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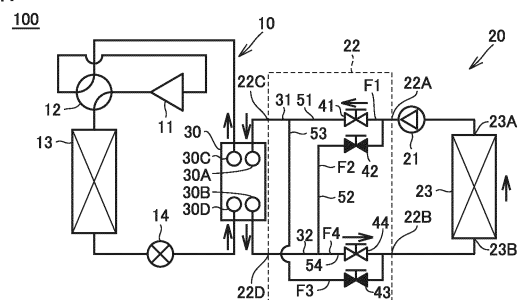
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(54) **REFRIGERATION CYCLE DEVICE**

(57) A refrigeration cycle apparatus (100, 101) includes a refrigerant circulation circuit (10) and a liquid medium circulation circuit (20). The refrigerant circulation circuit includes a compressor (11), a four-way valve (12), an air heat exchanger (13), an expansion valve (14), and a water heat exchanger (30). The liquid medium circulation circuit includes a pump (21), a liquid flow direction switching unit (22), the water heat exchanger (30), and an indoor heat exchanger (23). The water heat exchanger is configured to cause the non-azeotropic refrigerant mixture to exchange heat with the liquid medium. The four-way valve switches between a first state in which the non-azeotropic refrigerant mixture flows sequentially through the compressor, the air heat exchanger, and the water heat exchanger, and a second state in which the non-azeotropic refrigerant mixture flows sequentially through the compressor, the water heat exchanger, and the air heat exchanger. The liquid flow direction switching unit switches the direction in which the liquid medium flows through the liquid medium circulation circuit. In the first state, the non-azeotropic refrigerant mixture flows upward from below in the water heat exchanger, and the liquid medium flows downward from above in the water heat exchanger. In the second state, the non-azeotropic refrigerant mixture flows downward from above in the water heat exchanger, and the liquid medium flows upward from below in the water heat exchanger. The direc-

tion in which the liquid medium flows through the indoor heat exchanger is constant in the first state and the second state.

FIG.1



Description

TECHNICAL FIELD

[0001] The present disclosure relates to a refrigeration cycle apparatus.

BACKGROUND ART

[0002] In recent years, regulations for refrigerants used in refrigeration cycle apparatuses have been tightened and, as a permanent measure, use of a non-azeotropic refrigerant mixture having a large temperature gradient is under study.

[0003] When the non-azeotropic refrigerant mixture evaporates or condenses in a heat exchanger, the temperature of the non-azeotropic refrigerant mixture changes, and a difference between the start temperature and the end temperature (temperature gradient) is generated. When the flow direction of the non-azeotropic refrigerant mixture is the same as the flow direction of a heat medium (parallel flow) in the heat exchanger, the heat exchange efficiency in the heat exchanger is decreased.

[0004] A technique is known, for a refrigeration cycle apparatus using a non-azeotropic refrigerant mixture, by which the flow direction of the non-azeotropic refrigerant mixture in an evaporator is made opposite to the flow direction of a heat medium exchanging heat with the non-azeotropic refrigerant mixture in the evaporator (counterflow).

[0005] Japanese Patent Laying-Open No. H10-281575 discloses a refrigeration apparatus in which a non-azeotropic refrigerant mixture and a liquid medium are counterflow in a water heat exchanger in which heat is exchanged between the non-azeotropic refrigerant mixture and the liquid medium.

CITATION LIST

PATENT LITERATURE

[0006] PTL 1: Japanese Patent Laying-Open No. H10-281575

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0007] In general, the direction of air flowing through the use-side heat exchanger (indoor heat exchanger) is constant. In the refrigeration cycle apparatus disclosed in Japanese Patent Laying-Open No. H10-281575, the direction in which the liquid medium flows through the use-side heat exchanger (indoor heat exchanger) is reversed between cooling operation and heating operation, and therefore, when the direction of air flowing through the indoor heat exchanger is kept constant, the liquid medium and the air are parallel flow in either the cooling

operation or the heating operation. In this case, the heat exchange efficiency in the indoor heat exchanger is decreased and the power consumption of the refrigeration cycle apparatus is increased, as compared with the case where the liquid medium and the air are counterflow.

[0008] A principal object of the present disclosure is to provide a refrigeration cycle apparatus capable of suppressing decrease in heat exchange efficiency in an indoor heat exchanger, while a non-azeotrope refrigerant mixture and a liquid medium are counterflow in a water heat exchanger.

SOLUTION TO PROBLEM

[0009] A refrigeration cycle apparatus according to the present disclosure comprises: a refrigerant circulation circuit that comprises a compressor, a four-way valve, an air heat exchanger, an expansion valve, and a water heat exchanger, and that is configured to cause a non-azeotropic refrigerant mixture to circulate through the refrigerant circulation circuit; and a liquid medium circulation circuit that comprises a pump, a liquid flow direction switching unit, the water heat exchanger, and an indoor heat exchanger, and that is configured to cause a liquid medium to circulate through the liquid medium circulation circuit. The water heat exchanger is configured to cause the non-azeotropic refrigerant mixture to exchange heat with the liquid medium. The four-way valve is configured to switch between a first state in which the non-azeotropic refrigerant mixture flows sequentially through the compressor, the air heat exchanger, and the water heat exchanger, and a second state in which the non-azeotropic refrigerant mixture flows sequentially through the compressor, the water heat exchanger, and the air heat exchanger. The liquid flow direction switching unit is configured to switch a direction in which the liquid medium flows through the liquid medium circulation circuit. In the first state, the non-azeotropic refrigerant mixture flows upward from below in the water heat exchanger, and the liquid medium flows downward from above in the water heat exchanger. In the second state, the non-azeotropic refrigerant mixture flows downward from above in the water heat exchanger, and the liquid medium flows upward from below in the water heat exchanger. A direction in which the liquid medium flows in the indoor heat exchanger is constant in each of the first state and the second state.

ADVANTAGEOUS EFFECTS OF INVENTION

[0010] According to the present disclosure, a refrigeration cycle apparatus can be provided that is capable of suppressing decrease in heat exchange efficiency in an indoor heat exchanger, while a non-azeotropic refrigerant mixture and a liquid medium are counterflow in a water heat exchanger.

BRIEF DESCRIPTION OF DRAWINGS

[0011]

Fig. 1 is a diagram showing a first state of a refrigeration cycle apparatus according to Embodiment 1. Fig. 2 is a diagram showing a second state of the refrigeration cycle apparatus according to Embodiment 1.

Fig. 3 is a diagram showing a first state of a refrigeration cycle apparatus according to Embodiment 2. Fig. 4 is a diagram showing a second state of the refrigeration cycle apparatus according to Embodiment 2.

Fig. 5 is a diagram for illustrating a first flow path and a fourth flow path formed in a stack structure of a liquid flow direction switching unit in the first state shown in Fig. 3.

Fig. 6 is a diagram for illustrating a second flow path and a third flow path formed in the stack structure of the liquid flow direction switching unit in the second state shown in Fig. 4.

Fig. 7 is a diagram for illustrating a modification of the stack structure shown in Figs. 3 and 5.

Fig. 8 is a diagram for illustrating a modification of the stack structure shown in Figs. 4 and 6.

DESCRIPTION OF EMBODIMENTS

[0012] Embodiments of the present disclosure are described hereinafter with reference to the drawings. In the following drawings, the same or corresponding parts are denoted by the same reference numerals, and a description thereof is not repeated herein. In the following, the direction of gravity with respect to a position to be compared is referred to as "downward" and the direction opposite to "downward" with respect to a position to be compared is referred to as "upward." In Figs. 1 to 8, the Z direction represents the direction of gravity.

Embodiment 1

[0013] As shown in Figs. 1 and 2, a refrigeration cycle apparatus 100 according to Embodiment 1 includes a refrigerant circulation circuit 10 in which a non-azeotropic refrigerant mixture circulates, and a liquid medium circulation circuit 20 in which a liquid medium circulates. The non-azeotropic refrigerant mixture is, for example, HFC (hydrofluorocarbon)-based refrigerant or HC (hydrocarbon)-based refrigerant. An example of the HFC-based refrigerant is R407C, for example. The liquid medium may be any heat transfer medium whose temperature can change as heat is exchanged with the non-azeotropic refrigerant mixture, and an example of the liquid medium is water, for example.

[0014] Refrigerant circulation circuit 10 includes a compressor 11, a four-way valve 12, an air heat exchanger 13, an expansion valve 14, and a water heat exchanger

30. Liquid medium circulation circuit 20 includes a pump 21, a liquid flow direction switching unit 22, an indoor heat exchanger 23, and water heat exchanger 30. In refrigeration cycle apparatus 100, a first state shown in Fig. 1 and a second state shown in Fig. 2 are switched to each other by four-way valve 12 and liquid flow direction switching unit 22.

[0015] As shown in Figs. 1 and 2, four-way valve 12 switches the flow direction of the non-azeotropic refrigerant mixture flowing through refrigerant circulation circuit 10. Four-way valve 12 switches between the first state in which the non-azeotropic refrigerant mixture flows sequentially through compressor 11, air heat exchanger 13, expansion valve 14, and water heat exchanger 30, and the second state in which the non-azeotropic refrigerant mixture flows sequentially through compressor 11, water heat exchanger 30, expansion valve 14, and air heat exchanger 13.

[0016] As shown in Figs. 1 and 2, in response to switching between the first state and the second state by four-way valve 12, liquid flow direction switching unit 22 switches the flow direction of the liquid medium flowing through liquid medium circulation circuit 20. Liquid flow direction switching unit 22 switches the direction in which the liquid medium flows through liquid medium circulation circuit 20, in such a manner that the liquid medium flows downward from above in water heat exchanger 30 in the first state, the liquid medium flows upward from below in water heat exchanger 30 in the second state, and the direction in which the liquid medium flows through indoor heat exchanger 23 is constant in each of the first state and the second state.

[0017] Indoor heat exchanger 23 is, for example, an air heat exchanger in which a liquid medium exchanges heat with indoor air. In this case, refrigeration cycle apparatus 100 is an air conditioner. Indoor heat exchanger 23 may for example be a water heat exchanger in which a liquid medium exchanges heat with another liquid medium. Indoor heat exchanger 23 has an inlet 23B through which the liquid medium flows in, and an outlet 23A through which the liquid medium flows out. The flow direction of indoor air flowing through indoor heat exchanger 23 is constant in the first state and the second state. A fan for blowing indoor air to indoor heat exchanger 23 may be provided so as to rotate only in a certain direction. The rotational direction of the fan for blowing indoor air to indoor heat exchanger 23 may be non-reversible.

[0018] Water heat exchanger 30 is configured to cause the non-azeotropic refrigerant mixture flowing through refrigerant circulation circuit 10 to exchange heat with the liquid medium flowing through liquid medium circulation circuit 20. Water heat exchanger 30 is, for example, a plate heat exchanger. A flow path for the non-azeotropic refrigerant mixture and a flow path for the liquid medium are defined by plates. Water heat exchanger 30 has a third outflow-inflow portion 30C and a fourth outflow-inflow portion 30D through which the non-azeotropic refrigerant mixture flows out/in. Third outflow-inflow portion

30C is disposed upward relative to fourth outflow-inflow portion 30D. Water heat exchanger 30 further has a first outflow-inflow portion 30A and a second outflow-inflow portion 30B through which the liquid medium flows out/in. First outflow-inflow portion 30A is disposed upward relative to second outflow-inflow portion 30B.

[0019] Outlet 23A of indoor heat exchanger 23 is connected to each of first outflow-inflow portion 30A and second outflow-inflow portion 30B of water heat exchanger 30 through pump 21 and liquid flow direction switching unit 22.

[0020] Pump 21 is connected between outlet 23A of indoor heat exchanger 23 and an inflow portion 22A of liquid flow direction switching unit 22. Pump 21 is disposed outside liquid flow direction switching unit 22. The pump is configured to feed the liquid medium flowing out of outlet 23A of indoor heat exchanger 23, to inflow portion 22A of liquid flow direction switching unit 22. Pump 21 may be configured to feed the liquid medium flowing out of an outflow portion 22B of liquid flow direction switching unit 22, to inlet 23B of indoor heat exchanger 23.

[0021] Inlet 23B of indoor heat exchanger 23 is connected to each of first outflow-inflow portion 30A and second outflow-inflow portion 30B of water heat exchanger 30 through liquid flow direction switching unit 22. Outlet 23A is disposed upward relative to inlet 23B, for example.

[0022] Liquid flow direction switching unit 22 has inflow portion 22A through which the liquid medium flows in, outflow portion 22B through which the liquid medium flows out, as well as a fifth outflow-inflow portion 22C and a sixth outflow-inflow portion 22D through which the liquid medium flows out/in. Inflow portion 22A is connected to a discharge port of pump 21. Inflow portion 22A is connected to outlet 23A of indoor heat exchanger 23 through pump 21. Outflow portion 22B is connected to inlet 23B of indoor heat exchanger 23. Fifth outflow-inflow portion 22C is connected to first outflow-inflow portion 30A of water heat exchanger 30. Sixth outflow-inflow portion 22D is connected to second outflow-inflow portion 30B of water heat exchanger 30.

[0023] In the first state, liquid flow direction switching unit 22 forms a flow path for the liquid medium flowing from inflow portion 22A to fifth outflow-inflow portion 22C and a flow path for the liquid medium flowing from sixth outflow-inflow portion 22D to outflow portion 22B. In the first state, liquid flow direction switching unit 22 does not form a flow path for the liquid medium flowing from inflow portion 22A to sixth outflow-inflow portion 22D and a flow path for the liquid medium flowing from fifth outflow-inflow portion 22C to outflow portion 22B.

[0024] In the second state, liquid flow direction switching unit 22 forms a flow path for the liquid medium flowing from inflow portion 22A to sixth outflow-inflow portion 22D and a flow path for the liquid medium flowing from fifth outflow-inflow portion 22C to outflow portion 22B. In the second state, liquid flow direction switching unit 22 does not form a flow path for the liquid medium flowing from

inflow portion 22A to fifth outflow-inflow portion 22C and a flow path for the liquid medium flowing from sixth outflow-inflow portion 22D to outflow portion 22B.

[0025] Specifically, liquid flow direction switching unit 22 includes a first flow path F1, a second flow path F2, a third flow path F3, and a fourth flow path F4, as well as a first on-off valve 41, a second on-off valve 42, a third on-off valve 43, and a fourth on-off valve 44. Each of first on-off valve 41, second on-off valve 42, third on-off valve 43, and fourth on-off valve 44 is a one-way solenoid valve provided so as to open and close only a flow in one direction. First on-off valve 41 is a one-way solenoid valve that opens and closes only the flow in one direction from inflow portion 22A to a first through hole 61. Second on-off valve 42 is a one-way solenoid valve that opens and closes only the flow in one direction from inflow portion 22A to a second through hole 62. Third on-off valve 43 is a one-way solenoid valve that opens and closes only the flow in one direction from a third through hole 63 to outflow portion 22B. Fourth on-off valve 44 is a one-way solenoid valve that opens and closes only the flow in one direction from a fourth through hole 64 to outflow portion 22B. Each of first on-off valve 41, second on-off valve 42, third on-off valve 43, and fourth on-off valve 44 is provided so as to open or close the flow of water in the vertical direction.

[0026] First flow path F1 connects inflow portion 22A to fifth outflow-inflow portion 22C. First flow path F1 is connected between outlet 23A of indoor heat exchanger 23 and first outflow-inflow portion 30A of water heat exchanger 30. First on-off valve 41 opens and closes first flow path F1.

[0027] Second flow path F2 connects inflow portion 22A to sixth outflow-inflow portion 22D. Second flow path F2 is connected between outlet 23A of indoor heat exchanger 23 and second outflow-inflow portion 30B of water heat exchanger 30. Second on-off valve 42 opens and closes second flow path F2.

[0028] Third flow path F3 connects fifth outflow-inflow portion 22C to outflow portion 22B. Third flow path F3 is connected between first outflow-inflow portion 30A of water heat exchanger 30 and inlet 23B of indoor heat exchanger 23. Third on-off valve 43 opens and closes third flow path F3.

[0029] Fourth flow path F4 connects sixth outflow-inflow portion 22D to outflow portion 22B. Fourth flow path F4 is connected between second outflow-inflow portion 30B of water heat exchanger 30 and inlet 23B of indoor heat exchanger 23. Fourth on-off valve 44 opens and closes fourth flow path F4.

[0030] First flow path F1 and second flow path F2 are connected in parallel to each other with respect to inflow portion 22A. Third flow path F3 and fourth flow path F4 are connected in parallel to each other with respect to outflow portion 22B.

[0031] In the first state, first on-off valve 41 and fourth on-off valve 44 are opened, and second on-off valve 42 and third on-off valve 43 are closed. Accordingly, in the

first state, liquid flow direction switching unit 22 forms a flow of the liquid medium flowing from inflow portion 22A to fifth outflow-inflow portion 22C in first flow path F1, and a flow of the liquid medium flowing from sixth outflow-inflow portion 22D to outflow portion 22B in fourth flow path F4. In the first state, liquid flow direction switching unit 22 does not form a flow of the liquid medium flowing from inflow portion 22A to sixth outflow-inflow portion 22D in second flow path F2 and a flow of the liquid medium flowing from fifth outflow-inflow portion 22C to outflow portion 22B in third flow path F3.

[0032] In the second state, second on-off valve 42 and third on-off valve 43 are opened, and first on-off valve 41 and fourth on-off valve 44 are closed. Accordingly, in the second state, liquid flow direction switching unit 22 forms a flow of the liquid medium flowing from inflow portion 22A to sixth outflow-inflow portion 22D in second flow path F2, and a flow of the liquid medium flowing from fifth outflow-inflow portion 22C to outflow portion 22B in third flow path F3. In the second state, liquid flow direction switching unit 22 does not form a flow of the liquid medium flowing from inflow portion 22A to fifth outflow-inflow portion 22C in first flow path F1 and a flow of the liquid medium flowing from sixth outflow-inflow portion 22D to outflow portion 22B in fourth flow path F4.

[0033] More specifically, liquid flow direction switching unit 22 includes a plurality of pipes. Each of first flow path F1, second flow path F2, third flow path F3, and fourth flow path F4 is formed by at least one of the plurality of pipes.

[0034] The plurality of pipes include a first pipe 31 connected to first outflow-inflow portion 30A, a second pipe 32 connected to second outflow-inflow portion 30B, a third pipe 51 and a fourth pipe 53 connected in parallel to each other with respect to first pipe 31, and a fifth pipe 52 and a sixth pipe 54 connected in parallel to each other with respect to second pipe 32. Third pipe 51 and fifth pipe 52 are connected in parallel to each other with respect to inflow portion 22A. Fourth pipe 53 and sixth pipe 54 are connected in parallel to each other with respect to outflow portion 22B.

[0035] First flow path F1 is formed by first pipe 31 and third pipe 51 connected in series to each other. Second flow path F2 is formed by second pipe 32 and fifth pipe 52 connected in series to each other. Third flow path F3 is formed by first pipe 31 and fourth pipe 53 connected in series to each other. Fourth flow path F4 is formed by second pipe 32 and sixth pipe 54 connected in series to each other.

[0036] First on-off valve 41 is connected to third pipe 51. Second on-off valve 42 is connected to fifth pipe 52. Third on-off valve 43 is connected to fourth pipe 53. Fourth on-off valve 44 is connected to sixth pipe 54.

[0037] First pipe 31 forms a part of first flow path F1 that is located on the fifth outflow-inflow portion 22C side, and forms a part of third flow path F3 that is located on the fifth outflow-inflow portion 22C side. Second pipe 32 forms a part of second flow path F2 that is located on the

sixth outflow-inflow portion 22D side, and forms a part of fourth flow path F4 that is located on the sixth outflow-inflow portion 22D side. That is, a part of first flow path F1 that is located on the fifth outflow-inflow portion 22C side also serves as a part of third flow path F3 that is located on the fifth outflow-inflow portion 22C side. A part of second flow path F2 that is located on the sixth outflow-inflow portion 22D side also serves as a part of fourth flow path F4 that is located on the sixth outflow-inflow portion 22D side.

[0038] Next, operation of refrigeration cycle apparatus 100 is described.

[0039] As shown in Fig. 1, in the first state, the non-azeotropic refrigerant mixture discharged from compressor 11 is condensed through heat exchange with air in air heat exchanger 13. The condensed non-azeotropic refrigerant mixture is reduced in pressure by expansion valve 14, and thereafter evaporated through heat exchange with the liquid medium in water heat exchanger 30. The evaporated non-azeotropic refrigerant mixture is sucked into compressor 11.

[0040] In the first state, the liquid medium flowing out of pump 21 flows from inflow portion 22A into liquid flow direction switching unit 22. The liquid medium flowing into liquid flow direction switching unit 22 flows through first flow path F1 and flows out of liquid flow direction switching unit 22 from fifth outflow-inflow portion 22C. The liquid medium flowing out of liquid flow direction switching unit 22 flows from first outflow-inflow portion 30A into water heat exchanger 30. The liquid medium flowing into water heat exchanger 30 is cooled through heat exchange with the non-azeotropic refrigerant mixture. The cooled liquid medium flows out of water heat exchanger 30 from second outflow-inflow portion 30B, and flows from sixth outflow-inflow portion 22D into liquid flow direction switching unit 22. The liquid medium flowing into liquid flow direction switching unit 22 flows through fourth flow path F4 and flows out of liquid flow direction switching unit 22 from outflow portion 22B. The liquid medium flowing out of liquid flow direction switching unit 22 flows from inlet 23B into indoor heat exchanger 23 to exchange heat with indoor air in indoor heat exchanger 23 to thereby cool the indoor air. The liquid medium heated through the heat exchange flows into pump 21.

[0041] In the first state, the non-azeotropic refrigerant mixture flows from fourth outflow-inflow portion 30D into water heat exchanger 30, and flows out of water heat exchanger 30 from third outflow-inflow portion 30C. The liquid medium flows from first outflow-inflow portion 30A into water heat exchanger 30, and flows out of water heat exchanger 30 from second outflow-inflow portion 30B. In the first state, the non-azeotropic refrigerant mixture flowing upward from below in water heat exchanger 30 exchanges heat with the liquid medium flowing downward from above in water heat exchanger 30.

[0042] As shown in Fig. 2, in the second state, the non-azeotropic refrigerant mixture discharged from compres-

sor 11 is condensed through heat exchange with the liquid medium in water heat exchanger 30, reduced in pressure by expansion valve 14, and then evaporated through heat exchange with air in air heat exchanger 13. The evaporated non-azeotropic refrigerant mixture is sucked into compressor 11.

[0043] In the second state, the liquid medium flowing out of pump 21 flows from inflow portion 22A into liquid flow direction switching unit 22. The liquid medium flowing into liquid flow direction switching unit 22 flows through second flow path F2, and flows out of liquid flow direction switching unit 22 from sixth outflow-inflow portion 22D. The liquid medium flowing out of liquid flow direction switching unit 22 flows from second outflow-inflow portion 30B into water heat exchanger 30. The liquid medium flowing into water heat exchanger 30 is heated through heat exchange with the non-azeotropic refrigerant mixture. The heated liquid medium flows out of water heat exchanger 30 from first outflow-inflow portion 30A, and flows from fifth outflow-inflow portion 22C into liquid flow direction switching unit 22. The liquid medium flowing into liquid flow direction switching unit 22 flows through third flow path F3, and flows out of liquid flow direction switching unit 22 from outflow portion 22B. The liquid medium flowing out of liquid flow direction switching unit 22 flows from inlet 23B into indoor heat exchanger 23, and heats the indoor air through heat exchange with the indoor air in indoor heat exchanger 23. The liquid medium cooled through the heat exchange flows into pump 21.

[0044] In the second state, the non-azeotropic refrigerant mixture flows from third outflow-inflow portion 30C into water heat exchanger 30, and flows out of water heat exchanger 30 from fourth outflow-inflow portion 30D. The liquid medium flows from second outflow-inflow portion 30B into water heat exchanger 30, and flows out of water heat exchanger 30 from first outflow-inflow portion 30A. In the second state, the non-azeotropic refrigerant mixture flowing downward from above in water heat exchanger 30 exchanges heat with the liquid medium flowing upward from below in water heat exchanger 30.

[0045] Thus, in both the first state and the second state, the direction in which the liquid medium flows through water heat exchanger 30 is opposite to the direction in which the non-azeotropic refrigerant mixture flows through water heat exchanger 30. In other words, in water heat exchanger 30, the flow of the liquid medium and the flow of the non-azeotropic refrigerant mixture are counterflow in both the first state and the second state.

[0046] Further, the direction in which the liquid medium flows through indoor heat exchanger 23 is constant in the first state and the second state. That is, the flow direction of each of the liquid medium and the indoor air that exchange heat with each other in indoor heat exchanger 23 is constant in the first state and the second state. The direction in which the indoor air flows through indoor heat exchanger 23 may be set opposite to the direction in which the liquid medium flows through indoor

heat exchanger 23, in each of the first state and the second state. In indoor heat exchanger 23, the flow of the liquid medium and the flow of the indoor air may be counterflow in both of the first state and the second state.

[0047] Thus, in refrigeration cycle apparatus 100, the liquid medium and the indoor air can be counterflow in indoor heat exchanger 23, while the non-azeotropic refrigerant mixture and the liquid medium are counterflow in water heat exchanger 30, and therefore, decrease in heat exchange efficiency in water heat exchanger 30 and decrease in heat exchange efficiency in indoor heat exchanger 23 can be suppressed at the same time.

[0048] In refrigeration cycle apparatus 100, the direction in which the liquid medium flows from outflow portion 22B to inflow portion 22A of liquid flow direction switching unit 22 is constant regardless of the first state and the second state, and therefore, pump 21 is disposed in the flow path located downstream of outflow portion 22B and upstream of inflow portion 22A of liquid flow direction switching unit 22, in liquid medium circulation circuit 20. Therefore, relative to an existing refrigeration cycle apparatus which differs from refrigeration cycle apparatus 100 in that liquid medium circulation circuit 20 does not include liquid flow direction switching unit 22 and in which the liquid medium and the non-azeotropic refrigerant mixture are parallel flow in water heat exchanger 30 due to lack of liquid flow direction switching unit 22, refrigeration cycle apparatus 100 can easily be implemented by replacing the refrigerant flow path between pump 21 and water heat exchanger 30 and the refrigerant flow path between indoor heat exchanger 23 and water heat exchanger 30 in the existing apparatus, with liquid flow direction switching unit 22.

[0049] Each of first on-off valve 41, second on-off valve 42, third on-off valve 43, and fourth on-off valve 44 is a one-way solenoid valve provided so as to open and close only a flow in one direction. Each of such first on-off valve 41, second on-off valve 42, third on-off valve 43, and fourth on-off valve 44 is inexpensive as compared with a bidirectional solenoid valve provided to open and close a bidirectional flow.

[0050] At least one of first on-off valve 41, second on-off valve 42, third on-off valve 43, and fourth on-off valve 44 may be a one-way solenoid valve.

[0051] Each of first on-off valve 41, second on-off valve 42, third on-off valve 43, and fourth on-off valve 44 is provided so as to open or close the flow of water in the vertical direction. In this way, as compared with the case where each of first on-off valve 41, second on-off valve 42, third on-off valve 43, and fourth on-off valve 44 is provided so as to open or close the flow of water in the horizontal direction, the area of each on-off valve projected on a cross section perpendicular to the vertical direction is reduced and the installation space can be reduced.

[0052] At least one of first on-off valve 41, second on-off valve 42, third on-off valve 43, and fourth on-off valve 44 may be provided so as to open or close the flow of

water in the vertical direction.

Embodiment 2

[0053] As shown in Figs. 3 to 6, a refrigeration cycle apparatus 101 according to Embodiment 2 basically has the same configuration as refrigeration cycle apparatus 100 according to Embodiment 1, but is different from refrigeration cycle apparatus 100 in that liquid flow direction switching unit 22 includes a stack structure 60 instead of a plurality of pipes, i.e., third pipe 51, fourth pipe 53, fifth pipe 52, and sixth pipe 54. In the following, differences of refrigeration cycle apparatus 101 from refrigeration cycle apparatus 100 are mainly described.

[0054] As shown in Figs. 5 and 6, stack structure 60 includes a plurality of plates that are stacked on each other. The plurality of plates include a first plate P1, a second plate P2, a third plate P3, and a fourth plate P4.

[0055] First plate P1 and second plate P2 are arranged respectively at opposite ends in the direction in which the plurality of plates are stacked (the direction is simply referred to as stack direction hereinafter). Third plate P3 and fourth plate P4 are arranged between first plate P1 and second plate P2 in the stack direction. First plate P1, third plate P3, fourth plate P4, and second plate P2 are stacked in this order.

[0056] A first through hole 61, a second through hole 62, a third through hole 63, and a fourth through hole 64 are formed in first plate P1. First through hole 61 is connected to first on-off valve 41. Second through hole 62 is connected to second on-off valve 42. Third through hole 63 is connected to third on-off valve 43. Fourth through hole 64 is connected to fourth on-off valve 44.

[0057] A fifth through hole 65 and a sixth through hole 66 are formed in second plate P2. Fifth through hole 65 is connected to first outflow-inflow portion 30A of water heat exchanger 30. Sixth through hole 66 of water heat exchanger 30 is connected to second outflow-inflow portion 30B.

[0058] A seventh through hole 67, an eighth through hole 68, a ninth through hole 69, and a tenth through hole 70 are formed in third plate P3. Seventh through hole 67 is disposed between first through hole 61 and fifth through hole 65 so as to overlap first through hole 61 and fifth through hole 65 in the stack direction. Eighth through hole 68 is disposed between second through hole 62 and second plate P2 so as to overlap second through hole 62 and second plate P2 in the stack direction. Ninth through hole 69 is disposed between third through hole 63 and second plate P2 so as to overlap third through hole 63 and second plate P2 in the stack direction. Tenth through hole 70 is disposed between fourth through hole 64 and sixth through hole 66 so as to overlap fourth through hole 64 and sixth through hole 66 in the stack direction.

[0059] An eleventh through hole 71, a twelfth through hole 72, a thirteenth through hole 73, and a fourteenth through hole 74 are formed in fourth plate P4. Eleventh

through hole 71 is disposed between seventh through hole 67 and fifth through hole 65 so as to overlap seventh through hole 67 and fifth through hole 65 in the stack direction. Twelfth through hole 72 is disposed between eighth through hole 68 and second plate P2 so as to overlap eighth through hole 68 and second plate P2 in the stack direction. Thirteenth through hole 73 is disposed between ninth through hole 69 and second plate P2 so as to overlap ninth through hole 69 and second plate P2 in the stack direction. Fourteenth through hole 74 is disposed between tenth through hole 70 and sixth through hole 66 so as to overlap tenth through hole 70 and sixth through hole 66 in the stack direction.

[0060] Each of twelfth through hole 72 and thirteenth through hole 73 of fourth plate P4 is closed, for example, by second plate P2.

[0061] The thermal insulation property of each of the third plate and fourth plate P4 is higher than the thermal insulation property of each of the first plate and second plate P2. The thermal conductivity of each of the third plate and fourth plate P4 is lower than the thermal conductivity of each of the first plate and second plate P2.

[0062] Stack structure 60 includes a first seal member 75 connecting first through hole 61 and seventh through hole 67 to each other, a second seal member 76 connecting third through hole 63 and ninth through hole 69 to each other, a seal member 77 connecting sixth through hole 66 and fourteenth through hole 74 to each other, a seal member 78 connecting fourteenth through hole 74 and tenth through hole 70 to each other, and a seal member 79 connecting eighth through hole 68 and twelfth through hole 72 to each other. Seal member 77, fourteenth through hole 74, and seal member 78 are connected in this order in the stack direction. Seal member 77, fourteenth through hole 74, and seal member 78 form a third seal member that connects sixth through hole 66 and tenth through hole 70 to each other.

[0063] First seal member 75 and second seal member 76 are formed as separate members from each of first plate P1 and third plate P3, for example. Seal member 77 is formed as a separate member from each of second plate P2 and fourth plate P4, for example. Seal member 78 and seal member 79 are formed as separate members from each of third plate P3 and fourth plate P4, for example.

[0064] Each of first seal member 75, second seal member 76, seal member 77, seal member 78, and seal member 79 includes a heat insulator made of a material having the heat insulation property. The material having the heat insulation property means a material having a lower thermal conductivity than the material forming each of first plate P1 and second plate P2. The material forming each of first plate P1 and second plate P2 includes aluminum (Al), for example. The material forming each of first seal member 75, second seal member 76, seal member 77, seal member 78, and seal member 79 includes, for example, any one of polypropylene, polyethylene, and polystyrene, or a material mixture of at least two of polypro-

pylene, polyethylene, and polystyrene.

[0065] Between first plate P1 and third plate P3, a first space is formed outside first seal member 75 and second seal member 76. The first space is contiguous to each of second through hole 62, fourth through hole 64, eighth through hole 68, and tenth through hole 70.

[0066] Between third plate P3 and fourth plate P4, a third space is formed outside seal member 78 and seal member 79. The third space is contiguous to each of seventh through hole 67, ninth through hole 69, and eleventh through hole 71.

[0067] Between second plate P2 and fourth plate P4, a fourth space is formed outside seal member 77. The fourth space is contiguous to each of fifth through hole 65, eleventh through hole 71, and twelfth through hole 72.

[0068] As shown in Fig. 5, in the first state, first flow path F1 is formed as a flow path that is formed by connecting first through hole 61, first seal member 75, seventh through hole 67, the third space, eleventh through hole 71, the fourth space, and fifth through hole 65, in this order. A part of first flow path F1 is formed inside first seal member 75.

[0069] As shown in Fig. 5, in the first state, fourth flow path F4 is formed as a flow path that is formed by connecting sixth through hole 66, seal member 77, fourteenth through hole 74, seal member 78, tenth through hole 70, the first space, and fourth through hole 64, in this order. A part of fourth flow path F4 is formed inside each of seal member 77, fourteenth through hole 74, and seal member 78.

[0070] As shown in Fig. 5, in the first state, the liquid medium passing through first through hole 61 is caused, by first seal member 75, not to flow in the first space, but to flow only through seventh through hole 67. The liquid medium flowing into the third space from seventh through hole 67 flows only through eleventh through hole 71. The liquid medium flowing from seventh through hole 67 into the third space does not flow through ninth through hole 69, because third on-off valve 43 is closed, and is caused, by seal member 78 and seal member 79, not to flow through eighth through hole 68 and tenth through hole 70. The liquid medium flowing from eleventh through hole 71 into the fourth space flows only through fifth through hole 65. Since second on-off valve 42 and third on-off valve 43 are closed, the liquid medium flowing from eleventh through-hole 71 into the fourth space does not flow through twelfth through-hole 72 and thirteenth through-hole 73.

[0071] As shown in Fig. 5, in the first state, the liquid medium passing through sixth through hole 66 is caused, by seal member 77, not to flow in the fourth space, but to flow only through fourteenth through hole 74. The liquid medium passing through fourteenth through hole 74 is caused, by seal member 78, not to flow in the third space but to flow only through tenth through hole 70. The liquid medium flowing from tenth through hole 70 into the first space flows only through fourth through hole 64. Since second on-off valve 42 and third on-off valve 43 are

closed, the liquid medium flowing from tenth through-hole 70 into the first space does not flow through second through-hole 62 and third through-hole 63.

[0072] As shown in Fig. 6, in the second state, second flow path F2 is formed as a flow path that is formed by connecting second through hole 62, the first space, tenth through hole 70, seal member 78, fourteenth through hole 74, seal member 77, and sixth through hole 66 in this order. A part of second flow path F2 is formed inside each of seal member 77, fourteenth through hole 74, and seal member 78.

[0073] As shown in Fig. 6, in the second state, third flow path F3 is formed as a flow path that is formed by connecting fifth through hole 65, eleventh through hole 71, the third space, ninth through hole 69, second seal member 76, and third through hole 63 in this order. A part of third flow path F3 is formed inside second seal member 76.

[0074] As shown in Fig. 6, in the second state, the liquid medium passing through second through hole 62 flows through the first space to tenth through hole 70. The liquid medium passing through second through hole 62 is caused, by first seal member 75 and second seal member 76, not to flow through each of seventh through hole 67 and ninth through hole 69. The liquid medium passing through tenth through hole 70 is caused, by seal member 78, not to flow in the third space, but to flow only through fourteenth through hole 74. The liquid medium passing through fourteenth through hole 74 is caused, by seal member 77, not to flow in the fourth space, but to flow only through sixth through hole 66.

[0075] As shown in Fig. 6, in the second state, a part of the liquid medium passing through fifth through hole 65 flows through eleventh through hole 71 and the third space to ninth through hole 69. The remainder of the liquid medium passing through fifth through hole 65 flows through the fourth space and thirteenth through hole 73 to ninth through hole 69. Since first on-off valve 41 is closed, the liquid medium passing through fifth through hole 65 does not flow to seventh through hole 67. The liquid medium passing through ninth through hole 69 is caused, by second seal member 76, to flow only through third through hole 63.

[0076] Refrigeration cycle apparatus 101 basically has the same configuration as refrigeration cycle apparatus 100, and can therefore achieve similar advantageous effects to those of refrigeration cycle apparatus 100. Specifically, like refrigeration cycle apparatus 100, refrigeration cycle apparatus 101 can also open and close each of first on-off valve 41, second on-off valve 42, third on-off valve 43, and fourth on-off valve 44, in response to switching between the first state and the second state by four-way valve 12, to thereby suppress decrease in heat exchange efficiency in indoor heat exchanger 23, while the non-azeotropic refrigerant mixture and the liquid medium are counterflow in water heat exchanger 30. Stack structure 60 may be prepared as a plate heat exchanger.

[0077] Further, the installation space where stack

structure 60 is installed can be reduced as compared with the entire installation space of third pipe 51, fourth pipe 53, fifth pipe 52, and sixth pipe 54 shown in Figs. 1 and 2. This is for the reason that third pipe 51 and fourth pipe 53 are connected in parallel to each other and fifth pipe 52 and sixth pipe 54 are connected in parallel to each other, so that the installation space in the plane orthogonal to the direction in which each pipe extends is relatively large.

[0078] In refrigeration cycle apparatus 101, liquid flow direction switching unit 22 includes stack structure 60, which enables reduction of the installation space, as compared with liquid flow direction switching unit 22 including the plurality of pipes 51 to 54.

[0079] In refrigeration cycle apparatus 101, each of first seal member 75, second seal member 76, seal member 77, seal member 78, and seal member 79 includes a heat insulator made of a material having the heat insulation property.

[0080] Thus, it is possible to suppress heat exchange between the liquid medium flowing inside each seal member and the heat medium flowing outside each seal member. In the second state, second seal member 76 suppresses heat exchange between a part of second flow path F2 that is formed in the first space and a part of third flow path F3 that is formed inside second seal member 76. In the second state, seal member 78 suppresses heat exchange between another part of second flow path F2 that is formed inside seal member 78 and another part of third flow path F3 formed in the fourth space. Accordingly, in the second state, the liquid medium heated by water heat exchanger 30 can thereafter reach indoor heat exchanger 23 without being cooled through heat exchange with the liquid medium before being heated by water heat exchanger 30.

[0081] As described above, in the second state, a part of second flow path F2 and a part of third flow path F3 are disposed with third plate P3 interposed. Therefore, when the heat insulation property of third plate P3 is equivalent to or less than the heat insulation property of first plate P1, the liquid medium heated by water heat exchanger 30 is cooled through heat exchange with the liquid medium before being heated by water heat exchanger 30.

[0082] In contrast, in refrigeration cycle apparatus 101, the heat insulation property of third plate P3 is higher than the heat insulation property of first plate P1. Therefore, in the second state, the liquid medium heated by water heat exchanger 30 can thereafter reach indoor heat exchanger 23 without being cooled through heat exchange with the liquid medium before being heated by water heat exchanger 30.

[0083] While stack structure 60 shown in Figs. 5 and 6 includes four plates, the number of plates may be three or may be five or more.

[0084] As shown in Figs. 7 and 8, stack structure 60 may not include fourth plate P4. In the following, differences of stack structure 60 shown in Figs. 7 and 8 from

stack structure 60 shown in Figs. 5 and 6 are mainly described.

[0085] Each of eighth through hole 68 and ninth through hole 69 of third plate P3 is closed by second plate P2, for example.

[0086] Seal member 77 connects sixth through hole 66 to tenth through hole 70. Seal member 77 forms a third seal member that connects sixth through hole 66 to tenth through hole 70.

[0087] Between second plate P2 and third plate P3, a second space is formed outside seal member 77. The second space is contiguous to each of fifth through hole 65 and seventh through hole 67.

[0088] As shown in Fig. 7, in the first state, first flow path F1 is formed as a flow path that is formed by connecting first through hole 61, first seal member 75, seventh through hole 67, the second space, and fifth through hole 65 in this order. A part of first flow path F1 is formed inside first seal member 75.

[0089] As shown in Fig. 7, in the first state, fourth flow path F4 is formed as a flow path that is formed by connecting sixth through hole 66, seal member 77, tenth through hole 70, the first space, and fourth through hole 64 in this order. A part of fourth flow path F4 is formed inside seal member 77.

[0090] As shown in Fig. 8, in the second state, second flow path F2 is formed as a flow path that is formed by connecting second through hole 62, the first space, tenth through hole 70, seal member 77, and sixth through hole 66 in this order. A part of second flow path F2 is formed inside seal member 77.

[0091] As shown in Fig. 8, in the second state, third flow path F3 is formed as a flow path that is formed by connecting fifth through hole 65, the second space, ninth through hole 69, second seal member 76, and third through hole 63 in this order. A part of third flow path F3 is formed inside second seal member 76.

[0092] In refrigeration cycle apparatus 101 according to Embodiment 2, eighth through hole 68 may not be formed in third plate P3. Twelfth through hole 72 may not be formed in fourth plate P4. In this case, stack structure 60 may not include seal member 79.

[0093] In refrigeration cycle apparatus 101 according to Embodiment 2, stack structure 60 may be provided integrally with water heat exchanger 30. Water heat exchanger 30 may be formed as part of one plate heat exchanger and stack structure 60 may be formed as the remainder of the one plate heat exchanger. This eliminates the need for a pipe connecting water heat exchanger 30 to stack structure 60, to thereby enable further reduction of the installation space where refrigeration cycle apparatus 101 is installed.

[0094] The foregoing is a description of the embodiments of the present disclosure, and the above-described embodiments can be modified in various ways. The scope of the present disclosure is not limited to the above-described embodiments. It is intended that the scope of the present disclosure is defined by the claims,

and encompasses all variations equivalent in meaning and scope to the claims.

REFERENCE SIGNS LIST

[0095] 10 refrigerant circulation circuit; 11 compressor; 12 four-way valve; 13 air heat exchanger; 14 expansion valve; 20 liquid medium circulation circuit; 21 pump; 22 liquid flow direction switching unit; 22A inflow portion; 22B outflow portion; 22C fifth outflow-inflow portion; 22D sixth outflow-inflow portion; 23 indoor heat exchanger; 23A outlet; 23B inlet; 30 water heat exchanger; 30A first outflow-inflow portion; 30B second outflow-inflow portion; 30C third outflow-inflow portion; 30D fourth outflow-inflow portion; 31 first pipe; 32 second pipe; 41 first on-off valve; 42 second on-off valve; 43 third on-off valve; 44 fourth on-off valve; 51 third pipe; 52 fifth pipe; 53 fourth pipe; 54 sixth pipe; 60 stack structure; 61 first through hole; 62 second through hole; 63 third through hole; 64 fourth through hole; 65 fifth through hole; 66 sixth through hole; 67 seventh through hole; 68 eighth through hole; 69 ninth through hole; 70 tenth through hole; 71 eleventh through hole; 72 twelfth through hole; 73 thirteenth through hole; 74 fourteenth through hole; 75 first seal member; 76 second seal member; 77, 78, 79 seal member; 100, 101 refrigeration cycle apparatus

Claims

1. A refrigeration cycle apparatus comprising:

a refrigerant circulation circuit that comprises a compressor, a four-way valve, an air heat exchanger, an expansion valve, and a water heat exchanger, and that is configured to cause a non-azeotropic refrigerant mixture to circulate through the refrigerant circulation circuit; and a liquid medium circulation circuit that comprises a pump, a liquid flow direction switching unit, the water heat exchanger, and an indoor heat exchanger, and that is configured to cause a liquid medium to circulate through the liquid medium circulation circuit, wherein
the water heat exchanger is configured to cause the non-azeotropic refrigerant mixture to exchange heat with the liquid medium,
the four-way valve is configured to switch between a first state in which the non-azeotropic refrigerant mixture flows sequentially through the compressor, the air heat exchanger, and the water heat exchanger, and a second state in which the non-azeotropic refrigerant mixture flows sequentially through the compressor, the water heat exchanger, and the air heat exchanger,
the liquid flow direction switching unit is configured to switch a direction in which the liquid me-

dium flows through the liquid medium circulation circuit,

in the first state, the non-azeotropic refrigerant mixture flows upward from below in the water heat exchanger, and the liquid medium flows downward from above in the water heat exchanger,

in the second state, the non-azeotropic refrigerant mixture flows downward from above in the water heat exchanger, and the liquid medium flows upward from below in the water heat exchanger, and

a direction in which the liquid medium flows in the indoor heat exchanger is constant in each of the first state and the second state.

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

the indoor heat exchanger comprises an inlet through which the liquid medium flows in, and an outlet through which the liquid medium flows out,

the liquid flow direction switching unit comprises an inflow portion through which the liquid medium flowing out of the outlet flows in, and an outflow portion through which the liquid medium flows out toward the inlet, and

the pump is configured to feed the liquid medium flowing out of the outlet of the indoor heat exchanger, to the inflow portion of the liquid flow direction switching unit, or to feed the liquid medium flowing out of the outflow portion of the liquid flow direction switching unit to the inlet of the indoor heat exchanger.

3. The refrigeration cycle apparatus according to claim 2, wherein

the water heat exchanger comprises a first outflow-inflow portion and a second outflow-inflow portion through which the liquid medium flows out and flows in,

the first outflow-inflow portion is located upward relative to the second outflow-inflow portion, the liquid flow direction switching unit comprises:

a first flow path connected between the inflow portion and the first outflow-inflow portion;

a second flow path connected between the inflow portion and the second outflow-inflow portion;

a third flow path connected between the outflow portion and the first outflow-inflow portion;

a fourth flow path connected between the

- outflow portion and the second outflow-in-flow portion;
 a first on-off valve configured to open and close the first flow path;
 a second on-off valve configured to open and close the second flow path;
 a third on-off valve configured to open and close the third flow path; and
 a fourth on-off valve configured to open and close the fourth flow path,
- in the first state, the first on-off valve and the fourth on-off valve are opened, and the second on-off valve and the third on-off valve are closed, and
 in the second state, the second on-off valve and the third on-off valve are opened, and the first on-off valve and the fourth on-off valve are closed.
4. The refrigeration cycle apparatus according to claim 3, wherein
- the liquid flow direction switching unit comprises a plurality of pipes, and
 each of the first flow path, the second flow path, the third flow path, and the fourth flow path is formed by at least one of the plurality of pipes.
5. The refrigeration cycle apparatus according to claim 4, wherein
- the plurality of pipes comprise:
- a first pipe connected to the first outflow-inflow portion;
 a second pipe connected to the second outflow-inflow portion;
 a third pipe and a fourth pipe connected in parallel to each other with respect to the first pipe; and
 a fifth pipe and a sixth pipe connected in parallel to each other with respect to the second pipe,
- the first flow path is formed by the first pipe and the third pipe,
 the second flow path is formed by the first pipe and the fourth pipe,
 the third flow path is formed by the second pipe and the fifth pipe, and
 the fourth flow path is formed by the second pipe and the sixth pipe.
6. The refrigeration cycle apparatus according to claim 3, wherein
- the liquid flow direction switching unit comprises

a stack structure comprising a plurality of plates stacked on each other, the plurality of plates comprise:

- a first plate in which a first through hole connected to the first on-off valve, a second through hole connected to the second on-off valve, a third through hole connected to the third on-off valve, and a fourth through hole connected to the fourth on-off valve are formed;
 a second plate in which a fifth through hole connected to the first outflow-inflow portion and a sixth through hole connected to the second outflow-inflow portion are formed; and
 a third plate disposed between the first plate and the second plate, and

the plurality of plates are arranged to

- form, in the first state, the first flow path between the first through hole and the fifth through hole, and the fourth flow path between the fourth through hole and the sixth through hole, and
 form, in the second state, the second flow path between the second through hole and the sixth through hole, and the third flow path between the third through hole and the fifth through hole.

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

the fifth through hole is disposed to overlap the first through hole in a stack direction in which the plurality of plates are stacked,
 the sixth through hole is disposed to overlap the fourth through hole in the stack direction,
 in the third plate, a seventh through hole overlapping the first through hole and the fifth through hole in the stack direction, a ninth through hole overlapping the third through hole in the stack direction, and a tenth through hole overlapping the fourth through hole and the sixth through hole in the stack direction, are formed,
 the stack structure comprises: a first seal member connecting the first through hole to the seventh through hole; a second seal member connecting the third through hole to the ninth through hole; and a third seal member connecting the sixth through hole to the tenth through hole,
 between the first plate and the third plate, a first space contiguous to each of the second through hole, the fourth through hole, and the tenth through hole is formed outside the first seal

member and the second seal member,
 between the second plate and the third plate, a
 second space contiguous to each of the fifth
 through hole, the seventh through hole, and the
 ninth through hole is formed outside the third
 seal member, 5
 in the first state, a part of the first flow path is
 formed inside the first seal member, and a part
 of the fourth flow path is formed inside the third
 seal member, and 10
 in the second state, a part of the second flow
 path is formed in the first space, and a part of
 the third flow path is formed in the second space
 and inside the second seal member. 15

8. The refrigeration cycle apparatus according to claim
 7, wherein each of the first seal member, the second
 seal member, and the third seal member comprises
 a heat insulator made of a material having heat in-
 sulation property. 20
9. The refrigeration cycle apparatus according to any
 one of claims 6 to 8, wherein heat insulation property
 of the third plate is higher than heat insulation prop-
 erty of the first plate. 25
10. The refrigeration cycle apparatus according to any
 one of claims 3 to 9, wherein at least one of the first
 on-off valve, the second on-off valve, the third on-off
 valve, and the fourth on-off valve is a one-way sole-
 noid valve configured to open and close only a flow 30
 in one direction.
11. The refrigeration cycle apparatus according to any
 one of claims 3 to 10, wherein at least one of the first 35
 on-off valve, the second on-off valve, the third on-off
 valve, and the fourth on-off valve is configured to
 open or close a flow of the liquid medium in a vertical
 direction. 40

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FIG.1

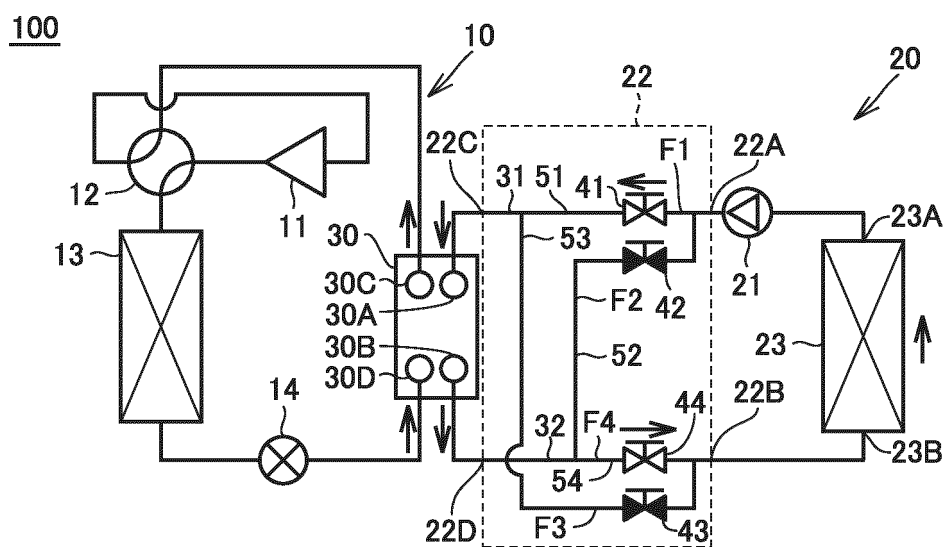


FIG.2

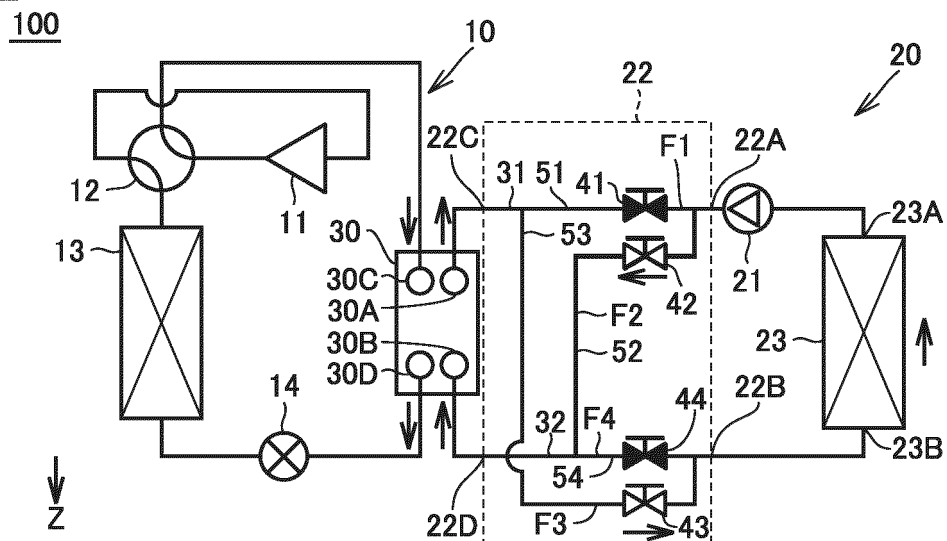


FIG.3

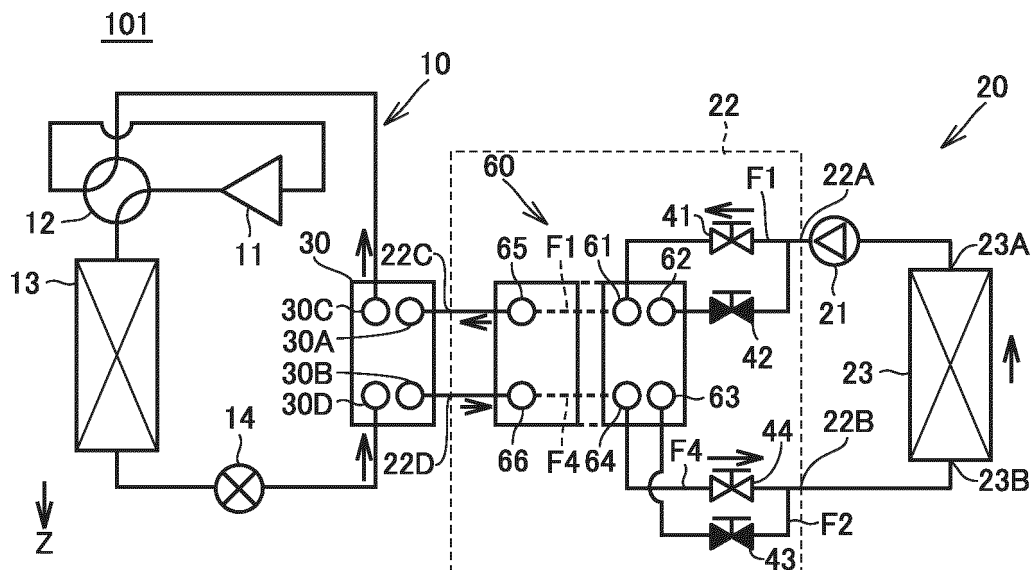


FIG.4

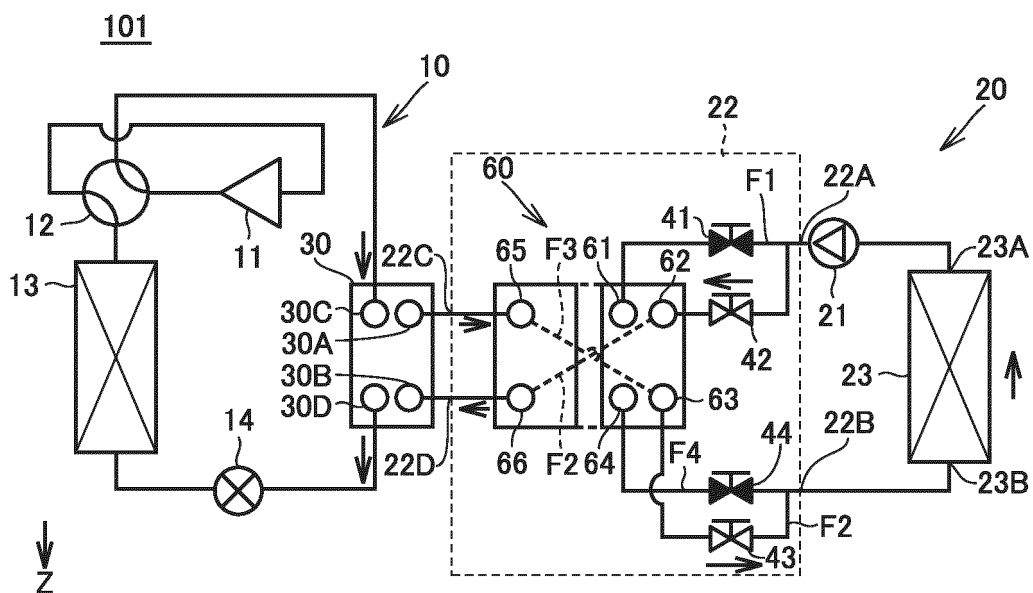


FIG.5

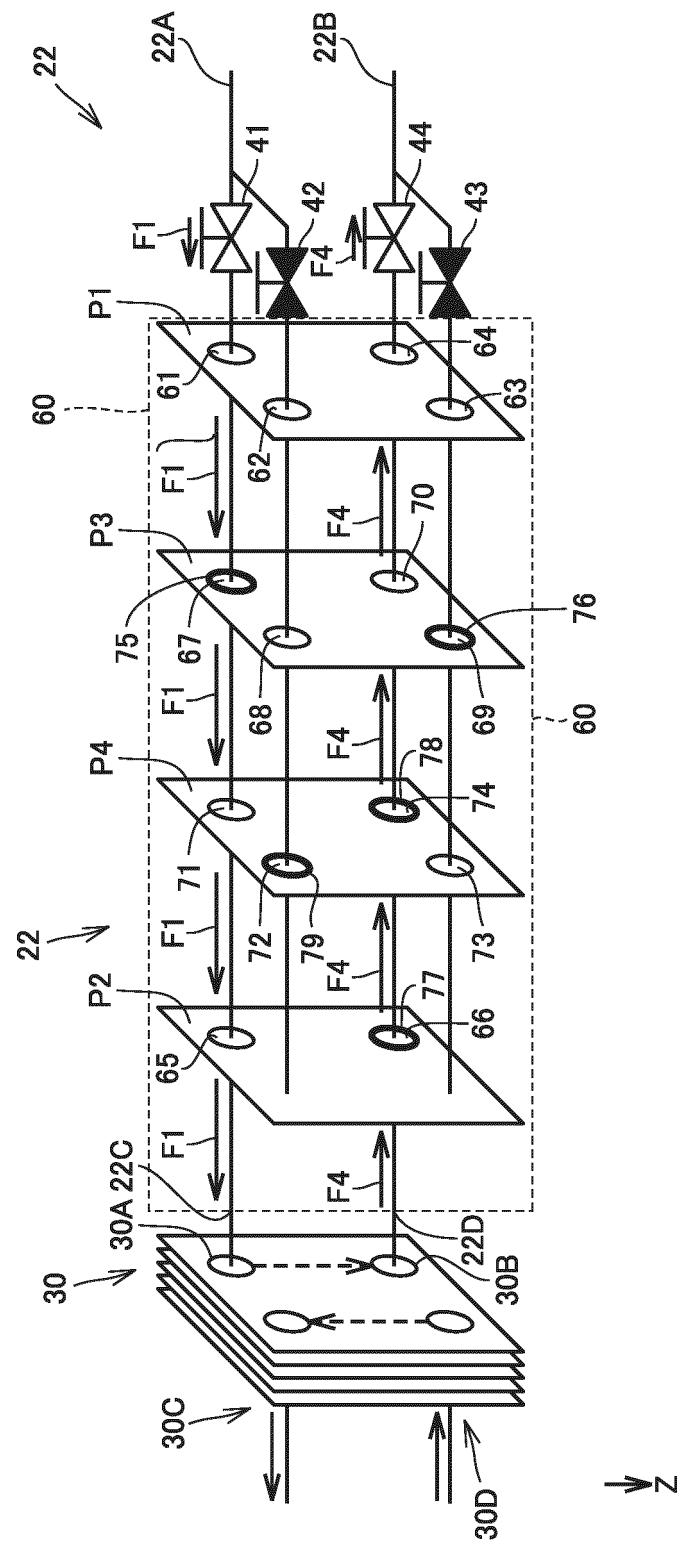


FIG.6

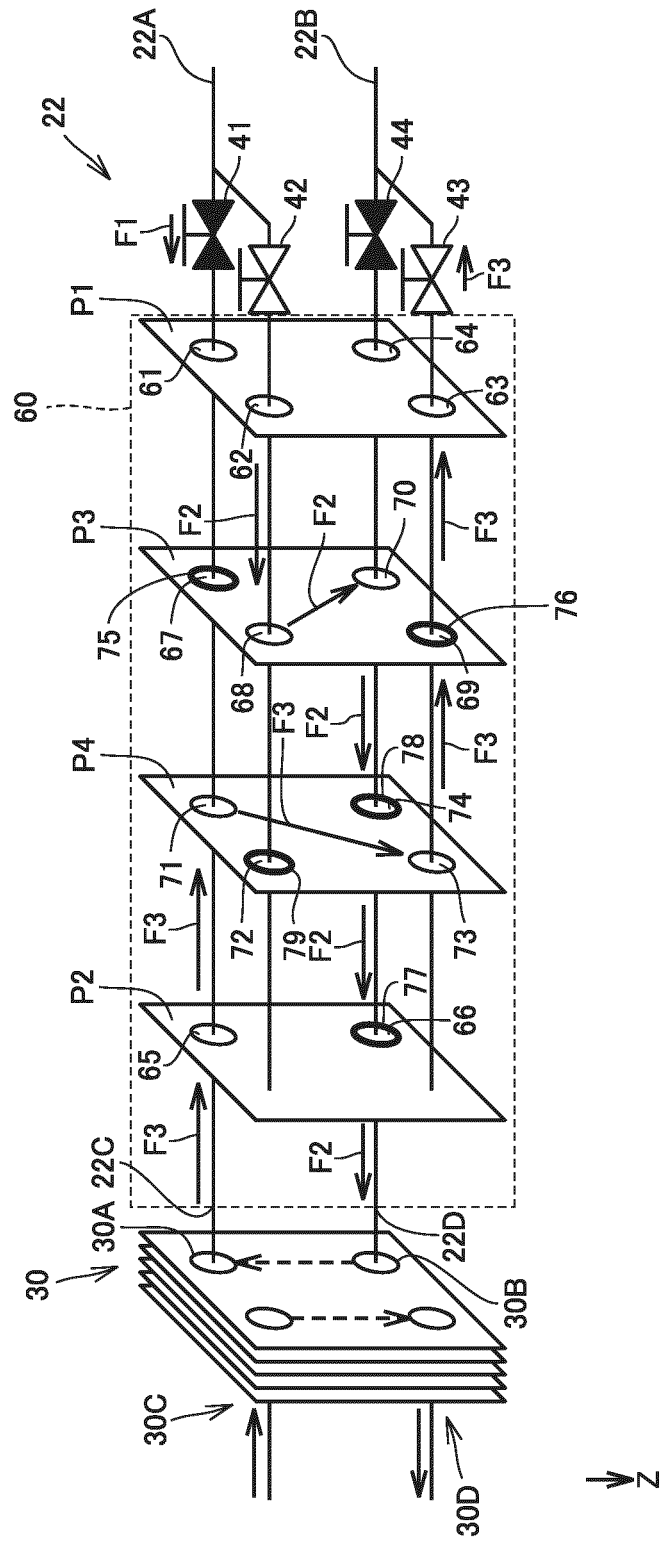


FIG.7

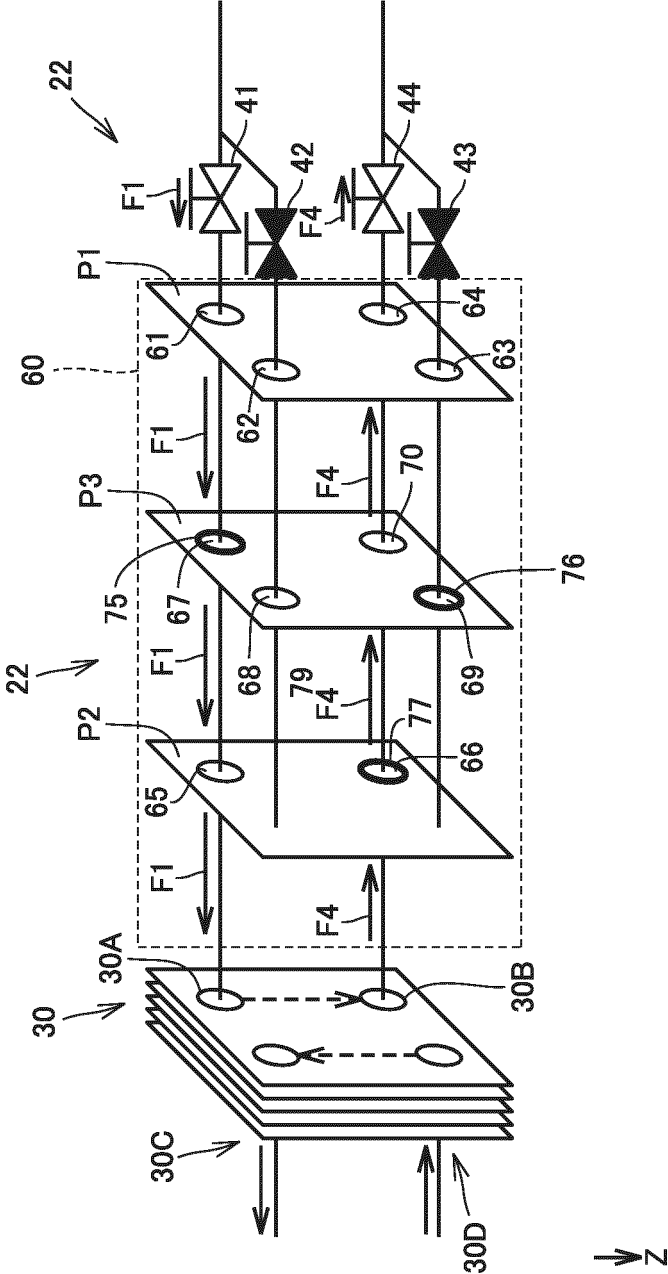
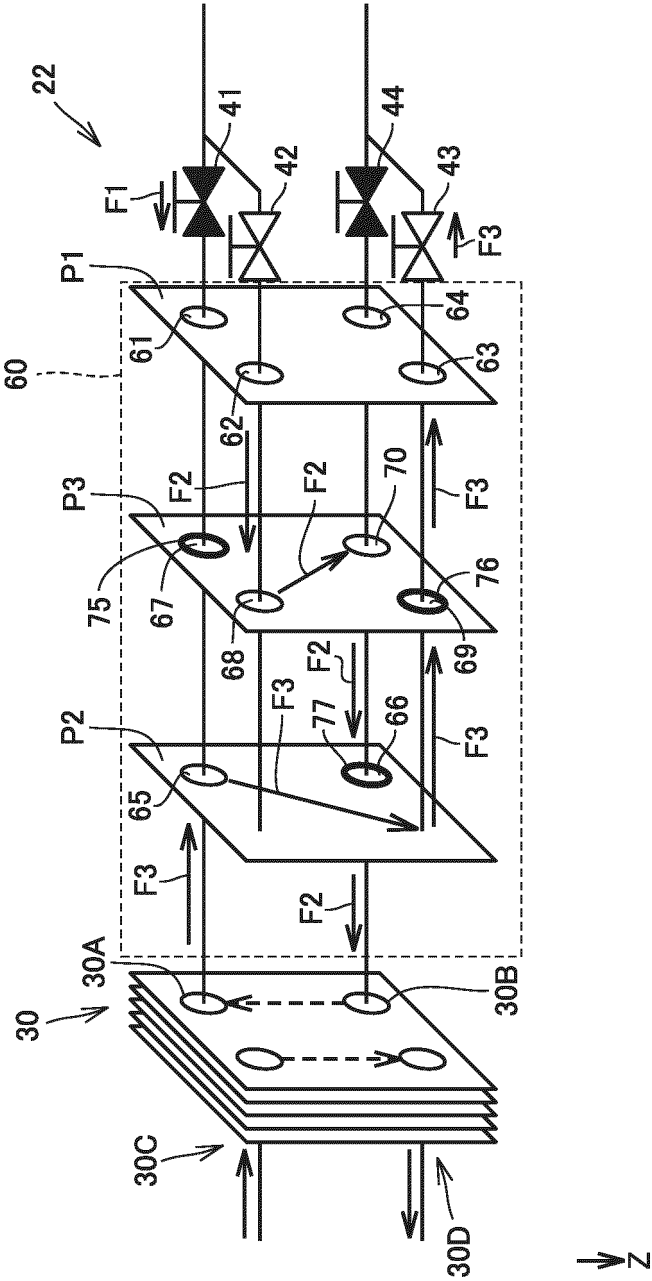


FIG.8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/021695

A. CLASSIFICATION OF SUBJECT MATTER

F25B 1/00(2006.01)i

FI: F25B1/00 399Y

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)

F25B1/00

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	JP 10-281575 A (DAIKIN IND LTD) 23 October 1998 (1998-10-23) paragraphs [0034]-[0099], fig. 1-3, 8-9	1-11
Y	JP 8-86477 A (HITACHI LTD) 02 April 1996 (1996-04-02) paragraphs [0012]-[0017], fig. 1-3	1-11
Y	WO 2012/070192 A1 (MITSUBISHI ELECTRIC CORPORATION) 31 May 2012 (2012-05-31) paragraphs [0017]-[0161], fig. 1-14	1-11
Y	JP 2009-18602 A (DAIKIN IND LTD) 29 January 2009 (2009-01-29) paragraphs [0031]-[0036], fig. 2-4	6-11



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search
29 June 2021 (29.06.2021)Date of mailing of the international search report
13 July 2021 (13.07.2021)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

International application No.

PCT/JP2021/021695

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2020-139641 A (IZUMI GIKEN CO LTD) 03 September 2020 (2020-09-03) paragraphs [0097]-[0103], [0110]-[0111], fig. 16, 22	6-11

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No. PCT/JP2021/021695
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JP 8-86477 A	02 Apr. 1996	(Family: none)	
WO 2012/070192 A1	31 May 2012	US 2013/0174594 A1 paragraphs [0034]- [0190], fig. 1-14 EP 2645014 A1 CN 103210262 A CN 106642788 A WO 2012/070083 A1 JP 2014-130003 A JP 2014-145583 A	
JP 2009-18602 A	29 Jan. 2009	(Family: none)	
JP 2020-139641 A	03 Sep. 2020	(Family: none)	

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