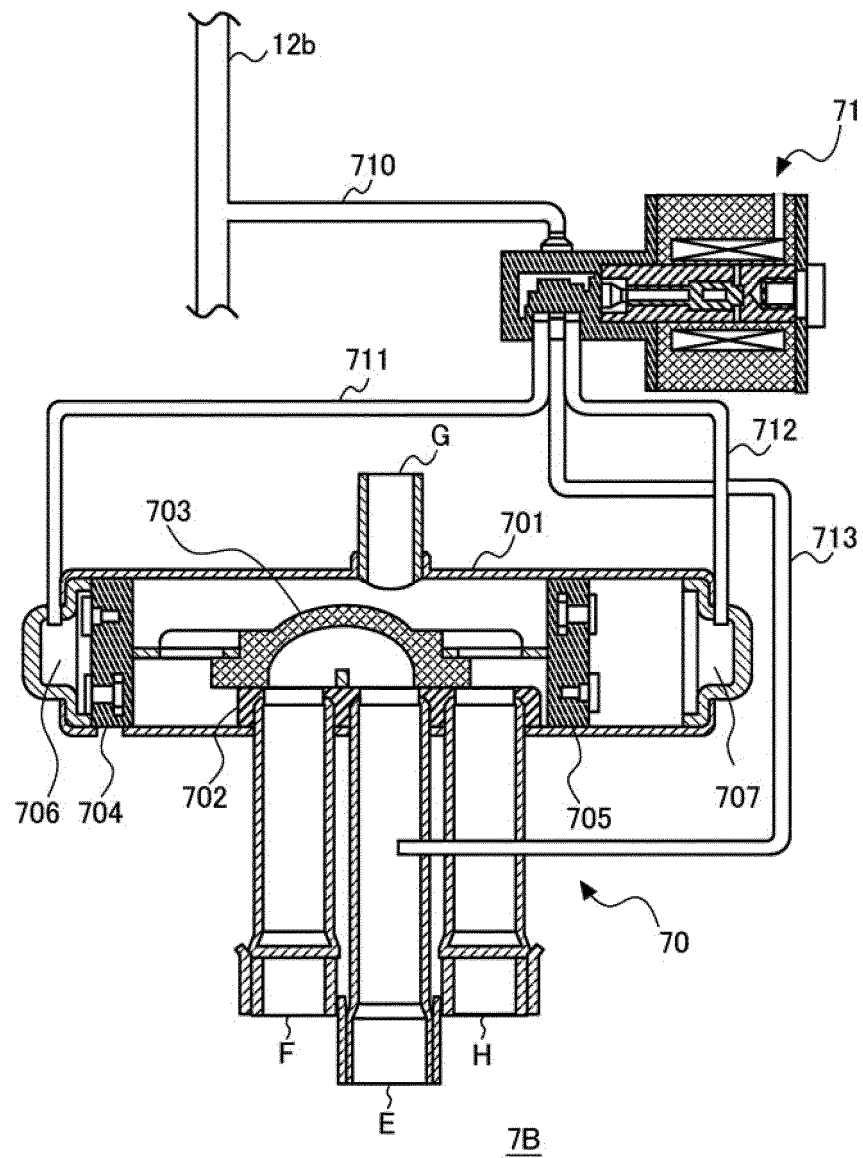


FIG. 10

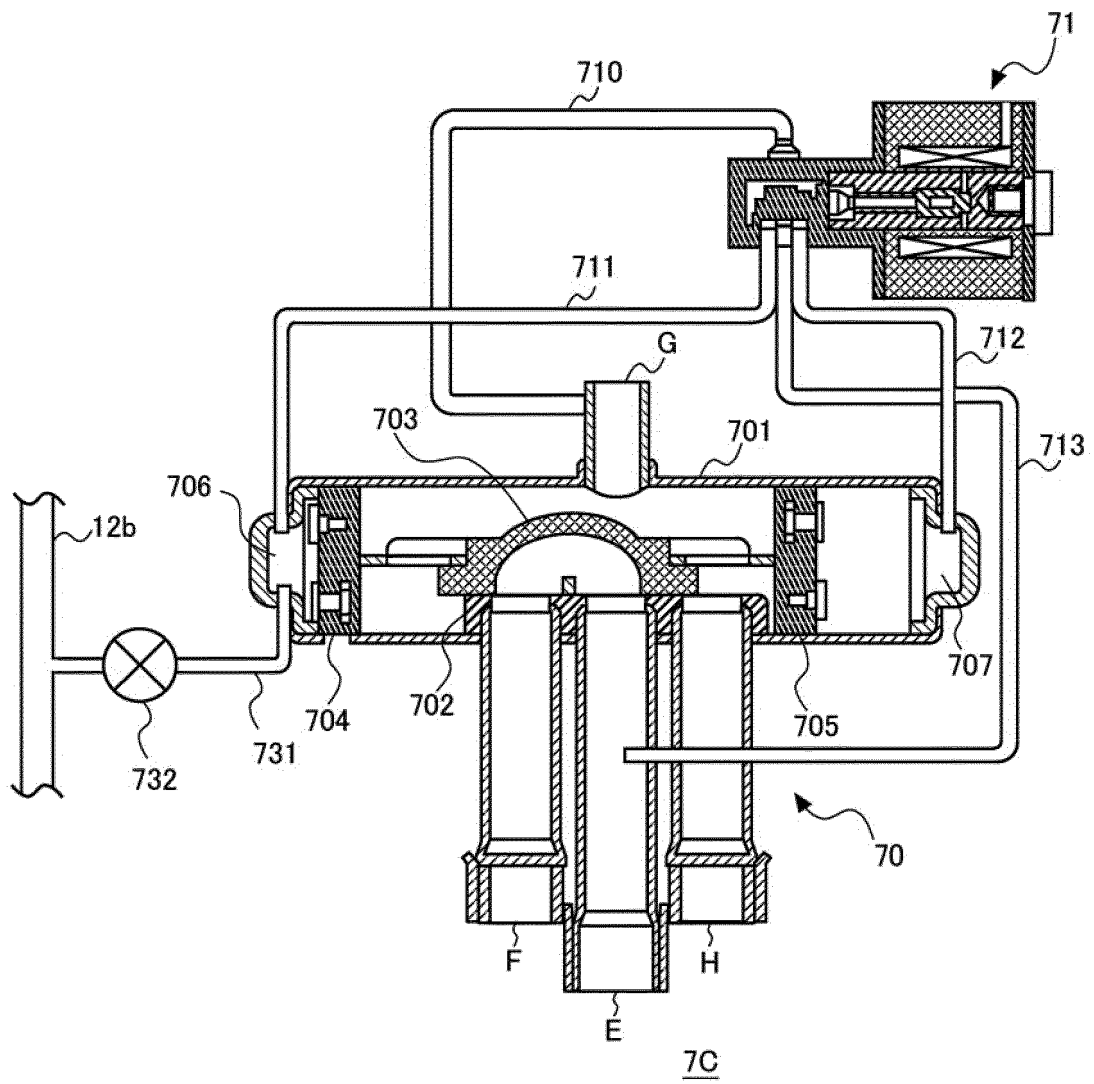
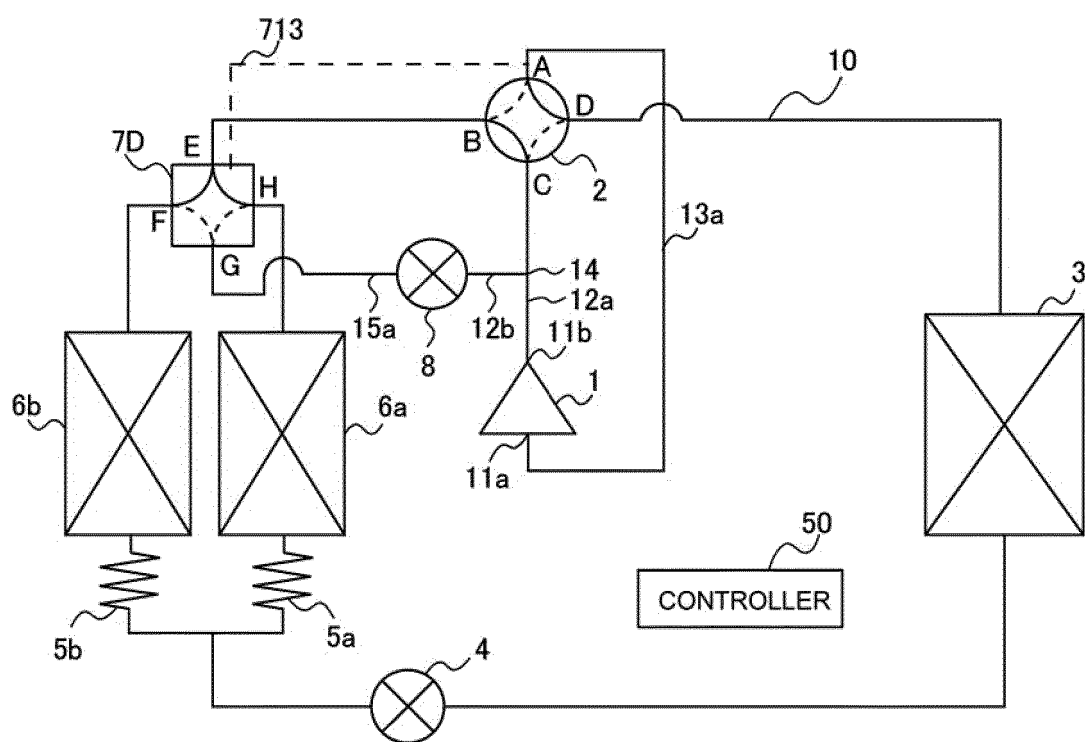


FIG. 11



100A

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/001626

A. CLASSIFICATION OF SUBJECT MATTER

F16K 31/34 (2006.01)i; F25B 41/26 (2021.01)i; F25B 41/20 (2021.01)i; F25B 47/02 (2006.01)i; F24F 11/41 (2018.01)i; F24F 11/42 (2018.01)i
 FI: F25B41/04 Z; F25B41/04 C; F25B47/02 540G; F24F11/41 250;
 F24F11/42; F16K31/34

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F25B41/20; F16K31/34; F24F11/41; F24F11/42; F25B41/26; F25B47/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2019/003291 A1 (MITSUBISHI ELECTRIC CORP.) 03 January 2019 (2019-01-03) paragraphs [0016]-[0074], fig. 2-14	1-2, 5-8
A	paragraphs [0016]-[0074], fig. 2-14	3-4
Y	WO 2020/261387 A1 (MITSUBISHI ELECTRIC CORP.) 30 December 2020 (2020-12-30) paragraphs [0036]-[0042], [0094]-[0099], fig. 2	1-2, 5-8
A	paragraphs [0036]-[0042], [0094]-[0099], fig. 2	3-4
A	JP 5-31489 Y2 (DAIKIN INDUSTRIES, LTD.) 12 August 1993 (1993-08-12) column 9, line 11 to column 10, line 28, fig. 3	1-8



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
 05 March 2021 (05.03.2021)

Date of mailing of the international search report
 16 March 2021 (16.03.2021)

Name and mailing address of the ISA/
 Japan Patent Office
 3-4-3, Kasumigaseki, Chiyoda-ku,
 Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/JP2021/001626

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
WO 2019/003291 A1	03 Jan. 2019	US 2020/0116374 A1 paragraphs [0029]- [0092], fig. 2-14 EP 3647672 A1 CN 110770517 A (Family: none)	
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REFERENCES CITED IN THE DESCRIPTION

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