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(54) HEAT PUMP SYSTEM

(57) A decrease in the heating capacity for a fluid to be heated in a radiator is prevented by thermal conduction via a joint portion between an economizer and the radiator in an integral heat exchanger.

A heat pump system (1) includes a refrigerant circuit (10) constituted by connecting a compressor (11), a radiator (12), an expansion mechanism (13), an evaporator (14), and an economizer (22). In this case, the economizer (22) constitutes an integral heat exchanger (20) in which the economizer (22) and the radiator (12) are integrated with each other. Moreover, the integral heat exchanger (20) includes a heat insulating part (44) between the economizer (22) and the radiator (12).

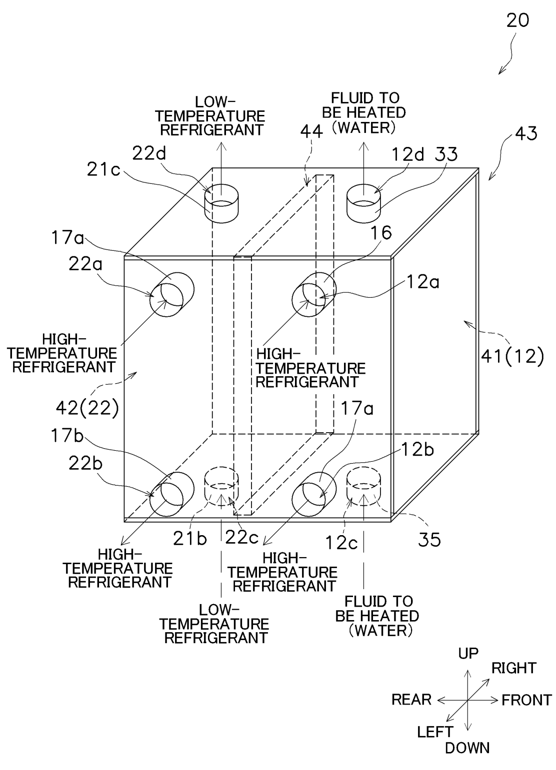

FIG. 2

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Description

Technical Field

[0001] The present disclosure relates to a heat pump system including a refrigerant circuit including an economizer.

Background Art

[0002] Hitherto, there is a heat pump system including a refrigerant circuit including an economizer. The refrigerant circuit is constituted by connecting a compressor that compresses a refrigerant, a radiator that cools the refrigerant compressed in the compressor using a fluid to be heated, an expansion mechanism that decompresses the refrigerant cooled in the radiator, and an evaporator that evaporates the refrigerant decompressed in the expansion mechanism. In addition, the refrigerant circuit is provided with an economizer that further cools the refrigerant cooled in the radiator using the refrigerant flowing through the refrigerant circuit. There may be such a heat pump system in which an economizer constitutes an integral heat exchanger in which the economizer and the radiator are integrated as disclosed in PTL 1 (the description of European Patent Application Publication No. 2952832).

Summary of Invention

[0003] However, with the above-described integral heat exchanger of the related art, the refrigerant flowing through the radiator is cooled by the refrigerant flowing through the economizer by thermal conduction via a joint portion between the economizer and the radiator, possibly decreasing the heating capacity for the fluid to be heated in the radiator.

[0004] A heat pump system according to a first aspect includes a refrigerant circuit constituted by connecting a compressor that compresses a refrigerant, a radiator that cools the refrigerant compressed in the compressor using a fluid to be heated, an expansion mechanism that decompresses the refrigerant cooled in the radiator, and an evaporator that evaporates the refrigerant decompressed in the expansion mechanism. In addition, an economizer is provided in the refrigerant circuit. The economizer further cools the refrigerant cooled in the radiator using the refrigerant flowing through the refrigerant circuit. In this case, the economizer constitutes an integral heat exchanger in which the economizer and the radiator are integrated with each other. In addition, in this case, the integral heat exchanger includes a heat insulating part between the economizer and the radiator.

[0005] In this case, the heat insulating part can suppress thermal conduction between the economizer and the radiator. Accordingly, in this case, the refrigerant flowing through the radiator is less likely to be cooled by the refrigerant flowing through the economizer. The decrease in the heating capacity for the fluid to be heated in the radiator can be suppressed.

[0006] In a heat pump system according to a second aspect, based on the heat pump system according to the first aspect, the heat insulating part is constituted by a material having a lower thermal conductivity than a thermal conductivity of a material that constitutes a portion through which the refrigerant and the fluid to be heated flow in the integral heat exchanger.

[0007] In this case, for example, the heat insulating part can be easily constituted by a resin material, a rubber material, or a ceramic material having a lower thermal conductivity than that of the material (a metal material) that constitutes the portion through which the refrigerant and the fluid to be heated flow.

[0008] In a heat pump system according to a third aspect, based on the heat pump system according to the first aspect, the heat insulating part is constituted by a gap that is provided between the radiator and the economizer and through which the refrigerant and the fluid to be heated do not flow.

[0009] In this case, the heat insulating part can be easily constituted by the gap.

[0010] In a heat pump system according to a fourth aspect, based on the heat pump system according to the third aspect, the gap is in a vacuum state.

[0011] In this case, the heat insulating capacity of the heat insulating part constituted by the gap can be improved.

[0012] In a heat pump system according to a fifth aspect, based on the heat pump system according to the fourth aspect, the integral heat exchanger is formed by vacuum brazing or diffusion bonding.

[0013] In this case, for example, when the integral heat exchanger is formed by stacking plate members and joining the plate members by vacuum brazing or diffusion bonding, since the gap through which the refrigerant and the fluid to be heated do not flow is formed between the plate members disposed between the radiator and the economizer, the gap between the plate members can be easily brought into a vacuum state.

[0014] In a heat pump system according to a sixth aspect, based on the heat pump system according to any one of the first to fifth aspects, the integral heat exchanger is a micro-flow-path heat exchanger.

[0015] In this case, the integral heat exchanger can be compact.

[0016] A heat pump system according to a seventh aspect, based on the heat pump system according to any one of the first to sixth aspects, further includes use-side equipment that heats inside of a room using the fluid to be heated that has been heated through heat exchange with the refrigerant in the radiator.

[0017] In this case, since the decrease in the heating capacity for the fluid to be heated is suppressed in the radiator, the decrease in the heating capacity in the use-side equipment can be suppressed.

Brief Description of Drawings

[0018]

[Fig. 1] Fig. 1 is a schematic configuration diagram of a heat pump system according to an embodiment of the present disclosure.
[Fig. 2] Fig. 2 is a perspective view illustrating an appearance of an integral heat exchanger in which a radiator and an economizer are integrated.
[Fig. 3] Fig. 3 is a view when a first flow path of the radiator is seen from a front side.
[Fig. 4] Fig. 4 is a view when a second flow path of the radiator is seen from the front side.
[Fig. 5] Fig. 5 is a view when a first flow path of the economizer is seen from the front side.
[Fig. 6] Fig. 6 is a view when a second flow path of the economizer is seen from the front side.
[Fig. 7] Fig. 7 is a view when the inside of a heat insulating part is seen from the front side.
[Fig. 8] Fig. 8 is an exploded perspective view illustrating the inside of the integral heat exchanger.
[Fig. 9] Fig. 9 is a view illustrating an integral heat exchanger according to Modification A and corresponding to Fig. 2.
[Fig. 10] Fig. 10 is a view illustrating the integral heat exchanger according to Modification A and corresponding to Fig. 4.
[Fig. 11] Fig. 11 is a view illustrating the integral heat exchanger according to Modification A and corresponding to Fig. 6.
[Fig. 12] Fig. 12 is a view illustrating the integral heat exchanger according to Modification A and corresponding to Fig. 7.
[Fig. 13] Fig. 13 is a view illustrating the integral heat exchanger according to Modification A and a view when a communication portion is seen from the front side.
[Fig. 14] Fig. 14 is a view illustrating the integral heat exchanger according to Modification A and corresponding to Fig. 8.
[Fig. 15] Fig. 15 is a schematic configuration diagram of a heat pump system according to Modification B.
[Fig. 16] Fig. 16 is a view illustrating an integral heat exchanger according to Modification B and corresponding to Fig. 2.
[Fig. 17] Fig. 17 is a view illustrating the integral heat exchanger according to Modification B and corresponding to Fig. 5.
[Fig. 18] Fig. 18 is a view illustrating an integral heat exchanger according to Modification C and corresponding to Fig. 2.
[Fig. 19] Fig. 19 is a view illustrating the integral heat exchanger according to Modification C and corresponding to Fig. 4.
[Fig. 20] Fig. 20 is a perspective view illustrating an appearance of an integral heat exchanger according to Modification D.
[Fig. 21] Fig. 21 is a sectional view taken along line A-A in Fig. 20.
[Fig. 22] Fig. 22 is a sectional view taken along line B-B in Fig. 20.
[Fig. 23] Fig. 23 is a view illustrating an integral heat exchanger according to Modification E and corresponding to Fig. 20.
[Fig. 24] Fig. 24 is a sectional view taken along line B-B in Fig. 23.
[Fig. 25] Fig. 25 is a view illustrating an integral heat exchanger according to Modification F and corresponding to Fig. 20.
[Fig. 26] Fig. 26 is a sectional view taken along line B-B in Fig. 25.
[Fig. 27] Fig. 27 is a view illustrating an integral heat exchanger according to Modification G and corresponding to Fig. 22.
[Fig. 28] Fig. 28 is a view illustrating the integral heat exchanger according to Modification G and corresponding to Fig. 22.

Description of Embodiments

[0019] A heat pump system is described below based on the drawings.

(1) Heat Pump System

<Configuration>

[0020] Fig. 1 is a schematic configuration diagram of a heat pump system 1 according to an embodiment of the present disclosure. The heat pump system 1 mainly includes a refrigerant circuit 10 through which a refrigerant serving as a heat exchange medium circulates, and a water circuit 30 through which water serving as a fluid to be heated circulates. The heat pump system 1 is an apparatus that heats the water using a refrigerant-compression heat pump cycle in the refrigerant circuit 10, and heats the inside of a room using the heated water.

[0021] The refrigerant circuit 10 mainly includes a compressor 11, a radiator 12, an expansion mechanism 13, an evaporator 14, an injection pipe 21, and an economizer 22. The refrigerant circuit 10 has, as a refrigerant, an HFC-based refrigerant, an HFO-based refrigerant, or a natural refrigerant.

[0022] The compressor 11 is a device that compresses the refrigerant. The compressor 11 is, for example, a compressor in which a refrigerant compression element of rotary type, scroll type or the like is driven by a driving mechanism such as a motor.

[0023] The radiator 12 is a device that cools the refrigerant compressed in the compressor 11 using the water circulating through the water circuit 30. The details of the radiator 12 will be described later. A discharge port 11b of the compressor 11 is connected to a refrigerant-side inlet (a second inlet 12a) of the radiator 12 via a discharge refrigerant pipe 16.

[0024] The expansion mechanism 13 is a device that decompresses the refrigerant cooled in the radiator 12 (in this case, the refrigerant further cooled in the economizer 22). The expansion mechanism 13 is, for example, an expansion valve or a capillary tube. A refrigerant-side outlet (a second outlet 12b) of the radiator 12 is connected to the expansion mechanism 13 via a high-temperature refrigerant pipe 17.

[0025] The evaporator 14 is a device that evaporates the refrigerant decompressed in the expansion mechanism 13. The evaporator 14 is, for example, a fin-and-tube heat exchanger that heats the refrigerant using the air. In this case, a fan 15 is provided to obtain a flow of the air serving as a heat source for the refrigerant. The fan 15 is a fan in which a blower element of such as propeller type is driven by a driving mechanism such as a motor. The expansion mechanism 13 is connected to an inlet 14a for the refrigerant of the evaporator 14 via a low-temperature refrigerant pipe 18. An outlet 14b for the refrigerant of the evaporator 14 is connected to an intake port 11a of the compressor 11 via an intake refrigerant pipe 19.

[0026] The injection pipe 21 is a refrigerant pipe that branches part of the refrigerant flowing through the high-temperature refrigerant pipe 17 and returns the part of the refrigerant to the compressor 11. One end of the injection pipe 21 is connected to the high-temperature refrigerant pipe 17. The other end of the injection pipe 21 is connected to an intermediate portion 11c of a compression stroke of the compressor 11. Alternatively, the other end of the injection pipe 21 need not be connected to the intermediate portion 11c of the compression stroke of the compressor 11, and may be connected to the intake port 11a of the compressor 11 or the intake refrigerant pipe 19. The injection pipe 21 is provided with an injection expansion mechanism 23. The injection expansion mechanism 23 is, for example, an expansion valve.

[0027] The economizer 22 is a device that further cools the refrigerant cooled in the radiator 12 using the refrigerant flowing through the refrigerant circuit 10. In this case, the economizer 22 cools the refrigerant cooled in the radiator 12 and flowing through the high-temperature refrigerant pipe 17 using the refrigerant flowing through the injection pipe 21, which serves as the refrigerant flowing through the refrigerant circuit 10 (more specifically, the refrigerant decompressed by the injection expansion mechanism 23). Thus, the economizer 22 is provided for the high-temperature refrigerant pipe 17 and the injection pipe 21. An inlet (a fourth inlet 22a) of the economizer 22 on the high-temperature refrigerant pipe 17 side is connected to a high-temperature refrigerant pipe 17a. An outlet (a fourth outlet 22b) of the economizer 22 on the high-temperature refrigerant pipe 17 side is connected to a portion 17b of the high-temperature refrigerant pipe 17 located close to the expansion mechanism 13. An inlet (a third inlet 22c) of the economizer 22 on the injection pipe 21 side is connected to a second portion 21b of the injection pipe 21. An outlet (a third inlet 22d) of the economizer 22 on the injection pipe 21 side is connected to a third portion 21c of the injection pipe 21. In this case, the injection pipe 21 includes a first portion 21a that connects the portion 17a of the high-temperature refrigerant pipe 17 located close to the radiator 12 to the injection expansion mechanism 23, the second portion 21b that connects the injection expansion mechanism 23 to the third inlet 22c of the economizer 22, and the third portion 21c that connects the third outlet 22d of the economizer 22 to the compressor 11. The details of the economizer 22 will be described later.

[0028] The water circuit 30 mainly includes the radiator 12, a pump 31, and use-side equipment 32. The water circuit 30 has sealed therein water.

[0029] As described above, the radiator 12 is the device that cools the refrigerant compressed in the compressor 11 using the water circulating through the water circuit 30. In other words, the radiator 12 is a device that heats the water using the refrigerant circulating through the refrigerant circuit 10. The details of the radiator 12 will be described later.

[0030] The pump 31 is a device that increases the pressure of the water. The pump 31 is, for example, a pump in which a centrifugal or positive-displacement pump element is driven by a driving mechanism such as a motor. In this case, a water-side outlet (a first outlet 12d) of the radiator 12 is connected to an intake port 31a of the pump 31 via an outlet water pipe 33.

[0031] The use-side equipment 32 is a device that heats the inside of the room using the water heated by the radiator 12. The use-side equipment 32 is, for example, a radiator or a floor heater. A discharge port 31b of the pump 31 is connected to an inlet 32a for the water of the use-side equipment 32 via a discharge water pipe 34. An outlet 32b for the water of the use-side equipment 32 is connected to a water-side inlet (a first inlet 12c) of the radiator 12 via an inlet water pipe 35.

[0032] The component devices of the above-described heat pump system 1 are controlled by a control device 2. The control device 2 is constituted by a control board or the like on which, for example, a microcomputer and a memory are mounted.

<Operation>

[0033] An operation of the heat pump system 1 is described next with reference to Fig. 1. As described above, the heat pump system 1 can heat the water using the refrigerant-compression heat pump cycle in the refrigerant circuit 10 and can heat the inside of the room using the heated water (heating operation). Note that the heating operation is performed by the control device 2.

[0034] In the refrigerant circuit 10, the refrigerant compressed in the compressor 11 and discharged therefrom is sent to the radiator 12. The refrigerant (the high-temperature refrigerant) sent to the radiator 12 exchanges heat with the water circulating through the water circuit 30 to be cooled and condensed. The refrigerant whose heat has been radiated in the radiator 12 is sent to the economizer 22. The refrigerant (the high-temperature refrigerant) sent to the economizer 22 exchanges heat with the refrigerant (the low-temperature refrigerant) branched from the high-temperature refrigerant pipe 17 to the injection pipe 21 to be further cooled. At this time, the refrigerant flowing through the injection pipe 21 is heated in the economizer 22 and is returned to the compressor 11. The refrigerant cooled in the economizer 22 is decompressed by the expansion mechanism 13 and then is sent to the evaporator 14. The refrigerant sent to the evaporator 14 exchanges heat with the air passing through the evaporator 14 by the fan 15 and is heated to be evaporated. The refrigerant evaporated in the evaporator 14 is taken into the compressor 11, is compressed by the compressor 11 again, and is discharged.

[0035] In contrast, in the water circuit 30, the water is heated by heat radiation from the refrigerant in the radiator 12. The pressure of the water heated in the radiator 12 is increased by the pump 31, and the water is discharged. The water discharged from the pump 31 is sent to the use-side equipment 32. The water sent to the use-side equipment 32 heats the inside of the room and hence is cooled. The water cooled in the use-side equipment 32 is sent to the radiator 12 and is heated again in the radiator 12.

(2) Details of Radiator and Economizer

[0036] The details of the radiator 12 and the economizer 22 are described next with reference to Figs. 1 to 8. In this case, Fig. 2 is a perspective view illustrating an appearance of an integral heat exchanger 20 in which the radiator 12 and the economizer 22 are integrated. Fig. 3 is a view when a first flow path 51 of the radiator 12 is seen from a front side. Fig. 4 is a view when a second flow path 61 of the radiator 12 is seen from the front side. Fig. 5 is a view when a first flow path 71 of the economizer 22 is seen from the front side. Fig. 6 is a view when a second flow path 81 of the economizer 22 is seen from the front side. Fig. 7 is a view when the inside of a heat insulating part 44 is seen from the front side. Fig. 8 is an exploded perspective view illustrating the inside of the integral heat exchanger 20. In addition, in the following description, expressions such as "up", "down", "left", "right", "front", and "rear" may be used to describe the direction or the positional relationship. The directions indicated by the expressions follow the directions of arrows indicated in the drawings unless otherwise noted.

[0037] In this case, the radiator 12 and the economizer 22 constitute the integral heat exchanger 20 in which the radiator 12 and the economizer 22 are integrated with each other. That is, the integral heat exchanger 20 includes the radiator 12 and the economizer 22.

[0038] The integral heat exchanger 20 mainly includes a radiator-side heat exchange part 41 that constitutes the radiator 12, an economizer-side heat exchange part 42 that constitutes the economizer 22, and a casing 43 in which the radiator-side heat exchange part 41 and the economizer-side heat exchange part 42 are provided. The radiator-side heat exchange part 41 is a part that cools the refrigerant (the high-temperature refrigerant) compressed in the compressor 11 using the fluid to be heated (water). The economizer-side heat exchange part 42 is a part that further cools the refrigerant cooled using the refrigerant (the low-temperature refrigerant) flowing through the refrigerant circuit 10 in the radiator 12 (the radiator-side heat exchange part 41). In this case, the economizer-side heat exchange part 42 is disposed on the rear side of the radiator-side heat exchange part 41. However, the front-rear relationship may be inverted.

[0039] In addition, in this case, the integral heat exchanger 22 further includes a heat insulating part 44 between (in this case, between in a front-rear direction) the economizer 22 (the economizer-side heat exchange part 42) and the radiator 12 (the radiator-side heat exchange part 41). That is, the heat insulating part 44 is provided in the casing 43 to be disposed between the radiator-side heat exchange part 41 and the economizer-side heat exchange part 42. In this case, the heat insulating part 44 is a part that suppresses thermal conduction between the economizer 22 (the economizer-side heat exchange part 42) and the radiator 12 (the radiator-side heat exchange part 41).

[0040] The radiator-side heat exchange part 41 (the radiator 12) is constituted by stacking a first layer 50 having formed therein a plurality of rows of first flow paths 51 through which the water flows, and a second layer 60 having formed therein a plurality of rows of second flow paths 61 through which the high-temperature refrigerant flows. In this case, a direction in which the first layer 50 and the second layer 60 are stacked (in this case, the front-rear direction in Figs. 2 and 8) serves as a stack direction. Moreover, a direction (in this case, a left-right direction) in which the first flow paths 51 are arrayed serves as an array direction of the first flow paths 51, and a direction (in this case, an up-down direction) in which the second flow paths 61 are arrayed serves as an array direction of the second flow paths 61. The first and second flow paths 51 and 61 are each a micro flow path having a very small flow-path sectional area (a flow path having an equivalent diameter of 1.5 mm or less). That is, the radiator 12 is referred to as a micro-flow-path heat exchanger. When the first layer 50 is seen in the stack direction (the front-rear direction) of the first and second layers 50 and 60, the first flow paths 51 extend from a position near a lower end portion to a position near an upper end portion of the first layer 50 in a direction (in this case, the up-down direction) intersecting with the array direction (the left-right direction) of the first flow paths 51. In addition, in this case, when the first layer 50 is seen in the stack direction (the front-rear direction), the first flow paths 51 have shapes meandering in the array direction (the left-right direction) of the first flow paths 51, thereby promoting thermal conduction. When the second layer 60 is seen in the stack direction (the front-rear direction) of the first and second layers 50 and 60, the second flow paths 61 extend from a position near a left end portion to a position near a right end portion of the second layer 60 in a direction (in this case, the left-right direction) intersecting with the array direction (the up-down direction) of the second flow paths 61. In addition, in this case, the second flow paths 61 are divided into a plurality of (in this case, four) flow-path groups arranged in the up-down direction, and extend to be folded back in the left-right direction from the flow-path group located at a lower left end portion toward the flow-path group located at an upper left end portion. As described above, in this case, the first flow paths 51 and the second flow paths 61 are arrayed to define orthogonal counter flow.

[0041] Moreover, in this case, the radiator-side heat exchange part 41 having the multilayer structure of the first layer 50 and the second layer 60 is constituted by alternately stacking a first plate member 52 having grooves serving as the first flow paths 51 formed in one surface thereof and a second plate member 62 having grooves serving as the second flow paths 61 formed in one surface thereof. The first and second plate members 52 and 62 are formed of a metal material. The grooves serving as the first flow paths 51 and the second flow paths 61 are formed, for example, by machining or etching the first and second plate members 52 and 62. A predetermined number of such grooved first plate members 52 and a predetermined number of such grooved second plate members 62 are stacked on one another, and then the first plate members 52 and the second plate members 62 are joined to one another by joining processing, such as vacuum brazing or diffusion bonding. Thus, the radiator-side heat exchange part 41 having the multilayer structure of the first layer 50 and the second layer 60 is obtained. In this case, the grooves serving as the flow paths 51 and 61 are formed in the one surfaces of both the first and second plate members 52 and 62. However, it is not limited thereto. The grooves serving as the flow paths 51 and 61 may be formed in both surfaces of one of the first and second plate members 52 and 62, or the grooves serving as the flow paths 51 and 61 may be formed in both surfaces of both the first and second plate members 52 and 62.

[0042] In this case, cutouts 53 and 54 are formed in a lower end portion and an upper end portion of each first plate member 52. The cutouts 53 and 54 respectively communicate with a lower end portion (an inlet portion for the water) and an upper end portion (an outlet portion for the water) of the first flow paths 51. Also, cutouts 63 and 64 are formed in a lower end portion and an upper end portion of each second plate member 62 to overlap the cutouts 53 and 54. Joining the first and second plate members 52 and 62 forms a first inlet header 13c that is a space where the cutouts 53 and 63 communicate with the lower end portion of the first flow paths 51, and a first outlet header 13d that is a space where the cutouts 54 and 64 communicate with the upper end portion of the first flow paths 51. Moreover, cutouts 65 and 66 are formed in an upper left end portion and a lower left end portion of each second plate member 62. The cutouts 65 and 66 respectively communicate with the upper left end portion (an inlet portion for the high-temperature refrigerant) and the lower left end portion (an outlet portion for the high-temperature refrigerant) of the second flow paths 61. Also, cutouts 55 and 56 are formed in an upper left end portion and a lower left end portion of each first plate member 52 to overlap the cutouts 65 and 66. Joining the first and second plate members 52 and 62 forms a second inlet header 13a that is a space where the cutouts 55 and 65 communicate with the upper left end portion of the second flow paths 61, and a second outlet header 13b that is a space where the cutouts 56 and 66 communicate with the lower left end portion of the second flow paths 61.

[0043] The economizer-side heat exchange part 42 (the economizer 22) is constituted by stacking a third layer 70 having formed therein a plurality of rows of third flow paths 71 through which the low-temperature refrigerant flows, and a fourth layer 80 having formed therein a plurality of rows of fourth flow paths 81 through which the high-temperature refrigerant flows. In this case, a direction in which the third layer 70 and the fourth layer 80 are stacked (in this case, the front-rear direction in Figs. 2 and 8) serves as a stack direction. Moreover, a direction (in this case, the left-right direction) in which the third flow paths 71 are arrayed serves as an array direction of the third flow paths 71, and a direction (in this case, the up-down direction) in which the fourth flow paths 81 are arrayed serves as an array direction of the fourth flow paths 81. The third and fourth flow paths 71 and 81 are each a micro flow path having a very small flow-path sectional area (a flow path having an equivalent diameter of 1.5 mm or less). That is, the economizer 22 is referred to as a micro-flow-path heat exchanger. When the third layer 70 is seen in the stack direction (the front-rear direction) of the third and fourth layers 70 and 80, the third flow paths 71 extend from a position near a lower end portion to a position near an upper end portion of the third layer 70 in a direction (in this case, the up-down direction) intersecting with the array direction (the left-right direction) of the third flow paths 71. In addition, in this case, when the third layer 70 is seen in the stack direction (the front-rear direction), the third flow paths 71 have shapes meandering in the array direction (the left-right direction) of the third flow paths 71, thereby promoting thermal conduction. When the fourth layer 80 is seen in the stack direction (the front-rear direction) of the third and fourth layers 70 and 80, the fourth flow paths 81 extend from a position near a left end portion to a position near a right end portion of the fourth layer 80 in a direction (in this case, the left-right direction) intersecting with the array direction (the up-down direction) of the fourth flow paths 81. In addition, in this case, the fourth flow paths 81 are divided into a plurality of (in this case, four) flow-path groups arranged in the up-down direction, and extend to be folded back in the left-right direction from the flow-path group located at a lower left end portion toward the flow-path group located at an upper left end portion. As described above, in this case, the third flow paths 71 and the fourth flow paths 81 are arrayed to define orthogonal counter flow.

[0044] Moreover, in this case, the economizer-side heat exchange part 42 having the multilayer structure of the third layer 70 and the fourth layer 80 is constituted by alternately stacking a third plate member 72 having grooves serving as the third flow paths 71 formed in one surface thereof and a fourth plate member 82 having grooves serving as the fourth flow paths 81 formed in one surface thereof. The third and fourth plate members 72 and 82 are formed of a metal material. The grooves serving as the third flow paths 71 and the fourth flow paths 81 are formed, for example, by machining or etching the third and fourth plate members 72 and 82. A predetermined number of such grooved third plate members 72 and a predetermined number of such grooved fourth plate members 82 are stacked on one another, and then the third plate members 72 and the fourth plate members 82 are joined to one another by joining processing, such as vacuum brazing or diffusion bonding. Thus, the economizer-side heat exchange part 42 having the multilayer structure of the third layer 70 and the fourth layer 80 is obtained. In this case, the grooves serving as the flow paths 71 and 81 are formed in the one surfaces of both the third and fourth plate members 72 and 82. However, it is not limited thereto. The grooves serving as the flow paths 71 and 81 may be formed in both surfaces of one of the third and fourth plate members 72 and 82, or the grooves serving as the flow paths 71 and 81 may be formed in both surfaces of both the third and fourth plate members 72 and 82.

[0045] In this case, cutouts 73 and 74 are formed in a lower end portion and an upper end portion of each third plate member 72. The cutouts 73 and 74 respectively communicate with a lower end portion (an inlet portion for the low-temperature refrigerant) and an upper end portion (an outlet portion for the low-temperature refrigerant) of the third flow paths 71. Also, cutouts 83 and 84 are formed in a lower end portion and an upper end portion of each fourth plate member 82 to overlap the cutouts 73 and 74. Joining the third and fourth plate members 72 and 82 forms a third inlet header 23c that is a space where the cutouts 73 and 83 communicate with the lower end portion of the third flow paths 71, and a third outlet header 23d that is a space where the cutouts 74 and 84 communicate with the upper end portion of the third flow paths 71. Moreover, cutouts 85 and 86 are formed in an upper left end portion and a lower left end portion of each fourth plate member 82. The cutouts 85 and 86 respectively communicate with the upper left end portion (an inlet portion for the high-temperature refrigerant) and the lower left end portion (an outlet portion for the high-temperature refrigerant) of the fourth flow paths 81. Also, cutouts 75 and 76 are formed in an upper left end portion and a lower left end portion of each third plate member 72 to overlap the cutouts 85 and 86. Joining the third and fourth plate members 72 and 82 forms a fourth inlet header 23a that is a space where the cutouts 75 and 85 communicate with the upper left end portion of the fourth flow paths 81, and a fourth outlet header 23b that is a space where the cutouts 76 and 86 communicate with the lower left end portion of the fourth flow paths 81.

[0046] The heat insulating part 44 forms a gap 90 between the radiator-side heat exchange part 41 (the radiator 12) and the economizer-side heat exchange part 42 (the economizer 22). The refrigerant and the water do not flow through the gap 90. In this case, the heat insulating part 44 includes a fifth plate member 91 located on the radiator-side heat exchange part 41 side, a sixth plate member 92 located on the economizer-side heat exchange part 42 side, and a seventh plate member 93 disposed between the fifth and sixth plate members 91 and 92. The fifth to seventh plate members 91 to 93 are formed of a metal material. The seventh plate member 93 has an opening 94 formed to form the gap 90. After the seventh plate member 93 is disposed between the fifth and sixth plate members 91 and 92, that is, after the fifth plate member 91, the seventh plate member 93, and the sixth plate member 92 are stacked on one another in that order from the front side in Figs. 2 and 8, the plate members 91, 93, and 92 are joined to one another by joining processing, such as vacuum brazing or diffusion bonding, thereby obtaining the heat insulating part 44 having the gap 90 formed therein. Vacuum brazing or diffusion bonding joins the plate members 91, 93, and 92 to one another in a vacuum atmosphere. The gap 90 thus obtained is in a vacuum state.

[0047] The casing 43 is a member in which the radiator-side heat exchange part 41, the economizer-side heat exchange part 42, and the heat insulating part 44 are provided. In this case, the casing 43 has a substantially rectangular parallelepiped shape. The first inlet 12c serving as an inlet for the water is formed in a front portion of a lower surface part of the casing 43, and communicates with the first inlet header 13c. The inlet water pipe 35 is connected to the first inlet 12c. The first outlet 12d serving as an outlet for the water is formed in a front portion of an upper surface part of the casing 43, and communicates with the first outlet header 13d. The outlet water pipe 33 is connected to the first outlet 12d. The second inlet 12a serving as an inlet for the high-temperature refrigerant is formed in an upper front portion of a left surface part of the casing 43, and communicates with the second inlet header 13a. The discharge refrigerant pipe 16 is connected to the second inlet 12a. The second outlet 12b serving as an outlet for the high-temperature refrigerant is formed in a lower front portion of the left surface part of the casing 43, and communicates with the second outlet header 13b. The high-temperature refrigerant pipe 17a is connected to the second outlet 12b. Moreover, the third inlet 22c serving as an inlet for the low-temperature refrigerant is formed in a rear portion of the lower surface part of the casing 43, and communicates with the third inlet header 23c. An injection pipe 21b is connected to the third inlet 22c. The third outlet 22d serving as an outlet for the low-temperature refrigerant is formed in a rear portion of the upper surface part of the casing 43, and communicates with the third outlet header 23d. The injection pipe 21b is connected to the third outlet 22d. The fourth inlet 22a serving as an inlet for the high-temperature refrigerant is formed in an upper rear portion of the left surface part of the casing 43, and communicates with the fourth inlet header 23a. The high-temperature refrigerant pipe 17a is connected to the fourth inlet 22a. The fourth outlet 22b serving as an outlet for the high-temperature refrigerant is formed in a lower rear portion of the left surface part of the casing 43, and communicates with the fourth outlet header 23b. The high-temperature refrigerant pipe 17b is connected to the fourth outlet 22b. In this case, respective surface parts of the casing 43 are constituted by a metal plate-shaped member.

[0048] In this case, the respective surface parts of the casing 43 are disposed to cover the radiator-side heat exchange part 41, the economizer-side heat exchange part 42, and the heat insulating part 44, and are joined to the radiator-side heat exchange part 41, the economizer-side heat exchange part 42, and the heat insulating part 44. In this case, the casing 43 is joined to the radiator-side heat exchange part 41, the economizer-side heat exchange part 42, and the heat insulating part 44 simultaneously with forming the radiator-side heat exchange part 41, the economizer-side heat exchange part 42, and the heat insulating part 44 by covering a stack in which predetermined numbers of the first to seventh plate members 52, 62, 72, 82, 91, 92, and 93 are stacked in a predetermined order with the respective surface parts of the casing 43, and then joining the plate members and the casing 43 by joining processing, such as vacuum brazing or diffusion bonding. However, all the radiator-side heat exchange part 41, the economizer-side heat exchange part 42, the heat insulating part 44, and the casing 43 may be joined not simultaneously. Only the radiator-side heat exchange part 41, the economizer-side heat exchange part 42, and the heat insulating part 44 may be joined by vacuum brazing or diffusion bonding first, and then the joined object in which the radiator-side heat exchange part 41, the economizer-side heat exchange part 42, and the heat insulating part 44 are joined may be joined to the casing 43.

[0049] With the integral heat exchanger 20 having such a configuration, during operation of the heat pump system 1, in the radiator 12, the water flows from the first inlet 12c into the first inlet header 13c, is branched from the first inlet header 13c to the inlet portion of the first flow paths 51, flows from the lower side toward the upper side in the first flow paths 51 to be heated through heat exchange with the high-temperature refrigerant, is joined at the first outlet header 13d from the outlet portion of the first flow paths 51, and flows out from the first outlet 12d. Moreover, in the radiator 12, the high-temperature refrigerant flows from the second inlet 12a into the second inlet header 13a, is branched from the second inlet header 13a to the inlet portion of the second flow paths 61, flows from the upper side toward the lower side while being folded back left and right in the second flow paths 61 to radiate heat through heat exchange with the water, is joined at the second outlet header 13b from the outlet portion of the second flow paths 61, and flows out from the second outlet 12b. Moreover, in the economizer 22, the low-temperature refrigerant flows from the third inlet 22c into the third inlet header 23c, is branched from the third inlet header 23c to the inlet portion of the third flow paths 71, flows from the lower side toward the upper side in the third flow paths 71 to be heated through heat exchange with the high-temperature refrigerant, is joined at the third outlet header 23d from the outlet portion of the third flow paths 71, and flows out from a third outlet 32d. Moreover, in the economizer 22, the high-temperature refrigerant flows from the fourth inlet 22a into the fourth inlet header 23a, is branched from the fourth inlet header 23a to the inlet portion of the fourth flow paths 81, flows from the upper side toward the lower side in the fourth flow paths 81 while being folded back left and right in the fourth flow paths 81 to radiate heat through heat exchange with the low-temperature refrigerant, is joined at the fourth outlet header 23b from the outlet portion of the fourth flow paths 81, and flows out from the fourth outlet 22b.

(3) Features

[0050] Features of the heat pump system 1 are described next.

<A> In this case, as described above, in the heat pump system 1 including the refrigerant circuit 10 including the economizer 22, the economizer 22 constitutes the integral heat exchanger 20 in which the economizer 22 and the radiator 12 are integrated.

With the integral heat exchanger of the related art, the refrigerant flowing through the radiator is cooled by the refrigerant flowing through the economizer by thermal conduction via the joint portion between the economizer and the radiator, possibly decreasing the heating capacity for the fluid to be heated in the radiator.

In contrast, in this case, the integral heat exchanger 20 includes the heat insulating part 44 between the economizer 22 and the radiator 12.

Accordingly, in this case, the heat insulating part 44 can suppress thermal conduction between the economizer 22 and the radiator 12. Thus, in this case, the refrigerant (the high-temperature refrigerant) flowing through the radiator 12 is less likely to be cooled by the refrigerant (in particular, the low-temperature refrigerant) flowing through the economizer 22. The decrease in the heating capacity for the fluid to be heated (in this case, the water) in the radiator 12 can be suppressed. Moreover, by suppressing the decrease in the heating capacity, the radiator 12 can be compact. The advantage of being compact by the integration of the radiator 12 and the economizer 22 with the heat insulating part 44 is large .

<B> Moreover, in this case, as described above, the heat insulating part 44 is constituted by the gap 90 that is provided between the radiator 12 and the economizer 22 and through which the refrigerant and the fluid to be heated do not flow.

Accordingly, in this case, the heat insulating part 44 can be easily constituted by the gap 90.

<C> Moreover, in this case, as described above, the gap 90 is in a vacuum state.

Accordingly, in this case, the heat insulation capacity of the heat insulating part 44 constituted by the gap 90 can be improved.

<D> Moreover, in this case, as described above, the integral heat exchanger 20 is formed by vacuum brazing or diffusion bonding.

In this case, as described above, when the integral heat exchanger 20 is formed by stacking the plate members 52, 62, 72, 82, and 91 to 93 and joining the plate members by vacuum brazing or diffusion bonding, the gap 90 through which the refrigerant and the fluid to be heated do not flow is formed among the plate members 91 to 93 disposed between the radiator 12 and the economizer 22, and hence the gap among the plate members 91 to 93 can be easily brought into a vacuum state.

<E> Also, in this case, as described above, the integral heat exchanger 20 is the micro-flow-path heat exchanger.

In this case, the integral heat exchanger 20 can be compact.

<F> Moreover, in this case, as described above, the use-side equipment 32 that heats the inside of the room using the fluid to be heated (the water) heated through heat exchange with the refrigerant in the radiator 12 is further provided.

Accordingly, in this case, the decrease in the heating capacity for the fluid to be heated (the water) in the radiator 12 is suppressed, and hence the decrease in the heating capacity of the use-side equipment 32 can be also suppressed.

(4) Modifications

<A>

[0051] In the above-described embodiment, the radiator 12 and the economizer 22 are integrated to constitute the integral heat exchanger 20 (see Figs. 2 to 8). However, in addition to this, a portion of the refrigerant pipe that connects both heat exchangers 12 and 22 may be included in the integral heat exchanger 20.

[0052] Specifically, in this case, as illustrated in Figs. 9, 3, 10, 5, and 11 to 14, the high-temperature refrigerant pipe 17a that sends the high-temperature refrigerant whose heat has been radiated in the radiator 12 to the economizer 22 is included in the integral heat exchanger 20 together with a branch portion thereof to an injection pipe 21a.

[0053] The integral heat exchanger 20 mainly includes the radiator-side heat exchange part 41 (the radiator 12), the economizer-side heat exchange part 42 (the economizer 22), the casing 43, and the heat insulating part 44. Moreover, in this case, the integral heat exchanger 20 further includes a communication portion 45 between (in this case, between in the front-rear direction) the heat insulating part 44 and the economizer 22 (the economizer-side heat exchange part 42).

[0054] Like the above-described embodiment, the radiator-side heat exchange part 41 (the radiator 12) is constituted by stacking the first layer 50 having formed therein the plurality of rows of first flow paths 51 through which the water flows, and the second layer 60 having formed therein the plurality of rows of second flow paths 61 through which the high-temperature refrigerant flows. In this case, the configuration of the radiator-side heat exchange part 41 is similar to that of the above-described embodiment, and hence the description thereof is omitted here.

[0055] The economizer-side heat exchange part 42 (the economizer 22) is constituted by stacking the third layer 70 having formed therein the plurality of rows of third flow paths 71 through which the low-temperature refrigerant flows, and the fourth layer 80 having formed therein the plurality of rows of fourth flow paths 81 through which the high-temperature refrigerant flows. In this case, the configuration of the economizer-side heat exchange part 42 is similar to that of the above-described embodiment, and hence the description thereof is omitted here.

[0056] Like the above-described embodiment, the heat insulating part 44 has the gap 90 that is formed between the radiator-side heat exchange part 41 (the radiator 12) and the economizer-side heat exchange part 42 (the economizer 22) and through which the refrigerant and the water do not flow. However, in this case, unlike the above-described embodiment, cutouts 91a to 93a are formed in lower left end portions of the fifth to seventh plate members 91 to 93 that constitute the heat insulating part 44 to overlap the cutouts 56 and 66. The cutouts 91a to 93a also constitute a portion of the second outlet header 13b. Hence, the seventh plate member 93 has the opening 94 for forming the gap 90 so as to avoid the cutout 93a.

[0057] The communication portion 45 is a portion that forms a flow path 96 that allows the second outlet header 13b of the radiator-side heat exchange part 41 (the radiator 12) and the fourth inlet header 23a of the economizer-side heat exchange part 42 (the economizer 22) to communicate with each other. In this case, the communication portion 45 includes an eighth plate member 95 located on the heat insulating part 44 side, and a ninth plate member 97 located on the economizer-side heat exchange part 42 side. The eighth and ninth plate members 95 and 97 are formed of a metal material. The eighth plate member 95 has cutouts 95a and 95b, and the flow path 96. The cutout 95a is formed in a lower left end portion of the eighth plate member 95 to overlap the cutouts 56, 66, and 91a to 93a, and constitutes a portion of the second outlet header 13b. The cutout 95b is formed in an upper left end portion of the eighth plate member 95 to overlap the cutouts 75 and 85, and constitutes a portion of the fourth inlet header 23a. The flow path 96 is a flow path that allows the cutout 95a (the second outlet header 13b) and the cutout 95b (the fourth inlet header 23a) to communicate with each other in the up-down direction. In this case, a flow path having the same shape as the shape of the fourth flow path 81 of the economizer-side heat exchange part 42 is employed. However, the shape of the flow path 96 is not limited thereto, and may be other shape as long as the shape allows the cutout 95a and the cutout 95b to communicate with each other in the up-down direction. A cutout 97a is formed in an upper left end portion of the ninth plate member 97 to overlap the cutouts 75, 85, and 95b, and constitutes a portion of the fourth inlet header 23a.

[0058] The casing 43 is a member provided with the communication portion 45 together with the radiator-side heat exchange part 41, the economizer-side heat exchange part 42, and the heat insulating part 44. The first inlet 12c serving as an inlet for the water is formed in the front portion of the lower surface part of the casing 43, and communicates with the first inlet header 13c. The inlet water pipe 35 is connected to the first inlet 12c. The first outlet 12d serving as an outlet for the water is formed in the front portion of the upper surface part of the casing 43, and communicates with the first outlet header 13d. The outlet water pipe 33 is connected to the first outlet 12d. The second inlet 12a serving as an inlet for the high-temperature refrigerant is formed in the upper front portion of the left surface part of the casing 43, and communicates with the second inlet header 13a. The discharge refrigerant pipe 16 is connected to the second inlet 12a. The second outlet 12b serving as an outlet for the high-temperature refrigerant is formed in the lower front portion of the left surface part of the casing 43, and communicates with the second outlet header 13b. However, unlike the above-described embodiment, not the high-temperature refrigerant pipe 17a, but the injection pipe 21a is connected to the second outlet 12b. Moreover, the third inlet 22c serving as an inlet for the low-temperature refrigerant is formed in the rear portion of the lower surface part of the casing 43, and communicates with the third inlet header 23c. The injection pipe 21b is connected to the third inlet 22c. The third outlet 22d serving as an outlet for the low-temperature refrigerant is formed in the rear portion of the upper surface part of the casing 43, and communicates with the third outlet header 23d. The injection pipe 21b is connected to the third outlet 22d. The fourth inlet 22a, which has been formed in the above-described embodiment, is not formed in the upper rear portion of the left surface part of the casing 43.

[0059] In this case, the respective surfaces of the casing 43 are disposed to cover the radiator-side heat exchange part 41, the economizer-side heat exchange part 42, the heat insulating part 44, and the communication portion 45, and are joined to the radiator-side heat exchange part 41, the economizer-side heat exchange part 42, the heat insulating part 44, and the communication portion 45. In this case, the casing 43 is joined to the radiator-side heat exchange part 41, the economizer-side heat exchange part 42, and the heat insulating part 44 simultaneously with forming the radiator-side heat exchange part 41, the economizer-side heat exchange part 42, the heat insulating part 44, and the communication portion 45 by covering a stack in which predetermined numbers of the first to seventh plate members 52, 62, 72, 82, 91, 92, 93, 95, and 97 are stacked in a predetermined order with the respective surface parts of the casing 43, and then joining the plate members and the casing 43 by joining processing, such as vacuum brazing or diffusion bonding.

[0060] With the integral heat exchanger 20 having such a configuration, during operation of the heat pump system 1, in the radiator 12, the water flows from the first inlet 12c into the first inlet header 13c, is branched from the first inlet header 13c to the inlet portion of the first flow paths 51, flows from the lower side toward the upper side in the first flow paths 51 to be heated through heat exchange with the high-temperature refrigerant, is joined at the first outlet header 13d from the outlet portion of the first flow paths 51, and flows out from the first outlet 12d. Moreover, in the radiator 12, the high-temperature refrigerant flows from the second inlet 12a into the second inlet header 13a, is branched from the second inlet header 13a to the inlet portion of the second flow paths 61, flows from the upper side toward the lower side while being folded back left and right in the second flow paths 61 to radiate heat through heat exchange with the water, and is joined at the second outlet header 13b from the outlet portion of the second flow paths 61. Then, part of the high-temperature refrigerant flows out from the second outlet 12b and is sent to the injection pipe 21a, and the residual high-temperature refrigerant is sent to the cutout 95a of the communication portion 45 via the cutouts 91a to 93a of the heat insulating part 44 that form a portion of the second outlet header 13b. The high-temperature refrigerant sent to the communication portion 45 flows from the lower side toward the upper side in the flow path 96, and is sent to the economizer 22 via the cutouts 95b and 97b of the communication portion 45 that form a portion of the fourth inlet header 23a. Moreover, in the economizer 22, the low-temperature refrigerant flows from the third inlet 22c into the third inlet header 23c, is branched from the third inlet header 23c to the inlet portion of the third flow paths 71, flows from the lower side toward the upper side in the third flow paths 71 to be heated through heat exchange with the high-temperature refrigerant, is joined at the third outlet header 23d from the outlet portion of the third flow paths 71, and flows out from the third outlet 32d. Moreover, in the economizer 22, the high-temperature refrigerant flows into the fourth inlet header 23a via the cutouts 95b and 97b of the communication portion 45, is branched from the fourth inlet header 23a to the inlet portion of the fourth flow paths 81, flows from the upper side toward the lower side in the fourth flow paths 81 while being folded back left and right in the fourth flow paths 81 to radiate heat through heat exchange with the low-temperature refrigerant, is joined at the fourth outlet header 23b from the outlet portion of the fourth flow paths 81, and flows out from the fourth outlet 22b.

<B>

[0061] In the above-described embodiment, as the economizer 22 that further cools the high-temperature refrigerant cooled in the radiator 12 using the refrigerant flowing through the refrigerant circuit 10, one that cools the high-temperature refrigerant using the low-temperature refrigerant flowing through the injection pipe 21 is employed (see Fig. 1). However, the economizer 22 is not limited thereto. For example, one that cools the high-temperature refrigerant using the low-temperature refrigerant evaporated in the evaporator 14 may be employed.

[0062] Specifically, as illustrated in Fig. 15, in the refrigerant circuit 10 of the above-described embodiment, the injection pipe 21 is omitted, and, as the economizer 22, one that cools the refrigerant cooled in the radiator 12 and flowing through the high-temperature refrigerant pipe 17 by the refrigerant flowing through the intake refrigerant pipe 19 as the refrigerant flowing through the refrigerant circuit 10 is employed. That is, the economizer 22 is provided in the high-temperature refrigerant pipe 17 and the intake refrigerant pipe 19. An inlet (a fourth inlet 22a) of the economizer 22 on the high-temperature refrigerant pipe 17 side is connected to a high-temperature refrigerant pipe 17a. An outlet (a fourth outlet 22b) of the economizer 22 on the high-temperature refrigerant pipe 17 side is connected to the portion 17b of the high-temperature refrigerant pipe 17 located close to the expansion mechanism 13. The inlet (the third inlet 22c) of the economizer 22 on the intake refrigerant pipe 19 side is connected to a portion 19a of the intake refrigerant pipe 19 located close to the evaporator 14. The outlet (the third inlet 22d) of the economizer 22 on the intake refrigerant pipe 19 side is connected to a portion 19b of the intake refrigerant pipe 19 located close to the compressor 11.

[0063] Even in this case, like the integral heat exchanger (see Figs. 2 to 8) of the above-described embodiment, the integral heat exchanger 20 in which the radiator 12 and the economizer 22 are integrated can be constituted.

[0064] Specifically, as illustrated in Figs. 16, 3, 4, 17, and 6 to 8, the integral heat exchanger 20 mainly includes the radiator-side heat exchange part 41 (the radiator 12), the economizer-side heat exchange part 42 (the economizer 22), the casing 43, and the heat insulating part 44.

[0065] Like the above-described embodiment, the radiator-side heat exchange part 41 (the radiator 12) is constituted by stacking the first layer 50 having formed therein the plurality of rows of first flow paths 51 through which the water flows, and the second layer 60 having formed therein the plurality of rows of second flow paths 61 through which the high-temperature refrigerant flows. In this case, the configuration of the radiator-side heat exchange part 41 is similar to that of the above-described embodiment, and hence the description thereof is omitted here.

[0066] The economizer-side heat exchange part 42 (the economizer 22) is constituted by stacking the third layer 70 having formed therein the plurality of rows of third flow paths 71 through which the low-temperature refrigerant flows, and the fourth layer 80 having formed therein the plurality of rows of fourth flow paths 81 through which the high-temperature refrigerant flows. In this case, the configuration of the economizer-side heat exchange part 42 is similar to that of the above-described embodiment, and hence the description thereof is omitted here.

[0067] Like the above-described embodiment, the heat insulating part 44 has the gap 90 that is formed between the radiator-side heat exchange part 41 (the radiator 12) and the economizer-side heat exchange part 42 (the economizer 22) and through which the refrigerant and the water do not flow. In this case, the configuration of the heat insulating part 44 is similar to that of the above described embodiment, and hence the description thereof is omitted here.

[0068] Like the above-described embodiment, the casing 43 is a member in which the radiator-side heat exchange part 41, the economizer-side heat exchange part 42, and the heat insulating part 44 are provided. However, in this case, as illustrated in Figs. 16 and 17, not the injection pipe 21a, but an intake refrigerant pipe 19a is connected to the third inlet 22c that is formed in the rear portion of the lower surface part of the casing 43 and that communicates with the third inlet header 23c. Moreover, not the injection pipe 21b, but an intake refrigerant pipe 19b is connected to the third outlet 22d that is formed in the rear portion of the upper surface part of the casing 43 and that communicates with the third outlet header 23d.

[0069] With the integral heat exchanger 20 having the above-described configuration, during operation of the heat pump system 1, like the above-described embodiment, the water is heated through heat exchange with the high-temperature refrigerant and the high-temperature refrigerant radiates heat in the radiator 12, and the low-temperature refrigerant is heated through heat exchange with the high-temperature refrigerant and the high-temperature refrigerant radiates heat in the economizer 22. Note that the modification differs from the above-described embodiment in that the low-temperature refrigerant is not the refrigerant flowing through the injection pipe 21, but is the refrigerant flowing through the intake refrigerant pipe 19.

<C>

[0070] Also in the integral heat exchanger 20 (in which the economizer 22 that cools the high-temperature refrigerant using the low-temperature refrigerant flowing through the intake refrigerant pipe 19 and the radiator 12 are integrated) of the above-described Modification B, a portion of the refrigerant pipe that connects both the heat exchangers 12 and 22 to each other may be included in the integral heat exchanger 20 like the above-described Modification A.

[0071] Specifically, in this case, as illustrated in Figs. 18, 3, 19, 17, and 11 to 14, the high-temperature refrigerant pipe 17a that sends the high-temperature refrigerant whose heat has been radiated in the radiator 12 to the economizer 22 is included in the integral heat exchanger 20.

[0072] Like the above-described Modification A, the integral heat exchanger 20 mainly includes the radiator-side heat exchange part 41 (the radiator 12), the economizer-side heat exchange part 42 (the economizer 22), the casing 43, the heat insulating part 44, and the communication portion 45.

[0073] Like the above-described Modification A, the radiator-side heat exchange part 41 (the radiator 12) is constituted by stacking the first layer 50 having formed therein the plurality of rows of first flow paths 51 through which the water flows, and the second layer 60 having formed therein the plurality of rows of second flow paths 61 through which the high-temperature refrigerant flows. In this case, the configuration of the radiator-side heat exchange part 41 is similar to that of the above-described Modification A, and hence the description thereof is omitted here.

[0074] The economizer-side heat exchange part 42 (the economizer 22) is constituted by stacking the third layer 70 having formed therein the plurality of rows of third flow paths 71 through which the low-temperature refrigerant flows, and the fourth layer 80 having formed therein the plurality of rows of fourth flow paths 81 through which the high-temperature refrigerant flows. In this case, the configuration of the economizer-side heat exchange part 42 is similar to that of the above-described Modification A, and hence the description thereof is omitted here.

[0075] Like the above-described Modification A, the heat insulating part 44 forms the gap 90 through which the refrigerant and the water do not flow, between the radiator-side heat exchange part 41 (the radiator 12) and the economizer-side heat exchange part 42 (the economizer 22). In this case, the configuration of the heat insulating part 44 is similar to that of the above-described Modification A, and hence the description is omitted here.

[0076] Like the above-described Modification A, the communication portion 45 forms the flow path 96 that allows the second outlet header 13b of the radiator-side heat exchange part 41 (the radiator 12) and the fourth inlet header 23a of the economizer-side heat exchange part 42 (the economizer 22) to communicate with each other. In this case, the configuration of the communication portion 45 is similar to that of the above-described Modification A, and hence the description is omitted here.

[0077] The casing 43 is a member provided with the communication portion 45 together with the radiator-side heat exchange part 41, the economizer-side heat exchange part 42, and the heat insulating part 44. The first inlet 12c serving as an inlet for the water is formed in the front portion of the lower surface part of the casing 43, and communicates with the first inlet header 13c. The inlet water pipe 35 is connected to the first inlet 12c. The first outlet 12d serving as an outlet for the water is formed in the front portion of the upper surface part of the casing 43, and communicates with the first outlet header 13d. The outlet water pipe 33 is connected to the first outlet 12d. The second inlet 12a serving as an inlet for the high-temperature refrigerant is formed in the upper front portion of the left surface part of the casing 43, and communicates with the second inlet header 13a. The discharge refrigerant pipe 16 is connected to the second inlet 12a. The second outlet 12b, which has been formed in the above-described Modification A, is not formed in the lower front portion of the left surface part of the casing 43. Moreover, the third inlet 22c serving as an inlet for the low-temperature refrigerant is formed in the rear portion of the lower surface part of the casing 43, and communicates with the third inlet header 23c. The intake refrigerant pipe 19a is connected to the third inlet 22c. The third outlet 22d serving as an outlet for the low-temperature refrigerant is formed in the rear portion of the upper surface part of the casing 43, and communicates with the third outlet header 23d. The intake refrigerant pipe 19b is connected to the third outlet 22d. Like the above-described Modification A, the fourth inlet 22a is not formed in the upper rear portion of the left surface part of the casing 43.

[0078] With the integral heat exchanger 20 having such a configuration, during operation of the heat pump system 1, in the radiator 12, the water flows from the first inlet 12c into the first inlet header 13c, is branched from the first inlet header 13c to the inlet portion of the first flow paths 51, flows from the lower side toward the upper side in the first flow paths 51 to be heated through heat exchange with the high-temperature refrigerant, is joined at the first outlet header 13d from the outlet portion of the first flow paths 51, and flows out from the first outlet 12d. Moreover, in the radiator 12, the high-temperature refrigerant flows from the second inlet 12a into the second inlet header 13a, is branched from the second inlet header 13a to the inlet portion of the second flow paths 61, flows from the upper side toward the lower side while being folded back left and right in the second flow paths 61 to radiate heat through heat exchange with the water, and is joined at the second outlet header 13b from the outlet portion of the second flow paths 61. The entirety of the high-temperature refrigerant is sent to the cutout 95a of the communication portion 45 via the cutouts 91a to 93a of the heat insulating part 44 that forms a portion of the second outlet header 13b. The high-temperature refrigerant sent to the communication portion 45 flows from the lower side toward the upper side in the flow path 96, and is sent to the economizer 22 via the cutouts 95b and 97b of the communication portion 45 that form a portion of the fourth inlet header 23a. Moreover, in the economizer 22, the low-temperature refrigerant flows from the third inlet 22c into the third inlet header 23c, is branched from the third inlet header 23c to the inlet portion of the third flow paths 71, flows from the lower side toward the upper side in the third flow paths 71 to be heated through heat exchange with the high-temperature refrigerant, is joined at the third outlet header 23d from the outlet portion of the third flow paths 71, and flows out from the third outlet 32d. Moreover, in the economizer 22, the high-temperature refrigerant flows into the fourth inlet header 23a via the cutouts 95b and 97b of the communication portion 45, is branched from the fourth inlet header 23a to the inlet portion of the fourth flow paths 81, flows from the upper side toward the lower side in the fourth flow paths 81 while being folded back left and right in the fourth flow paths 81 to radiate heat through heat exchange with the low-temperature refrigerant, is joined at the fourth outlet header 23b from the outlet portion of the fourth flow paths 81, and flows out from the fourth outlet 22b.

<D>

[0079] In the above-described embodiment and modifications, the case of employing the micro-flow-path heat exchanger as the integral heat exchanger 20 in which the radiator 12 and the economizer 22 are integrated has been described (see Figs. 2 to 14, and 16 to 18) as an example. However, the integral heat exchanger 20 in which the radiator 12 and the economizer 22 are integrated is not limited to the micro-flow-path heat exchanger. For example, a plate heat exchanger may be employed as the integral heat exchanger 20 in which the radiator 12 and the economizer 22 are integrated.

[0080] Specifically, for the integral heat exchanger 20, a configuration of a plate heat exchanger corresponding to the configurations of the above-described embodiment and Modification B (the micro-flow-path heat exchanger) can be employed as illustrated in Figs. 20 to 22. In this case, the integral heat exchanger 20 mainly includes a plurality of first plate members 110 that constitute the radiator 12, a plurality of second plate members 120 that constitute the economizer 22, and a plurality of third plate members 130 that constitute the casing 43. Moreover, in this case, the integral heat exchanger 22 further includes the heat insulating part 44 between (in this case, between in the front-rear direction) the economizer 22 and the radiator 12. The heat insulating part 44 is constituted by a plurality of fourth plate members 140.

[0081] The first plate members 110 are stacked in the front-rear direction so that the first flow paths 51 through which the water flows and the second flow paths 61 through which the high-temperature refrigerant flows are alternately formed. The first plate members 110 are formed of a metal material. The first plate members 110 have shapes with protrusions and depressions formed by press working or the like that serve as the first flow paths 51 and the second flow paths 61. Moreover, openings 110c and 110d are formed in lower left portions and upper left portions of the first plate members 110. The openings 110c and 110d respectively communicate with the lower portion (the inlet portion for the water) and the upper portion (the outlet portion for the water) of the first flow paths 51, and respectively form the first inlet header 13c that is a space to communicate with the lower portion of the first flow paths 51 and the first outlet header 13d that is a space to communicate with the upper portion of the first flow paths 51. Moreover, openings 110a and 110b are formed in upper right portions and lower right portions of the first plate members 110. The openings 110a and 110b respectively communicate with the upper portion (the inlet portion for the high-temperature refrigerant) and the lower portion (the outlet portion for the high-temperature refrigerant) of the second flow paths 61, and respectively form the second inlet header 13a that is a space to communicate with the upper portion of the second flow paths 61 and the second outlet header 13b that is a space to communicate with the lower portion of the second flow paths 61. In this case, the first plate members 110 are stacked, and then the first plate members 110 are joined by joining processing, such as vacuum brazing, welding, or bolt fastening, thereby obtaining the radiator 12.

[0082] The second plate members 120 are stacked in the front-rear direction so that the third flow paths 71 through which the low-temperature refrigerant flows and the fourth flow paths 81 through which the high-temperature refrigerant flows are alternately formed. The second plate members 120 are formed of a metal material. The second plate members 120 have shapes formed by press working or the like with protrusions and depressions that serve as the third flow paths 71 and the fourth flow paths 81. Moreover, openings 120c and 120d are formed in lower left portions and upper left portions of the second plate members 120. The openings 120c and 120d respectively communicate with the lower portion (the inlet portion for the low-temperature refrigerant) and the upper portion (the outlet portion for the low-temperature refrigerant) of the third flow paths 71, and respectively form the third inlet header 23c that is a space to communicate with the lower portion of the third flow paths 71 and the third outlet header 23d that is a space to communicate with the upper portion of the third flow paths 71. Moreover, openings 120a and 120b are formed in upper right portions and lower right portions of the second plate members 120. The openings 120a and 120b respectively communicate with the upper portion (the inlet portion for the high-temperature refrigerant) and the lower portion (the outlet portion for the high-temperature refrigerant) of the fourth flow paths 81, and respectively form the fourth inlet header 23a that is a space to communicate with the upper portion of the fourth flow paths 81 and the fourth outlet header 23b that is a space to communicate with the lower portion of the fourth flow paths 81. In this case, the second plate members 120 are stacked, and then the second plate members 120 are joined by joining processing, such as vacuum brazing, welding, or bolt fastening, thereby obtaining the economizer 22.

[0083] The fourth plate members 140 are stacked in the front-rear direction to form the gap 90 through which the refrigerant and the water do not flow, between the radiator 12 and the economizer 22. The fourth plate members 140 are formed of a metal material. In this case, the fourth plate members 140 are stacked, and then the fourth plate members 140 are joined by joining processing, such as vacuum brazing, welding, or bolt fastening, thereby obtaining the heat insulating part 44. Note that vacuum brazing joins the fourth plate members 140 to each other in a vacuum atmosphere, and hence the gap 90 obtained thereby is in a vacuum state.

[0084] The first inlet 12c serving as the inlet for the water is formed in a lower left portion of the third plate member 130 on the radiator 12 side (in this case, on the front side), and communicates with the first inlet header 13c. The inlet water pipe 35 is connected to the first inlet 12c. The first outlet 12d serving as the outlet for the water is formed in an upper left portion of the third plate member 130 on the radiator 12 side, and communicates with the first outlet header 13d. The outlet water pipe 33 is connected to the first outlet 12d. The second inlet 12a serving as the inlet for the high-temperature refrigerant is formed in an upper right portion of the third plate member 130 on the radiator 12 side, and communicates with the second inlet header 13a. The discharge refrigerant pipe 16 is connected to the second inlet 12a. The second outlet 12b serving as the outlet for the high-temperature refrigerant is formed in a lower right portion of the third plate member 130 on the radiator 12 side, and communicates with the second outlet header 13b. The high-temperature refrigerant pipe 17a is connected to the second outlet 12b. Moreover, the third inlet 22c serving as the inlet for the low-temperature refrigerant is formed in a lower left portion of the third plate member 130 on the economizer 22 side (in this case, the rear side), and communicates with the third inlet header 23c. The injection pipe 21b or the intake refrigerant pipe 19a is connected to the third inlet 22c. The third outlet 22d serving as the outlet for the low-temperature refrigerant is formed in an upper left portion of the third plate member 130 on the economizer 22 side, and communicates with the third outlet header 23d. The injection pipe 21b or the intake refrigerant pipe 19b is connected to the third outlet 22d. The fourth inlet 22a serving as the inlet for the high-temperature refrigerant is formed in an upper right portion of the third plate member 130 on the economizer 22 side, and communicates with the fourth inlet header 23a. The high-temperature refrigerant pipe 17a is connected to the fourth inlet 22a. The fourth outlet 22b serving as the outlet for the high-temperature refrigerant is formed in a lower right portion of the third plate member 130 on the economizer 22 side, and communicates with the fourth outlet header 23b. The high-temperature refrigerant pipe 17b is connected to the fourth outlet 22b. In this case, the third plate members 130 that constitute the casing 43 are formed of a metal material.

[0085] In this case, the third plate members 130 of the casing 43 are disposed to sandwich the radiator 12, the economizer 22, and the heat insulating part 44 in the front-rear direction, and are joined to the radiator 12, the economizer 22, and the heat insulating part 44. For example, the casing 43 is joined to the radiator 12, the economizer 22, and the heat insulating part 44 simultaneously with forming the radiator 12, the economizer 22, and the heat insulating part 44 by stacking predetermined numbers of the first to fourth plate members 110 to 140 in a predetermined order, and then joining the plate members and the casing 43 by joining processing, such as vacuum brazing, welding, or bolt fastening.

[0086] Also in the integral heat exchanger 20 having the above-described configuration, like the above-described embodiment and Modification B, the water is heated through heat exchange with the high-temperature refrigerant and the high-temperature refrigerant radiates heat in the radiator 12, and the low-temperature refrigerant is heated through heat exchange with the high-temperature refrigerant and the high-temperature refrigerant radiates heat in the economizer 22.

<E>

[0087] Also in the above-described Modification D (in which the economizer 22 that cools the high-temperature refrigerant using the low-temperature refrigerant flowing through the injection pipe 21 is employed), like Modification A (see Figs. 9, 3, 10, 5, and 11 to 14), as illustrated in Figs. 23, 21, and 24, the high-temperature refrigerant pipe 17a that sends the high-temperature refrigerant whose heat has been radiated in the radiator 12 to the economizer 22 may be included in the integral heat exchanger 20 together with the branch portion to the injection pipe 21a.

[0088] In this case, a fourth flow path 81a included in the fourth flow paths 81 that constitute the economizer 22 and being adjacent to the heat insulating part 44 on the rear side functions as the communication portion 45. Specifically, the opening 120b is not formed to inhibit a space of a lower right portion of the second plate member 120 that forms the fourth flow path 81a from communicating with the fourth outlet header 23b, and an opening 141 is formed in the heat insulating part 44 (in this case, the fourth plate member 140) to extend therethrough in the front-rear direction in a state not communicating with the gap 90, to allow the fourth flow path 81a being adjacent to the heat insulating part 44 on the rear side and the second outlet header 13b to communicate with each other. Accordingly, the fourth flow path 81a included in the fourth flow paths 81 that constitute the economizer 22 and being adjacent to the heat insulating part 44 on the rear side forms a flow path (corresponding to the flow path 96 of Modification A) that allows the second outlet header 13b of the radiator 12 and the fourth inlet header 23a of the economizer 22 to communicate with each other. Hence, the fourth inlet 22a, which has been formed in the above-described Modification D, is not formed in the upper right portion of the third plate member 130 on the economizer 22 side (in this case, on the rear side).

[0089] Also in the integral heat exchanger 20 having the above-described configuration, like the above-described Modification A, the water is heated through heat exchange with the high-temperature refrigerant and the high-temperature refrigerant radiates heat in the radiator 12, and the low-temperature refrigerant is heated through heat exchange with the high-temperature refrigerant and the high-temperature refrigerant radiates heat in the economizer 22.

<F>

[0090] Also in the above-described Modification D (the case in which the economizer 22 that cools the high-temperature refrigerant using the low-temperature refrigerant flowing through the intake refrigerant pipe 19 is employed), like Modification C (see Figs. 18, 3, 19, 17, and 11 to 14), as illustrated in Figs. 25, 21, and 26, the high-temperature refrigerant pipe 17a that sends the high-temperature refrigerant whose heat has been radiated in the radiator 12 to the economizer 22 may be included in the integral heat exchanger 20 together with the branch portion to the injection pipe 21a.

[0091] In this case, the fourth flow path 81a included in the fourth flow paths 81 that constitute the economizer 22 and being adjacent to the heat insulating part 44 on the rear side functions as the communication portion 45. Specifically, the opening 120b is not formed to inhibit a space of a lower right portion of the second plate member 120 that forms the fourth flow path 81a from communicating with the fourth outlet header 23b, and the opening 141 is formed in the heat insulating part 44 (in this case, the fourth plate member 140) to extend therethrough in the front-rear direction in a state not communicating with the gap 90, to allow the fourth flow path 81a being adjacent to the heat insulating part 44 on the rear side and the second outlet header 13b to communicate with each other. Accordingly, the fourth flow path 81a included in the fourth flow paths 81 that constitute the economizer 22 and being adjacent to the heat insulating part 44 on the rear side forms a flow path (corresponding to the flow path 96 of Modification A) that allows the second outlet header 13b of the radiator 12 and the fourth inlet header 23a of the economizer 22 to communicate with each other. Hence, the second outlet 12b, which has been formed in the above-described Modification D, is not formed in the lower right portion of the third plate member 130 on the radiator 12 side (in this case, on the front side), and the fourth inlet 22a, which has been formed in the above-described Modification D, is not formed in the upper right portion of the third plate member 130 on the economizer 22 side (in this case, the rear side).

[0092] Also in the integral heat exchanger 20 having the above-described configuration, like the above-described Modification C, the water is heated through heat exchange with the high-temperature refrigerant and the high-temperature refrigerant radiates heat in the radiator 12, and the low-temperature refrigerant is heated through heat exchange with the high-temperature refrigerant and the high-temperature refrigerant radiates heat in the economizer 22.

<G>

[0093] In the above-described embodiment and modifications, the heat insulating part 44 is formed by the gap 90 through which the refrigerant and the water do not flow. However, it is not limited thereto.

[0094] For example, as illustrated in Fig. 27, in the configuration of Modification D, a ceramic material 90a whose thermal conductivity is lower than that of a material (in this case, a metal material) that constitutes a portion through which the refrigerant and the fluid to be heated flow (in this case, the plate members 110 and 120) may be provided in the gap 90.

[0095] Moreover, as illustrated in Fig. 28, the ceramic material 90a may be directly provided between the economizer 22 and the radiator 12 instead of providing the gap 90 between the economizer 22 and the radiator 12.

[0096] Note that, for the material 90a having a lower thermal conductivity than that of a material that constitutes the portion through which the refrigerant and the fluid to be heated flow, a resin material or a rubber material may be used. Moreover, the configuration having the heat insulating part 44 using such a material having a low thermal conductivity is not limited to the configuration of Modification D, another embodiment and another modification may employ the configuration.

<H>

[0097] In the above-described embodiment and modifications, the water is used as the fluid to be heated that is heated by the refrigerant in the radiator 12. However, it is not limited thereto. The fluid to be heated may be other fluids such as brine.

<I>

[0098] In the above-described embodiment and Modifications A to C, the first flow paths 51 of the radiator 12, and the third flow paths 71 of the economizer 22 have the meandering shapes. However, it is not limited thereto. The first and third flow paths 51 and 71 may have other shapes such as straight shapes.

<J>

[0099] In the above-described embodiment and Modifications A to C, the second flow paths 61 of the radiator 12 and the fourth flow paths 81 of the economizer 22 have the shapes folded back left and right at three positions. However, it is not limited thereto, and the number of folded back positions may be two or four, or no folded back portion may be provided. Moreover, the second flow paths 61 and the fourth flow paths 81 may have meandering shapes like the first flow paths.

<K>

[0100] The arrangement of the outlets and inlets 12a to 12d, and 22a to 22d of the radiator 12 and the economizer 22 is not limited to those of the above-described embodiment and modifications, and appropriate arrangement may be employed in accordance with the configurations of flow paths.

[0101] The embodiment of the present disclosure has been described above, and it is understood that the embodiment and details can be modified in various ways without departing from the idea and scope of the present disclosure described in the claims.

Industrial Applicability

[0102] The present disclosure is widely applicable to a heat pump system including a refrigerant circuit including an economizer.

Reference Signs List

[0103]

1	heat pump system
10	refrigerant circuit
11	compressor
12	radiator
13	expansion mechanism
14	evaporator
20	integral heat exchanger
22	economizer
32	use-side equipment
44	heat insulating part
90	gap

Citation List

Patent Literature

[0104] PTL 1: Description of European Patent Application Publication No. 2952832

Claims

1. A heat pump system (1) comprising:

a refrigerant circuit (10) constituted by connecting a compressor (11) that compresses a refrigerant, a radiator (12) that cools the refrigerant compressed in the compressor using a fluid to be heated, an expansion mechanism (13) that decompresses the refrigerant cooled in the radiator, and an evaporator (14) that evaporates the refrigerant decompressed in the expansion mechanism; and
an economizer (22) that is provided in the refrigerant circuit and that further cools the refrigerant cooled in the radiator using the refrigerant flowing through the refrigerant circuit,
wherein the economizer constitutes an integral heat exchanger (20) in which the economizer and the radiator are integrated with each other, and
wherein the integral heat exchanger includes a heat insulating part (44) between the economizer and the radiator.

2. The heat pump system according to Claim 1, wherein the heat insulating part is constituted by a material having a lower thermal conductivity than a thermal conductivity of a material that constitutes a portion through which the refrigerant and the fluid to be heated flow in the integral heat exchanger.

3. The heat pump system according to Claim 1, wherein the heat insulating part is constituted by a gap (90) that is provided between the radiator and the economizer and through which the refrigerant and the fluid to be heated do not flow.

4. The heat pump system according to Claim 3, wherein the gap is in a vacuum state.

5. The heat pump system according to Claim 4, wherein the integral heat exchanger is formed by vacuum brazing or diffusion bonding.

6. The heat pump system according to any one of Claims 1 to 5, wherein the integral heat exchanger is a micro-flow-path heat exchanger.

7. The heat pump system according to any one of Claims 1 to 6 further comprising use-side equipment (32) that heats inside of a room using the fluid to be heated that has been heated through heat exchange with the refrigerant in the radiator.

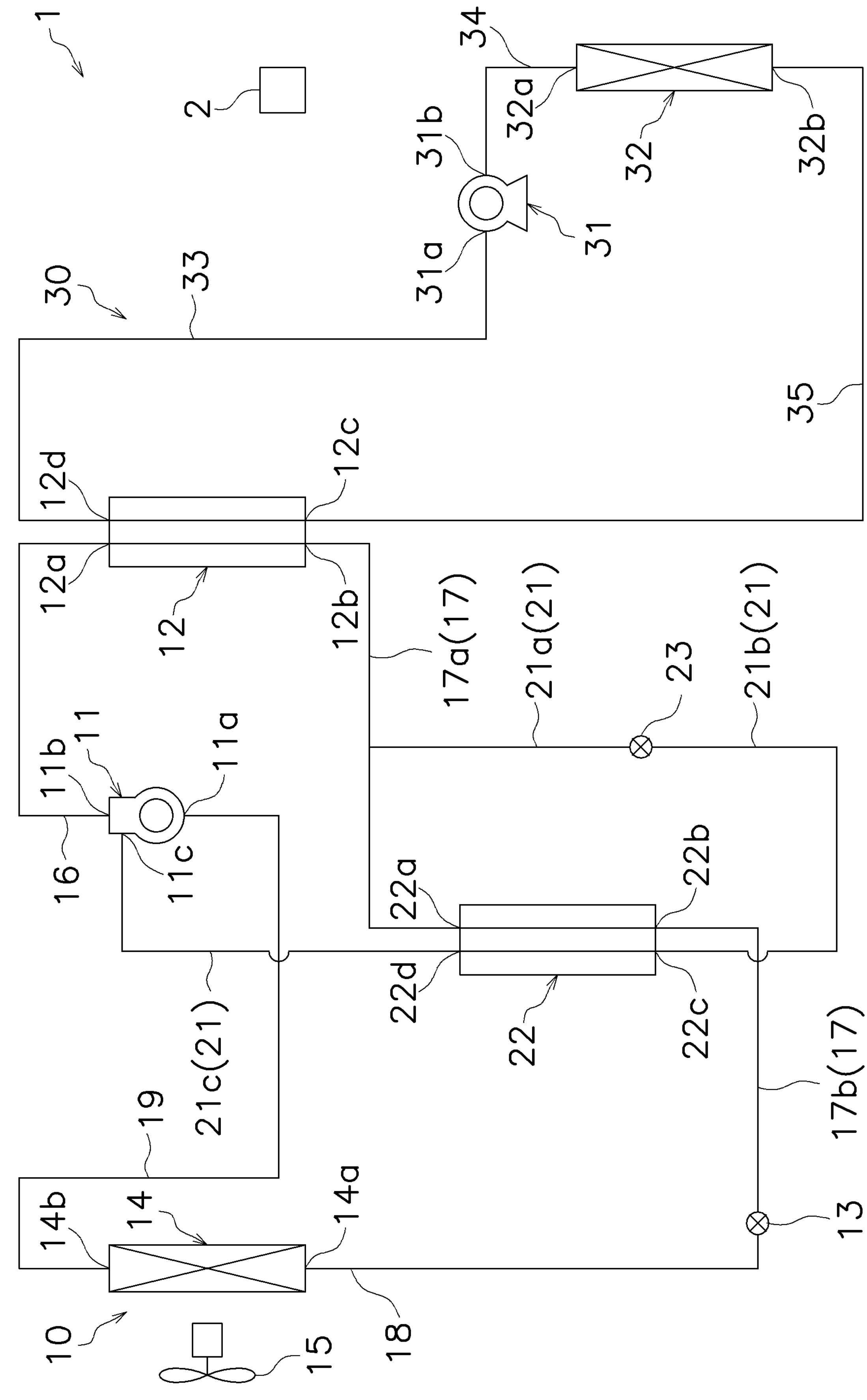
1
2
30
33
31a
31
31b
34
32a
32
32b
35
12d
12c
12a
12
12b
17a(17)
21a(21)
23
21b(21)
11b
11
11a
16
11c
22a
22b
22d
22
22c
21c(21)
19
17b(17)
14b
14
14a
13
10
15
18

FIG. 1

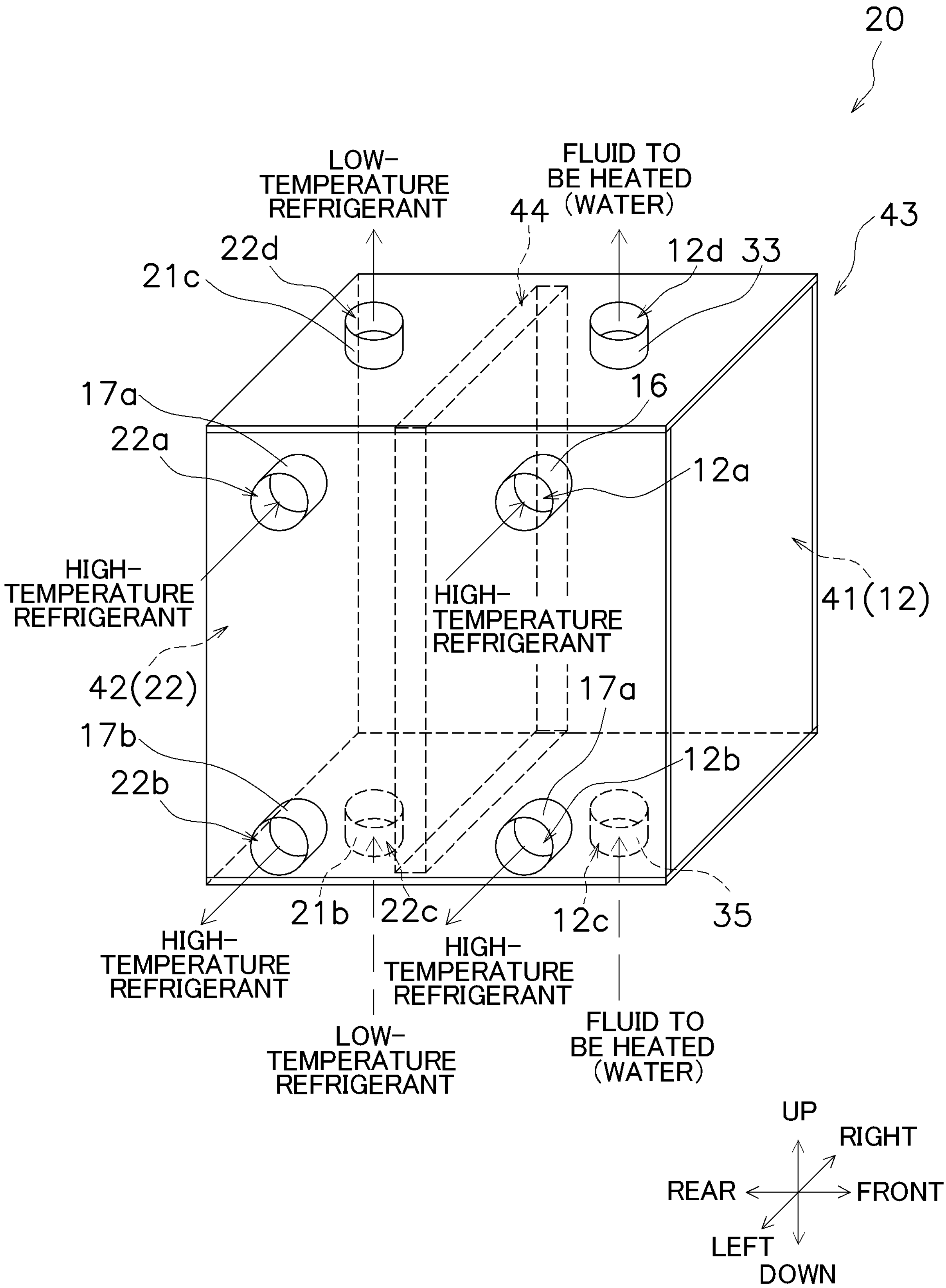
20
LOW-
TEMPERATURE
REFRIGERANT
FLUID TO
BE HEATED
(WATER)
44
43
22d
12d
33
21c
17a
16
22a
12a
HIGH-
TEMPERATURE
REFRIGERANT
HIGH-
TEMPERATURE
REFRIGERANT
41(12)
42(22)
17a
17b
12b
22b
21b
22c
12c
35
HIGH-
TEMPERATURE
REFRIGERANT
HIGH-
TEMPERATURE
REFRIGERANT
LOW-
TEMPERATURE
REFRIGERANT
FLUID TO
BE HEATED
(WATER)
UP
RIGHT
REAR
FRONT
LEFT
DOWN

FIG. 2

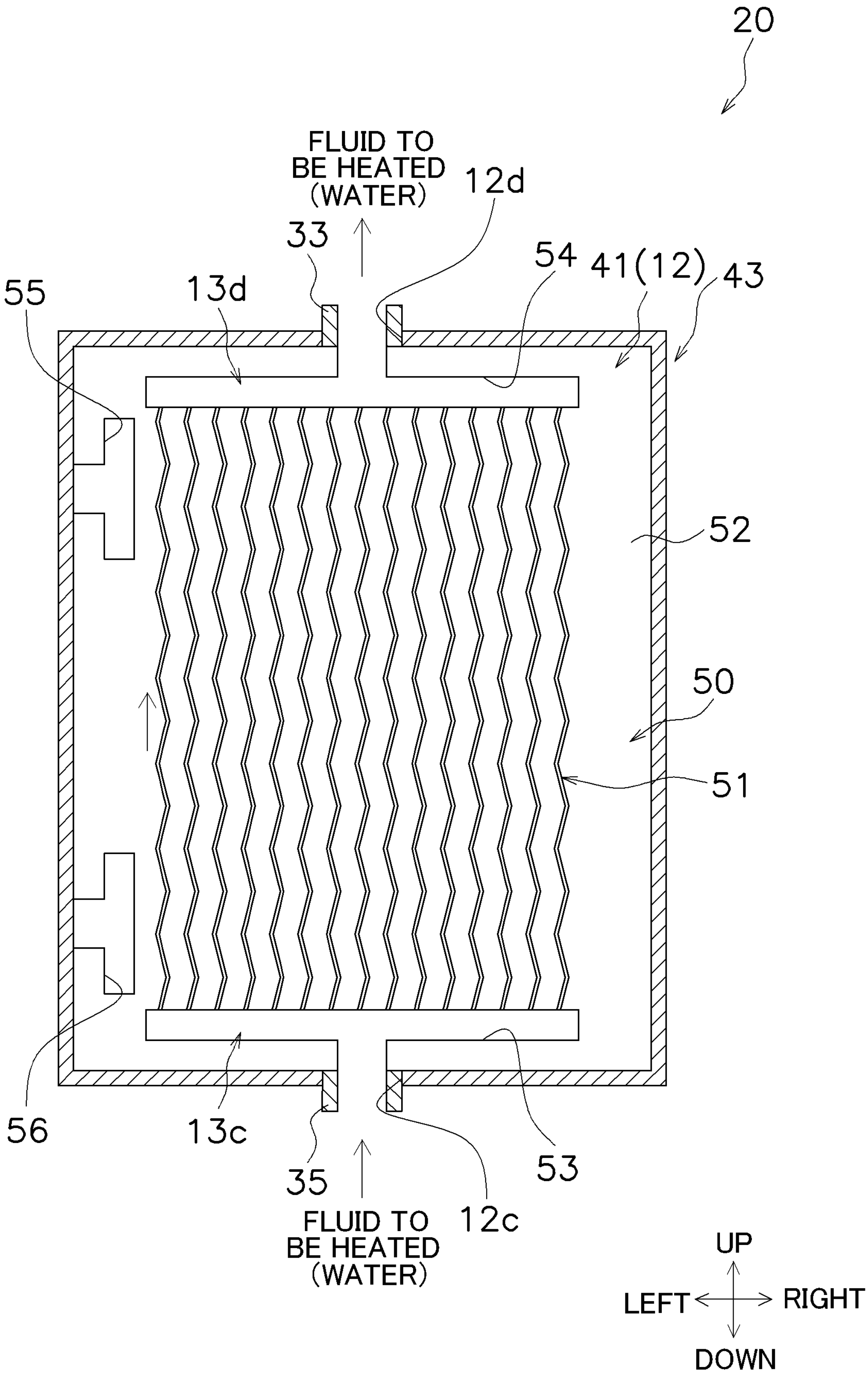
20
FLUID TO
BE HEATED
(WATER)
12d
33
54
41(12)
43
55
13d
52
50
51
56
13c
35
53
12c
FLUID TO
BE HEATED
(WATER)
UP
LEFT
RIGHT
DOWN

FIG. 3

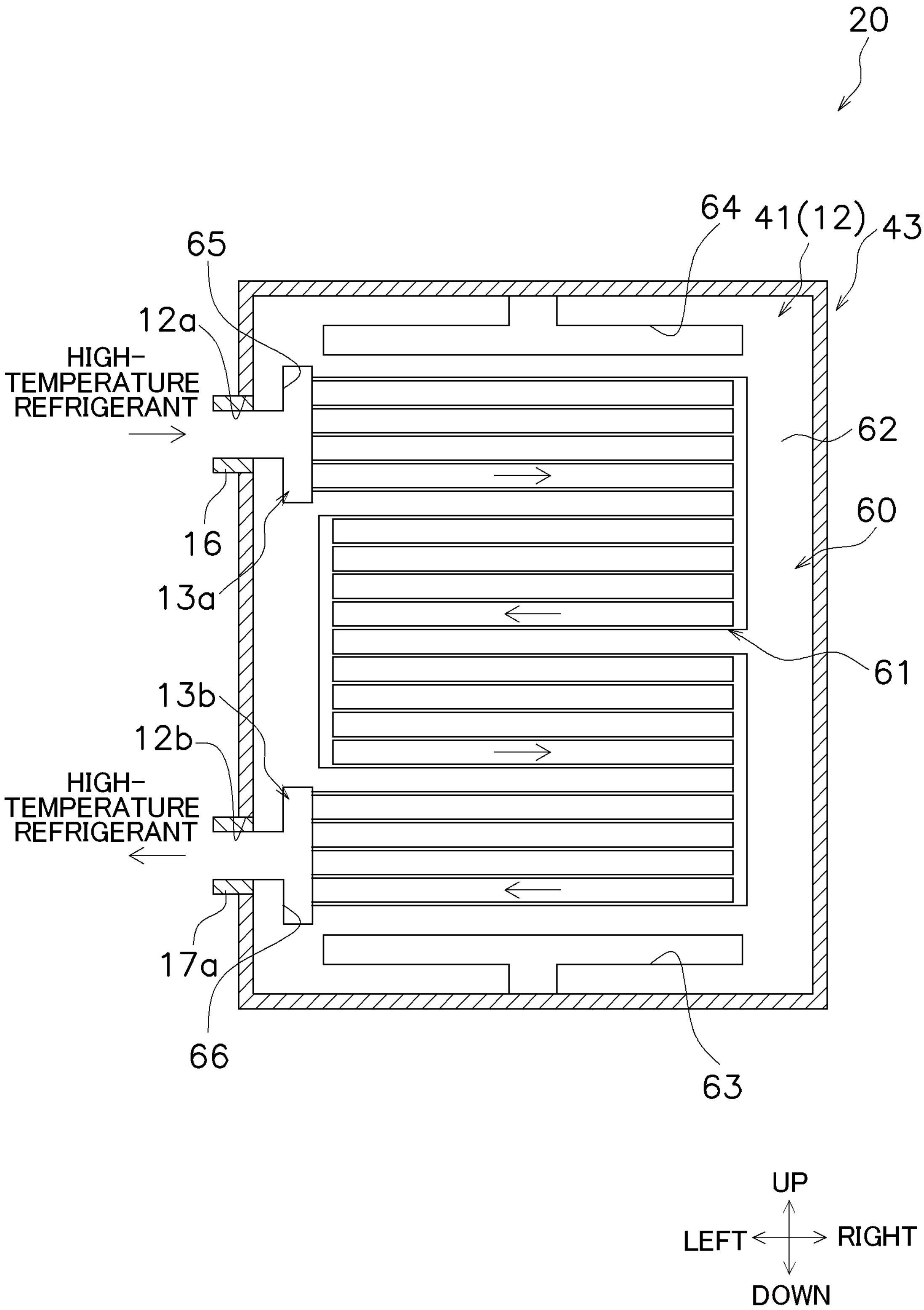
20
64
41(12)
43
65
12a
HIGH-TEMPERATURE REFRIGERANT
62
60
16
13a
61
13b
12b
HIGH-TEMPERATURE REFRIGERANT
17a
66
63
UP
LEFT
RIGHT
DOWN

FIG. 4

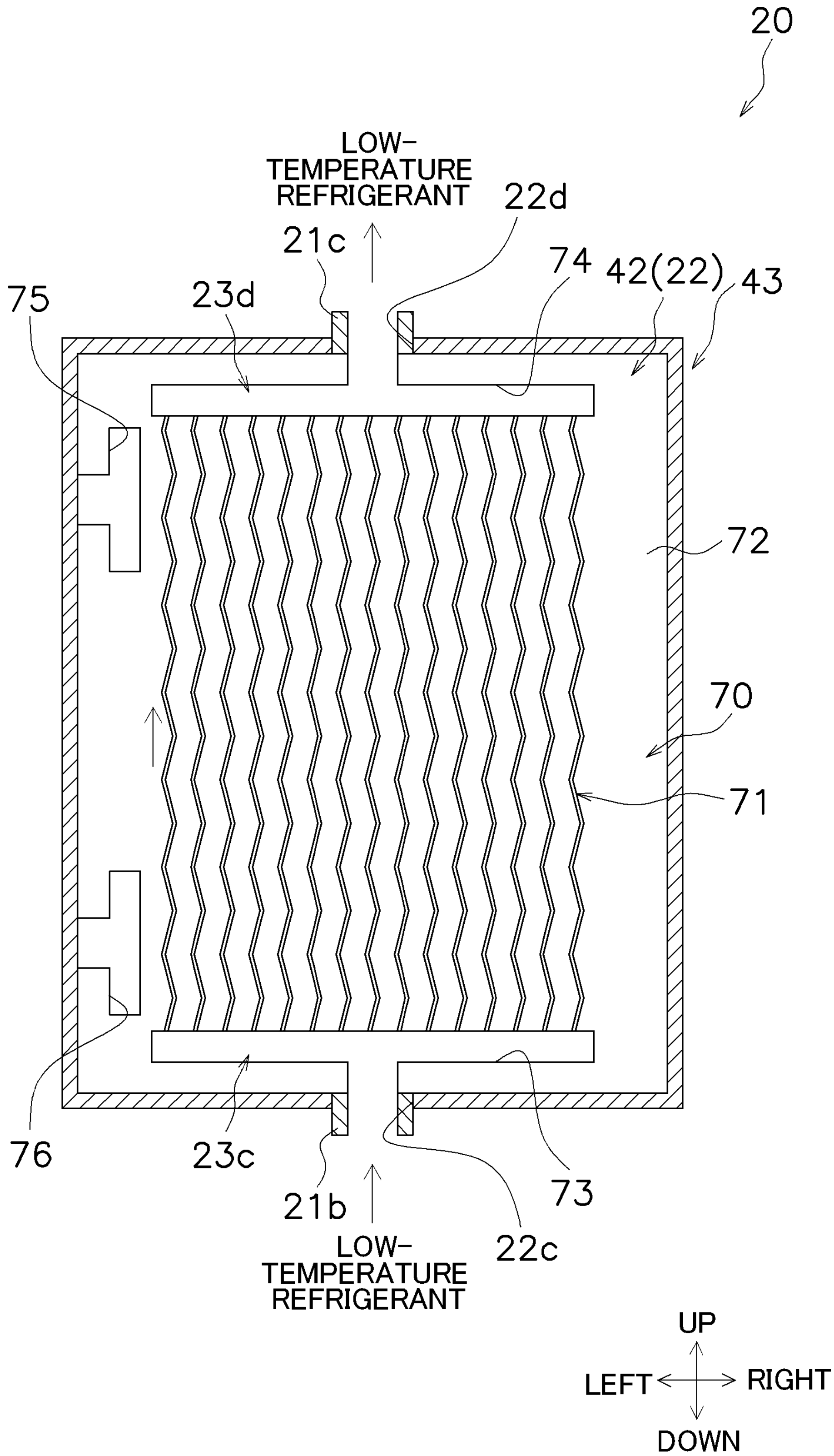
20
LOW-
TEMPERATURE
REFRIGERANT
22d
21c
74
42(22)
43
75
23d
72
70
71
76
23c
21b
73
22c
LOW-
TEMPERATURE
REFRIGERANT
UP
LEFT
RIGHT
DOWN

FIG. 5

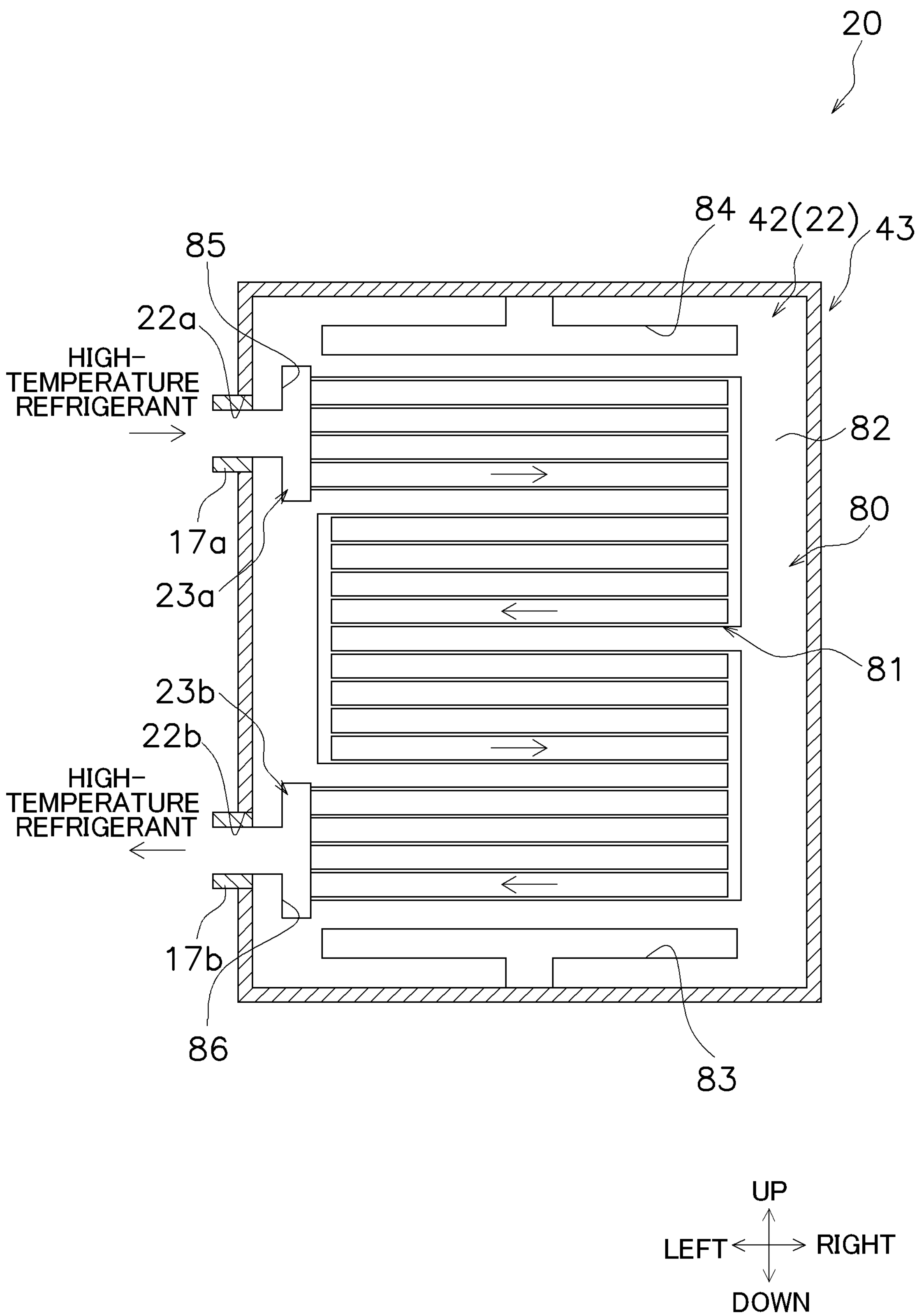
20
84
42(22)
43
85
22a
HIGH-
TEMPERATURE
REFRIGERANT
82
80
17a
23a
81
23b
22b
HIGH-
TEMPERATURE
REFRIGERANT
17b
86
83
UP
LEFT
RIGHT
DOWN

FIG. 6

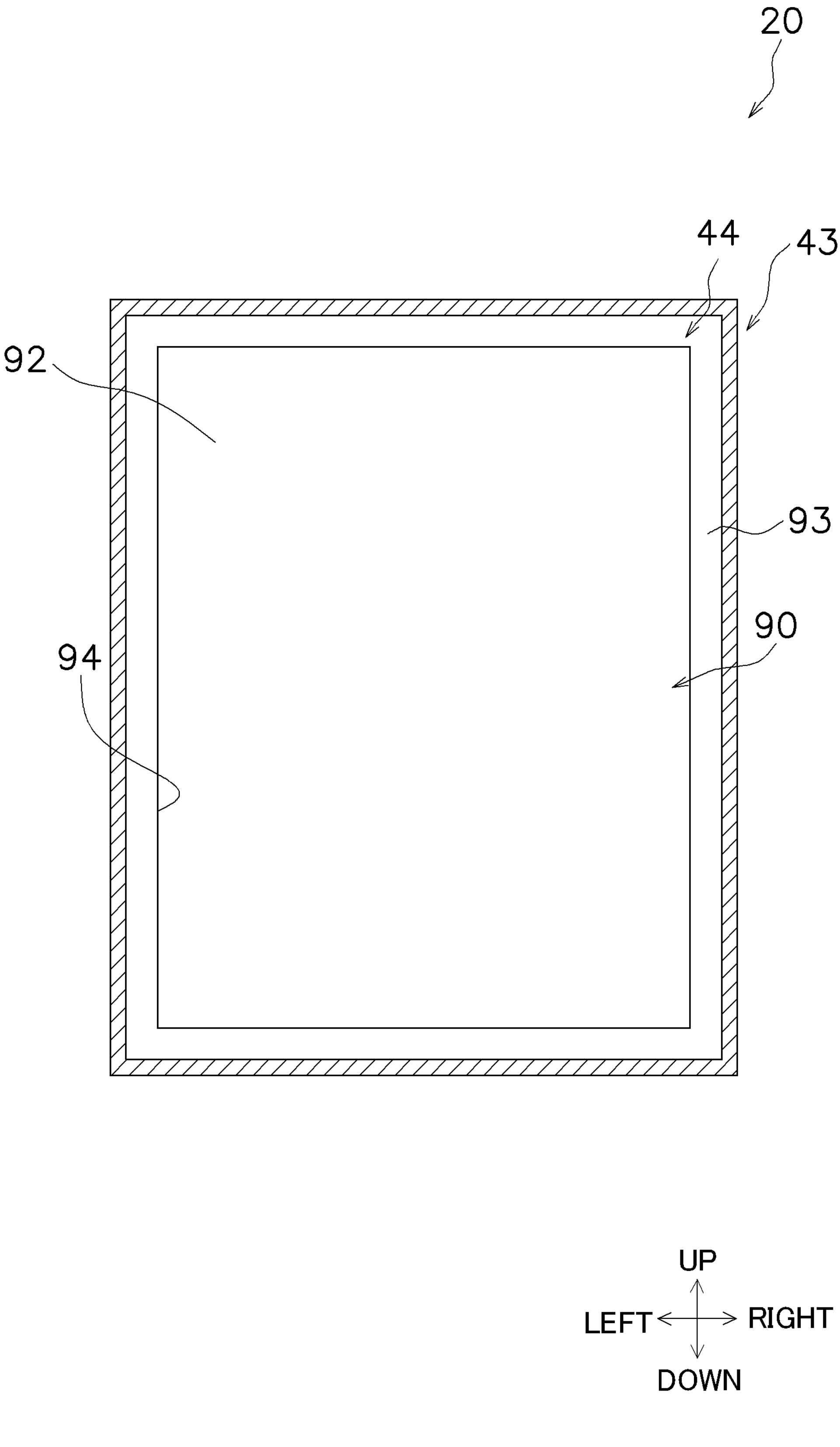

FIG. 7

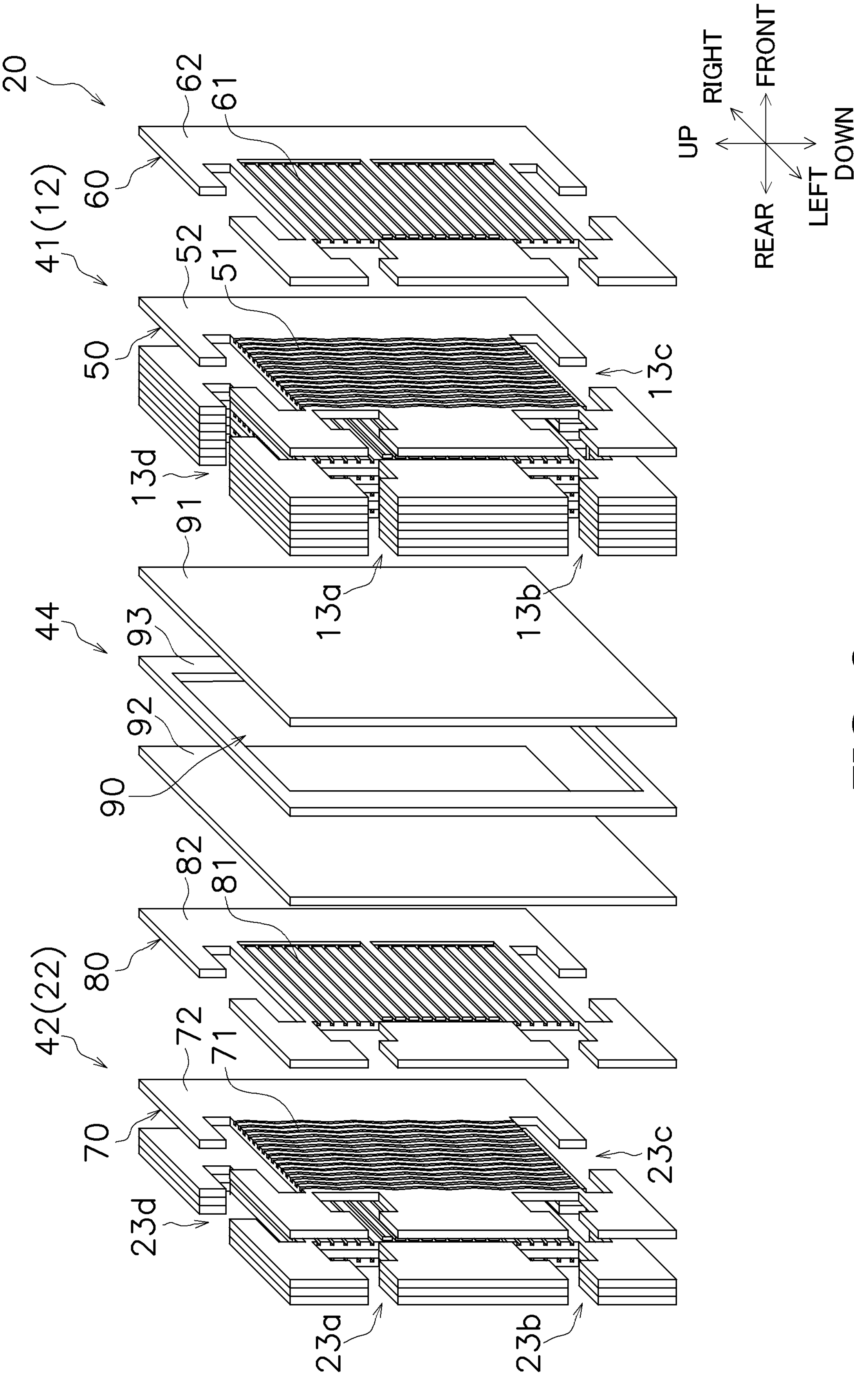
20
62
61
60
41(12)
52
51
50
13c
13d
91
13a
13b
44
93
92
90
82
81
80
42(22)
72
71
70
23c
23d
23a
23b
UP
RIGHT
FRONT
DOWN
LEFT
REAR

FIG. 8

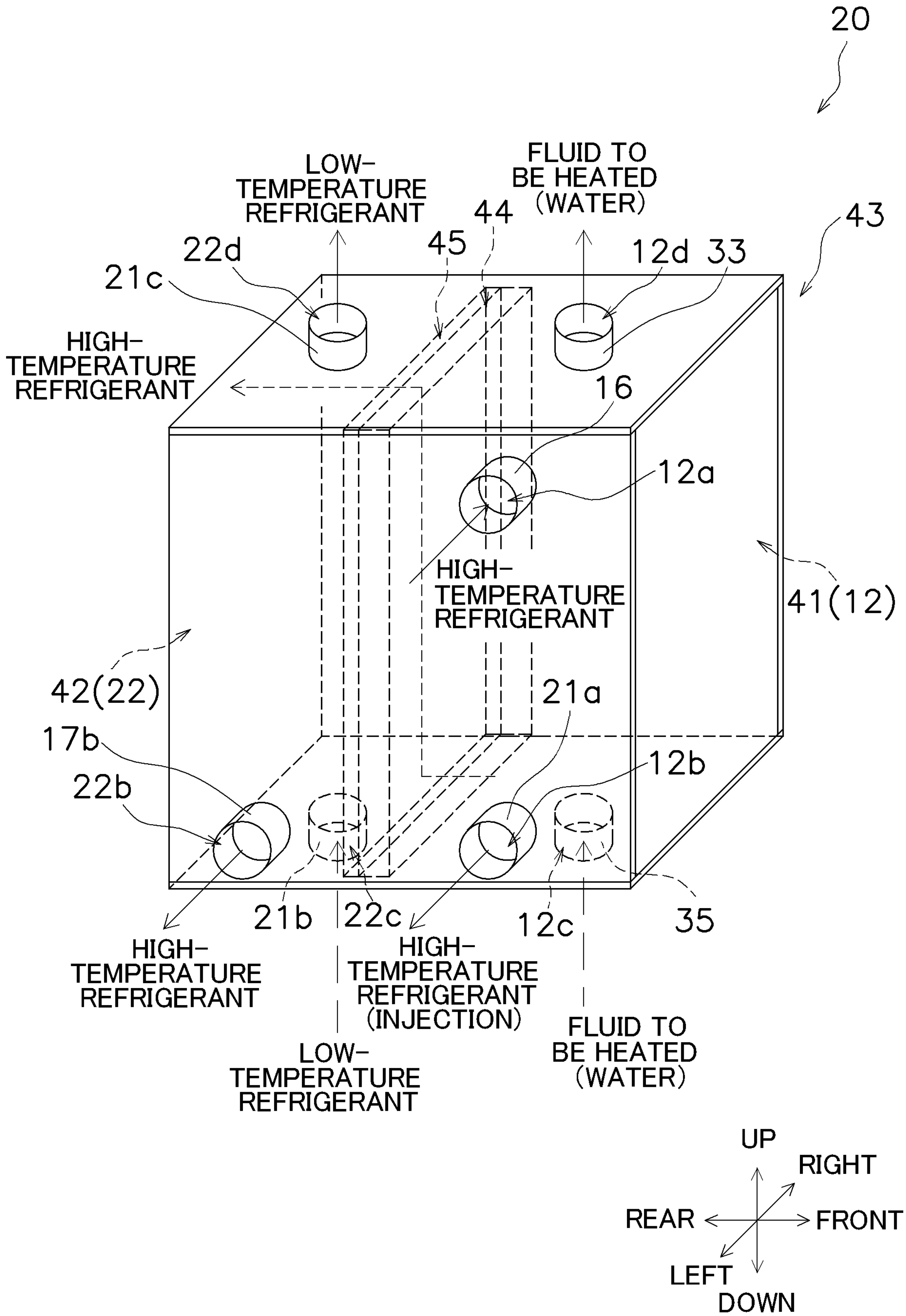
20
LOW-
TEMPERATURE
REFRIGERANT
FLUID TO
BE HEATED
(WATER)
44
43
45
22d
12d
33
21c
HIGH-
TEMPERATURE
REFRIGERANT
16
12a
HIGH-
TEMPERATURE
REFRIGERANT
41(12)
42(22)
21a
17b
12b
22b
21b
22c
12c
35
HIGH-
TEMPERATURE
REFRIGERANT
HIGH-
TEMPERATURE
REFRIGERANT
(INJECTION)
LOW-
TEMPERATURE
REFRIGERANT
FLUID TO
BE HEATED
(WATER)
UP
RIGHT
REAR
FRONT
LEFT
DOWN

FIG. 9

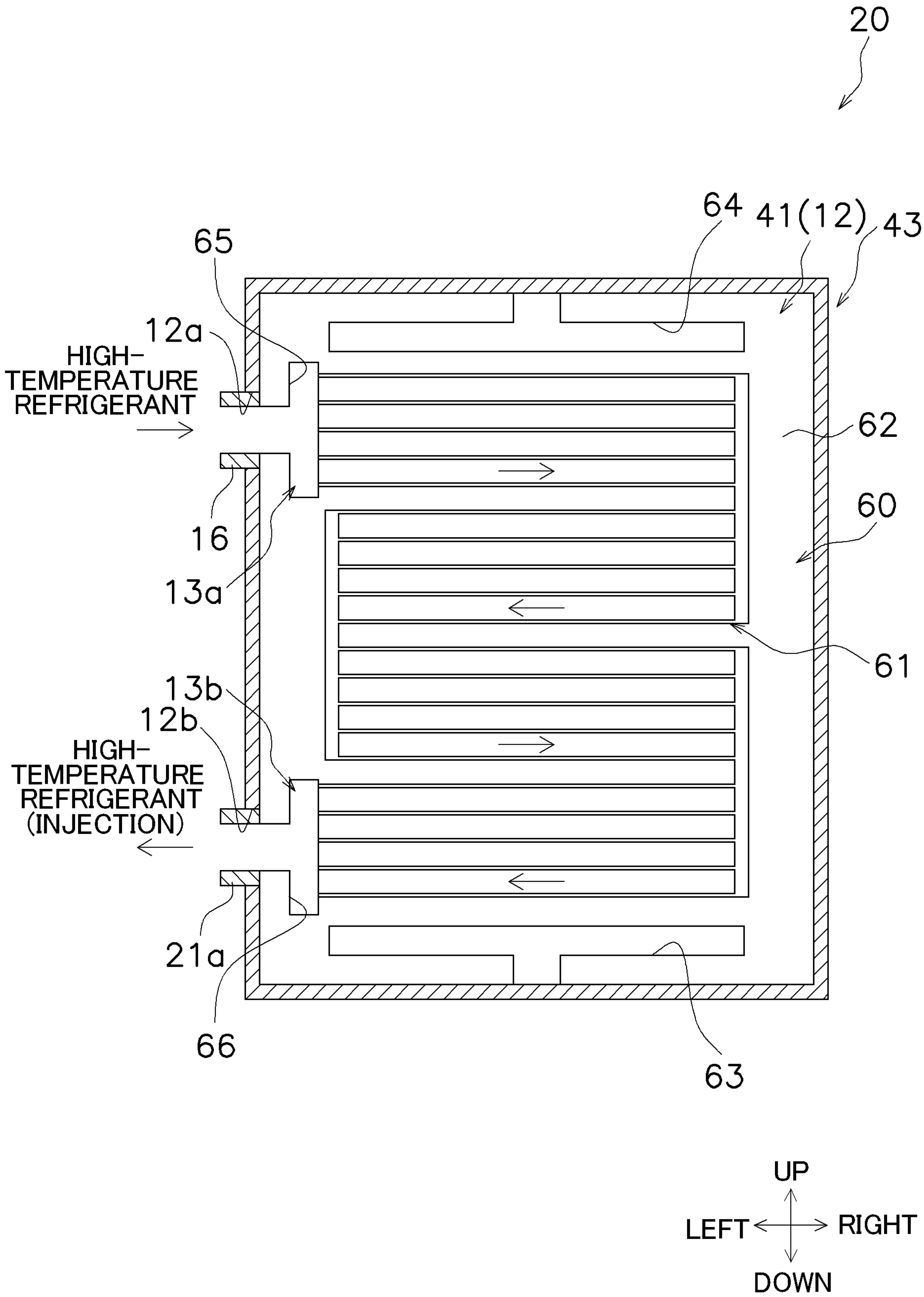
20
64
41(12)
43
65
12a
HIGH-
TEMPERATURE
REFRIGERANT
62
16
60
13a
61
13b
12b
HIGH-
TEMPERATURE
REFRIGERANT
(INJECTION)
21a
66
63
UP
LEFT
RIGHT
DOWN

FIG. 10

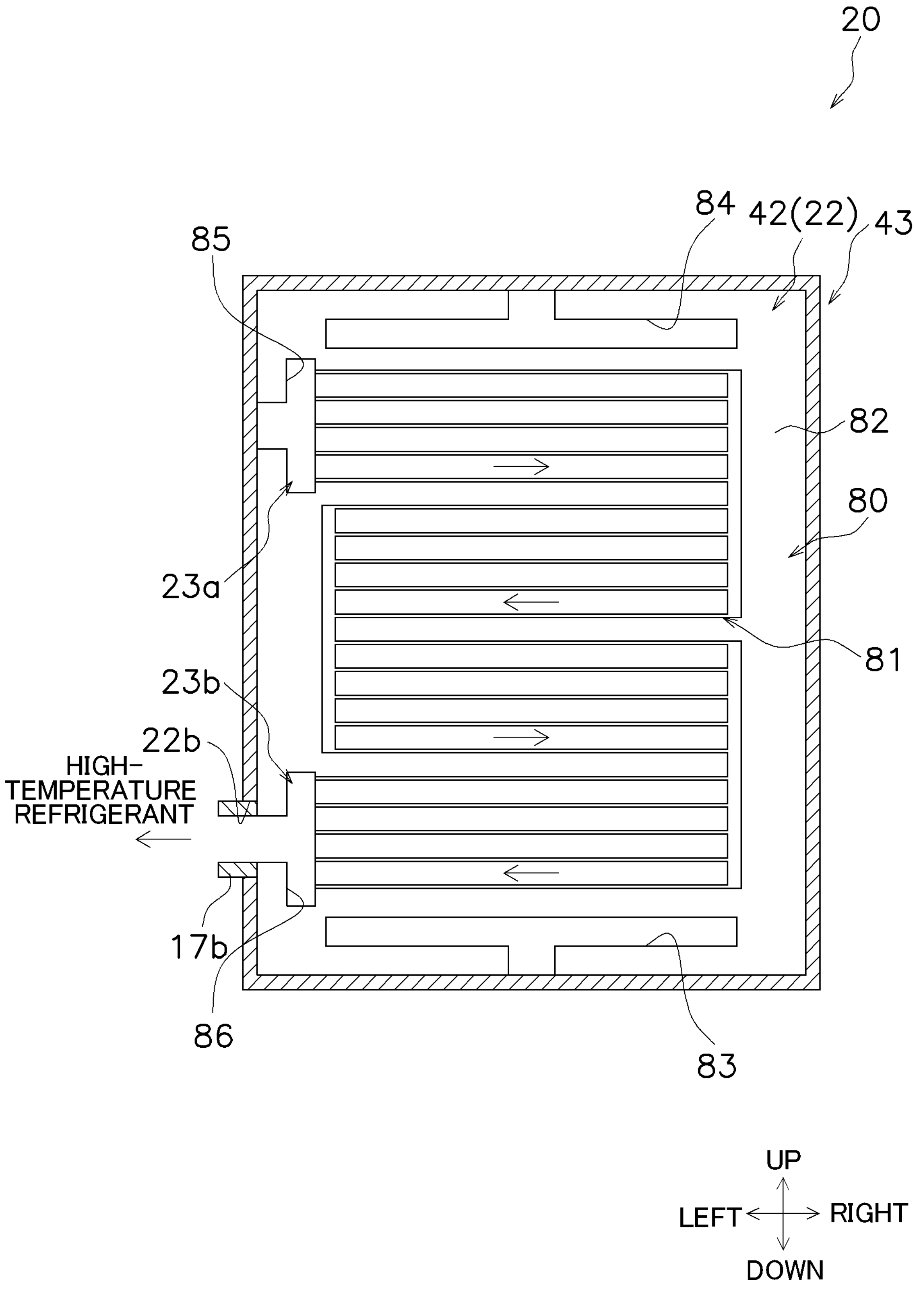
20
84
42(22)
43
85
82
80
23a
81
23b
22b
HIGH-
TEMPERATURE
REFRIGERANT
17b
86
83
UP
LEFT
RIGHT
DOWN

FIG. 11

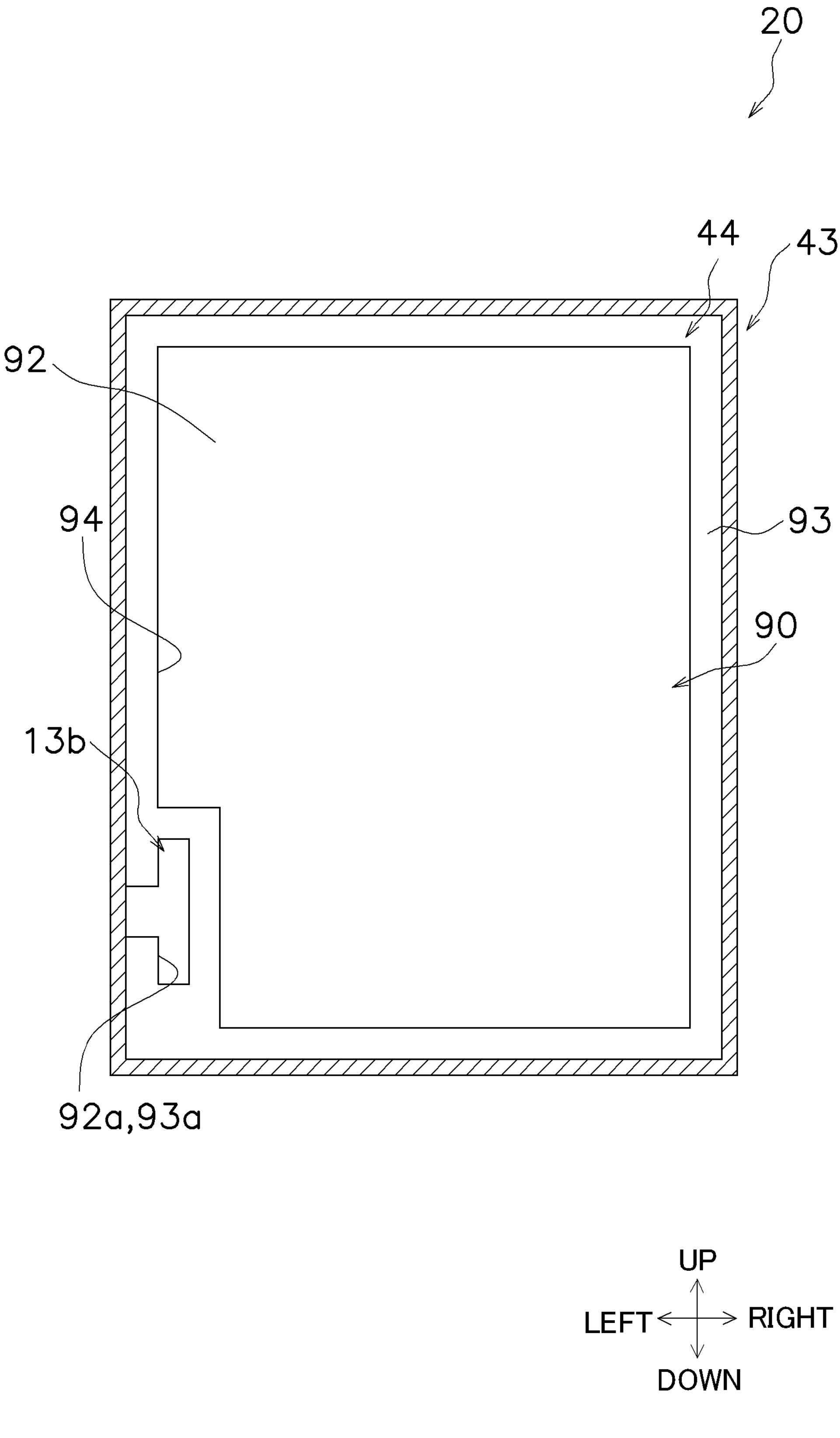

FIG. 12

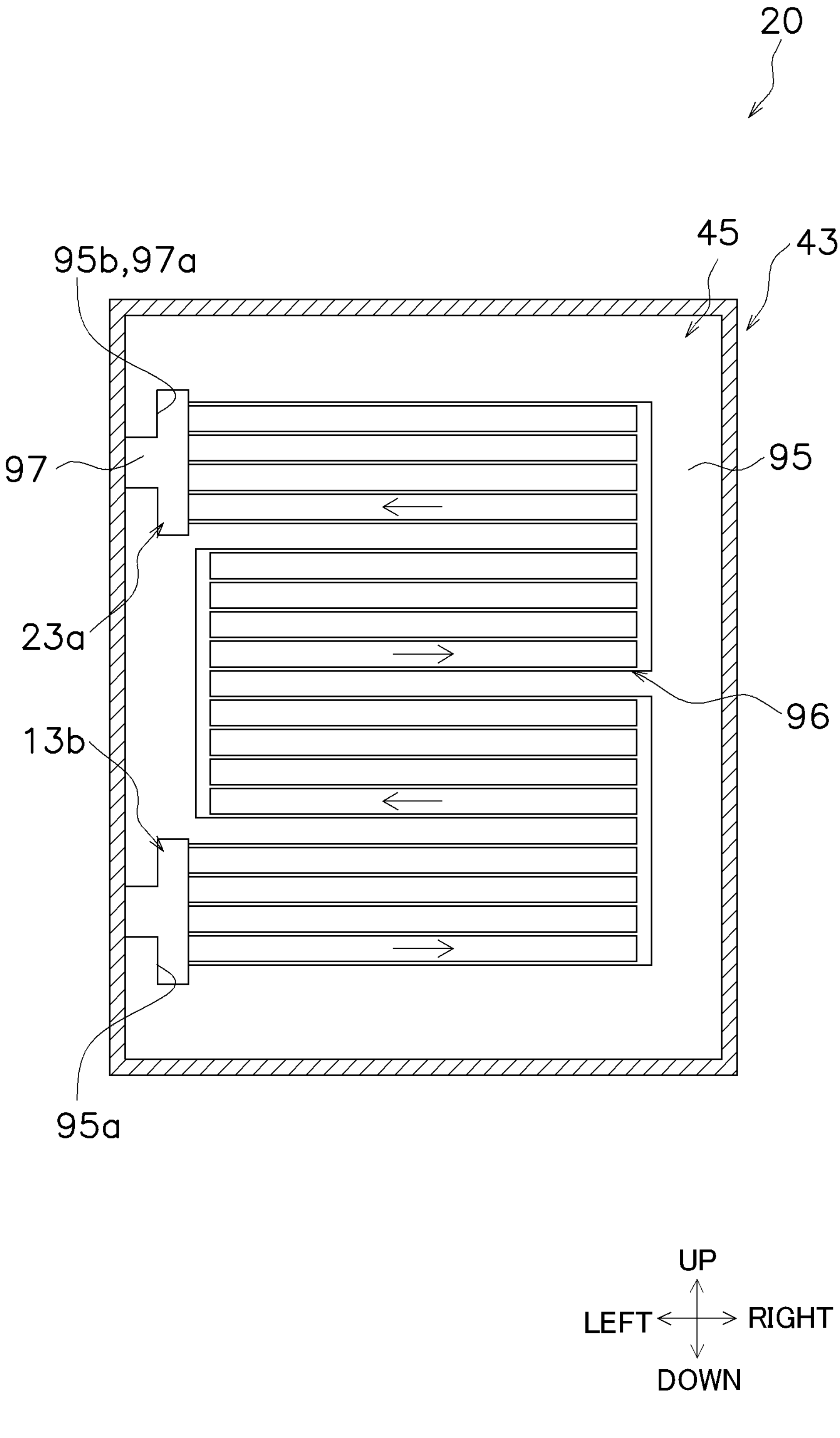

FIG. 13

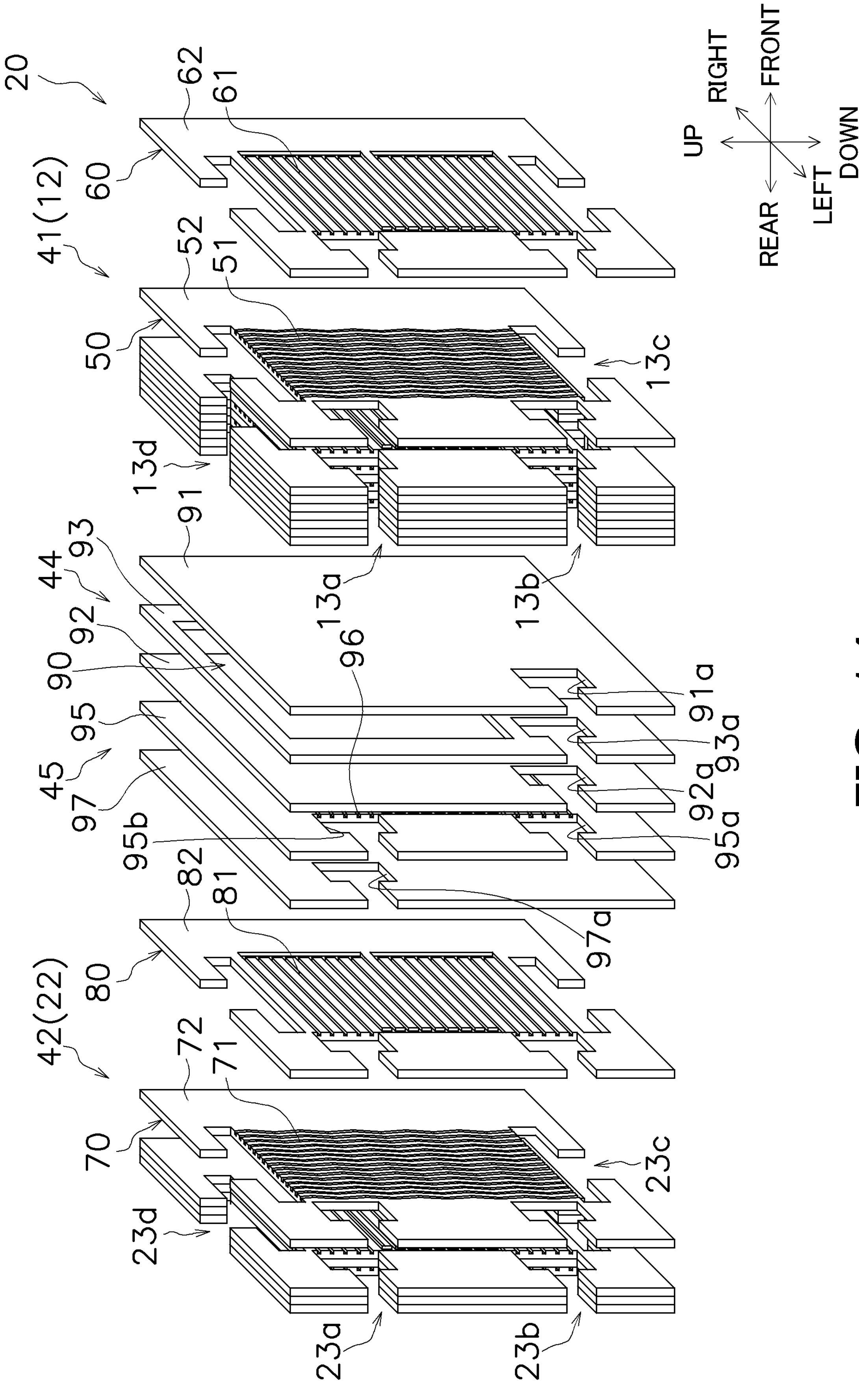
20
62
61
60
41(12)
52
51
50
13c
13d
91
13a
13b
44
93
92
90
96
91a
93a
95
45
97
92a
95b
95a
82
81
97a
80
42(22)
72
71
70
23c
23d
23a
23b
UP
RIGHT
FRONT
DOWN
LEFT
REAR

FIG. 14

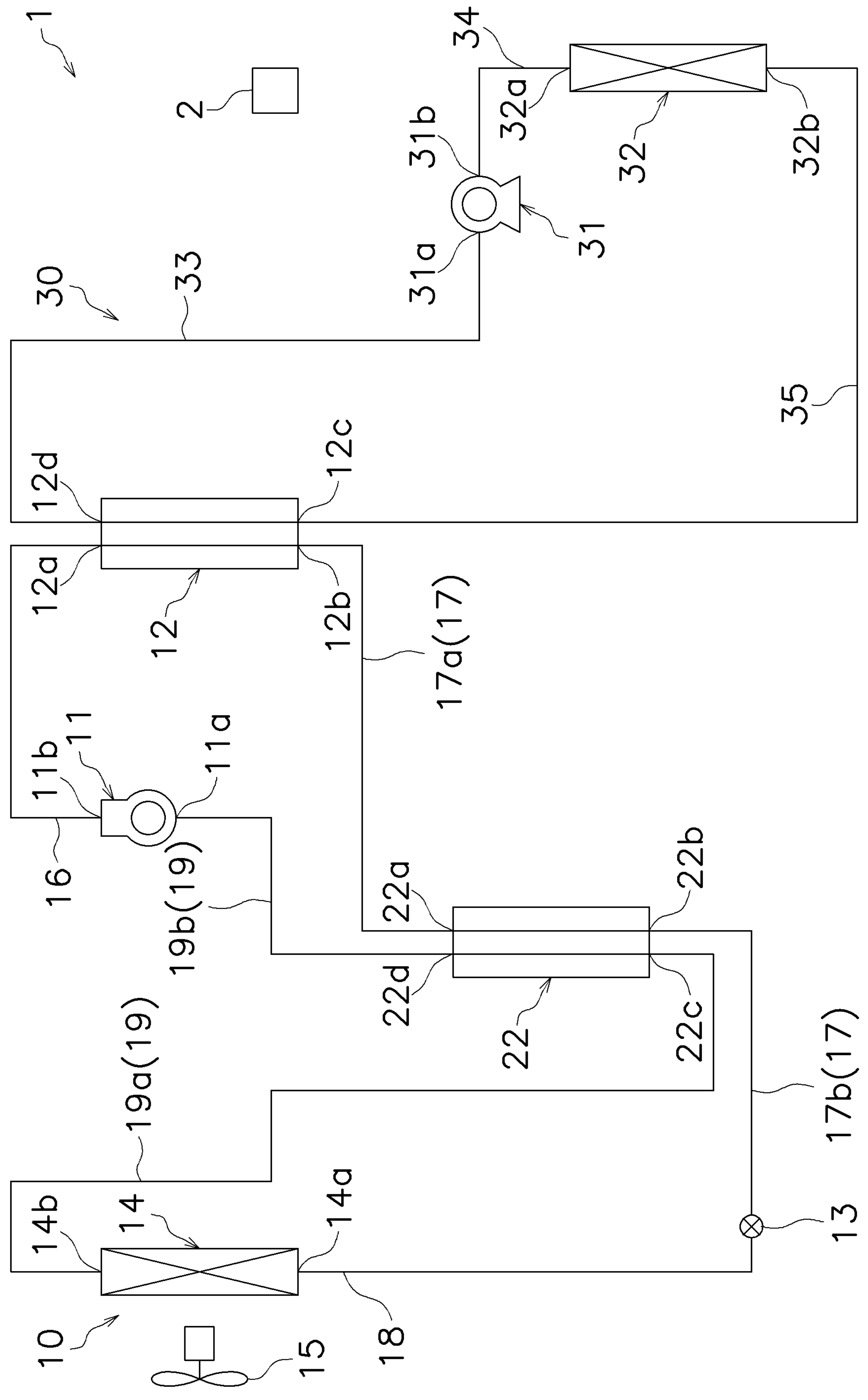
1
2
30
33
34
31a
31b
31
32a
32
32b
35
12d
12c
12a
12
12b
17a(17)
11b
11
11a
16
19b(19)
22a
22b
22d
22
22c
19a(19)
17b(17)
14b
14
14a
13
10
15
18

FIG. 15

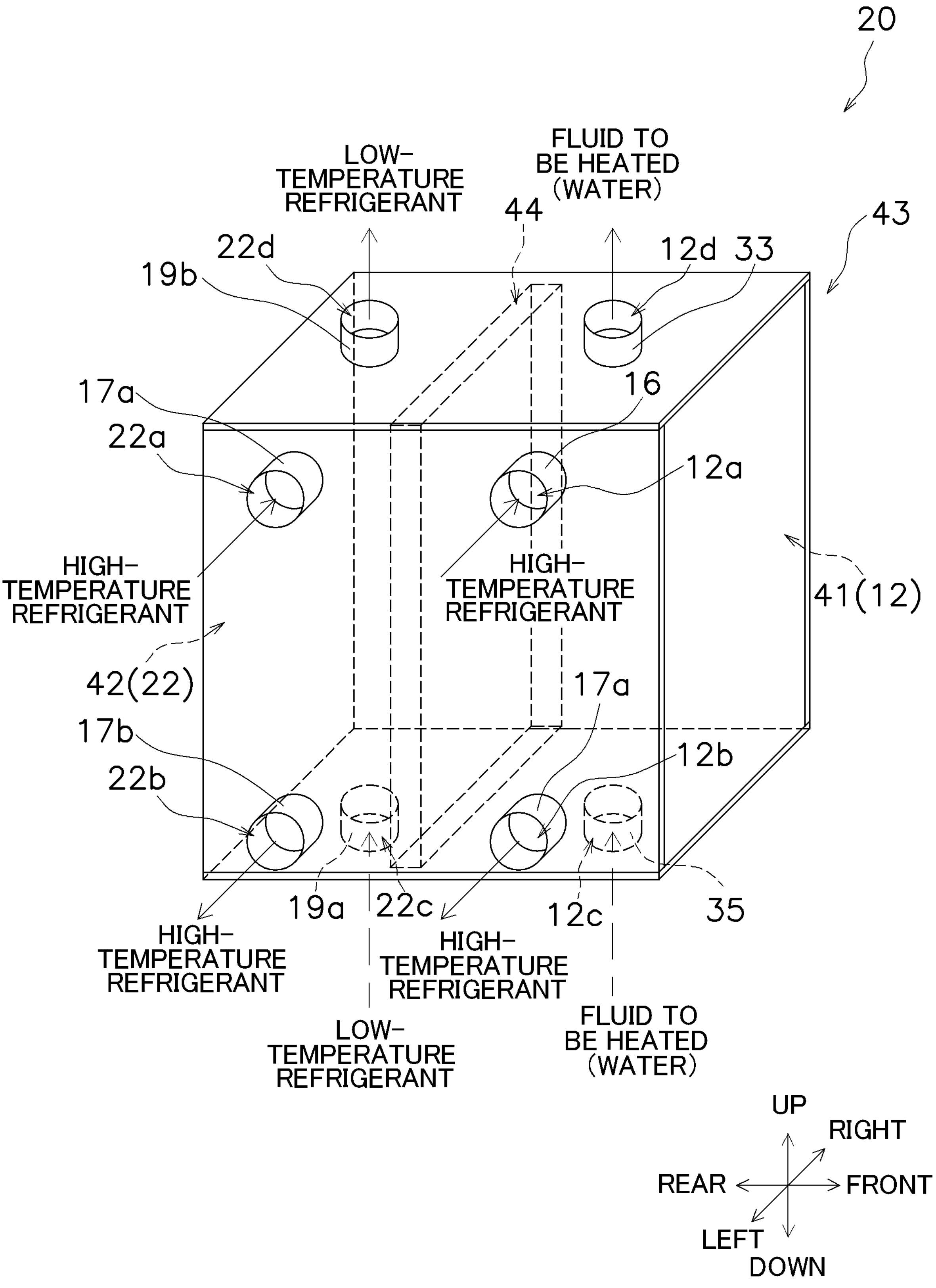
20
LOW-
TEMPERATURE
REFRIGERANT
FLUID TO
BE HEATED
(WATER)
44
43
22d
19b
12d
33
17a
16
22a
12a
HIGH-
TEMPERATURE
REFRIGERANT
HIGH-
TEMPERATURE
REFRIGERANT
41(12)
42(22)
17a
17b
12b
22b
19a
22c
12c
35
HIGH-
TEMPERATURE
REFRIGERANT
HIGH-
TEMPERATURE
REFRIGERANT
LOW-
TEMPERATURE
REFRIGERANT
FLUID TO
BE HEATED
(WATER)
UP
RIGHT
REAR
FRONT
LEFT
DOWN

FIG. 16

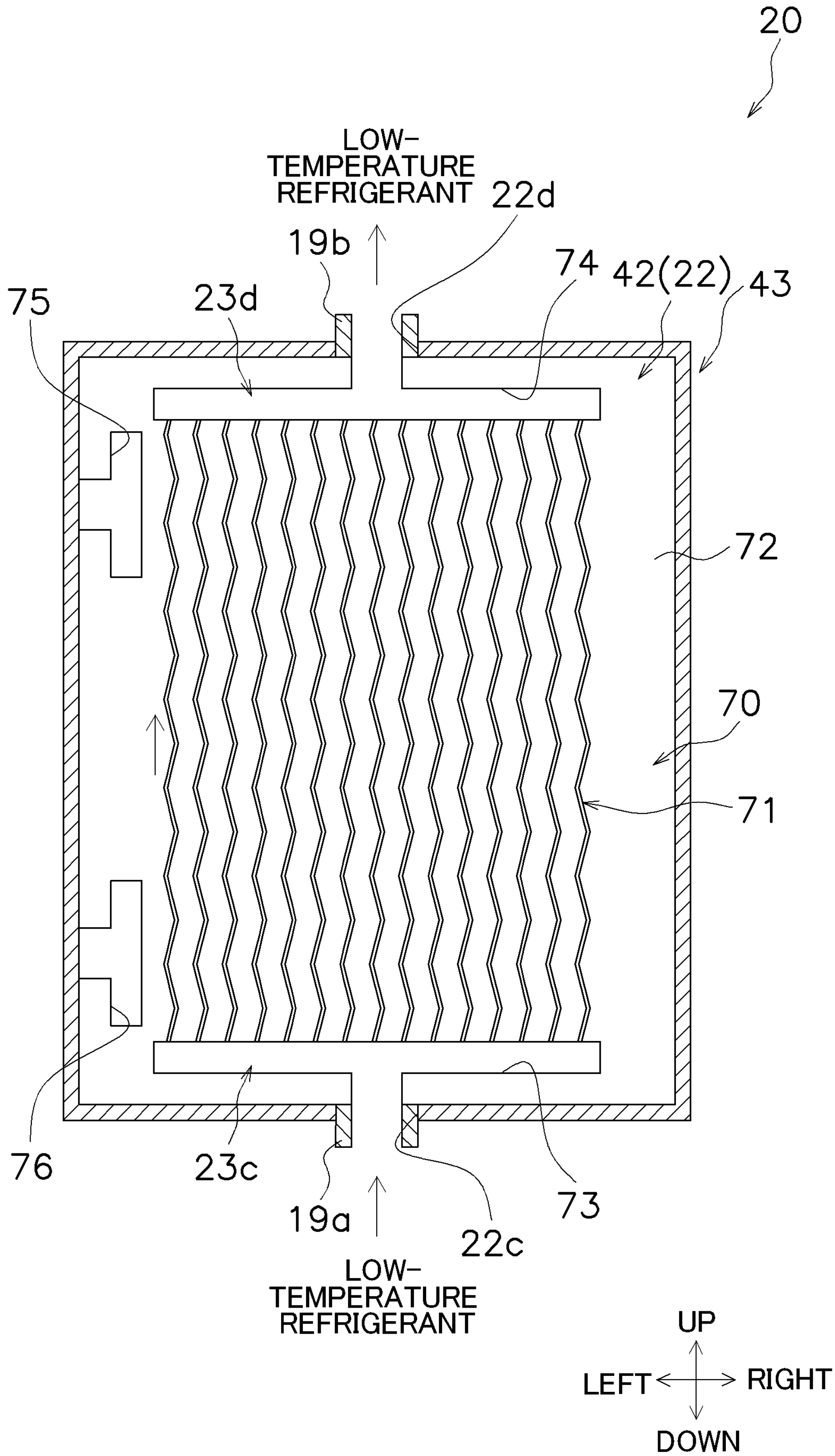
20
LOW-
TEMPERATURE
REFRIGERANT
22d
19b
74
42(22)
43
75
23d
72
70
71
76
23c
19a
22c
73
LOW-
TEMPERATURE
REFRIGERANT
UP
LEFT
RIGHT
DOWN

FIG. 17

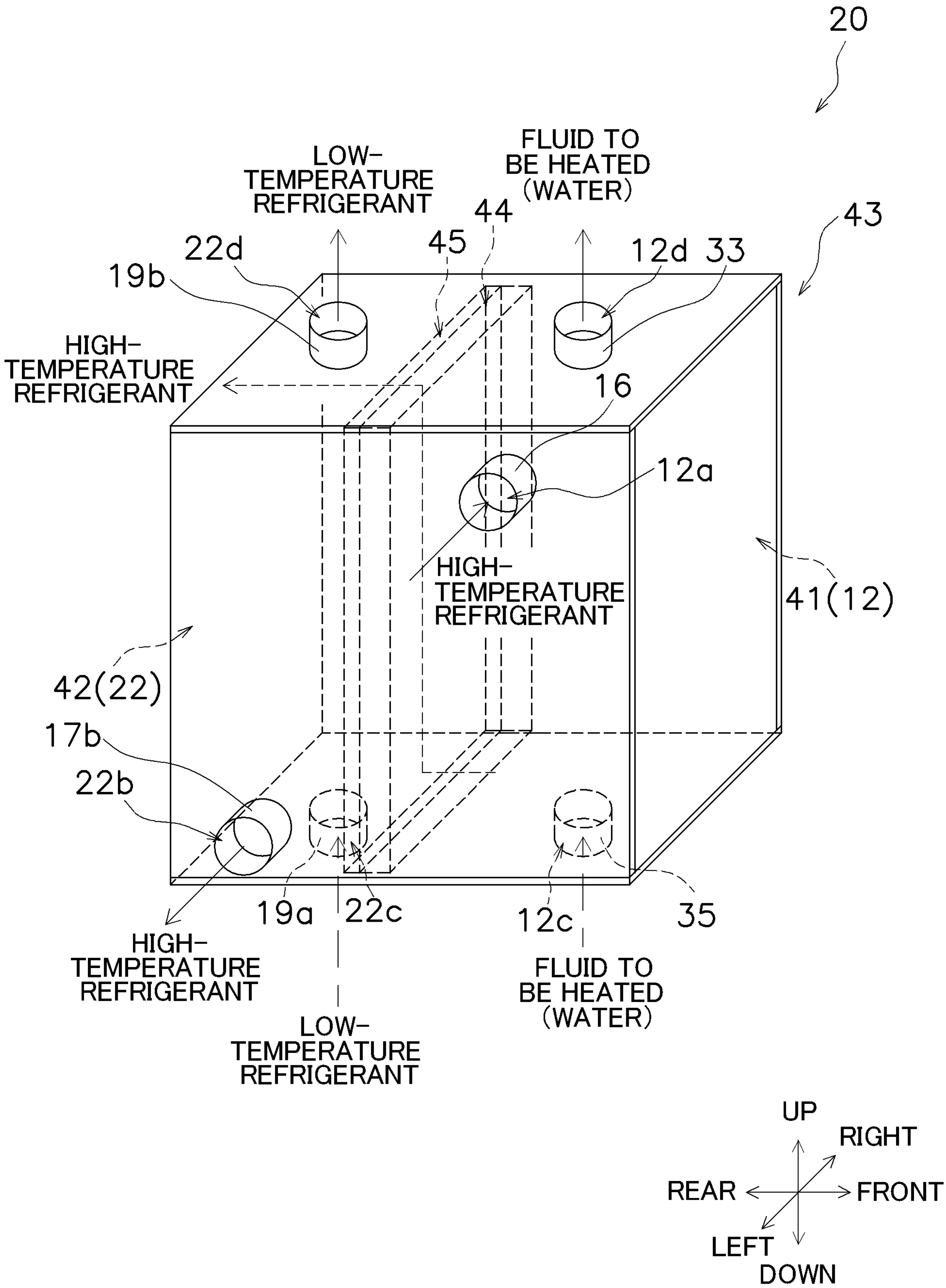
20
LOW-
TEMPERATURE
REFRIGERANT
FLUID TO
BE HEATED
(WATER)
44
43
45
22d
12d
33
19b
HIGH-
TEMPERATURE
REFRIGERANT
16
12a
HIGH-
TEMPERATURE
REFRIGERANT
41(12)
42(22)
17b
22b
19a
22c
12c
35
HIGH-
TEMPERATURE
REFRIGERANT
LOW-
TEMPERATURE
REFRIGERANT
FLUID TO
BE HEATED
(WATER)
UP
RIGHT
REAR
FRONT
LEFT
DOWN

FIG. 18

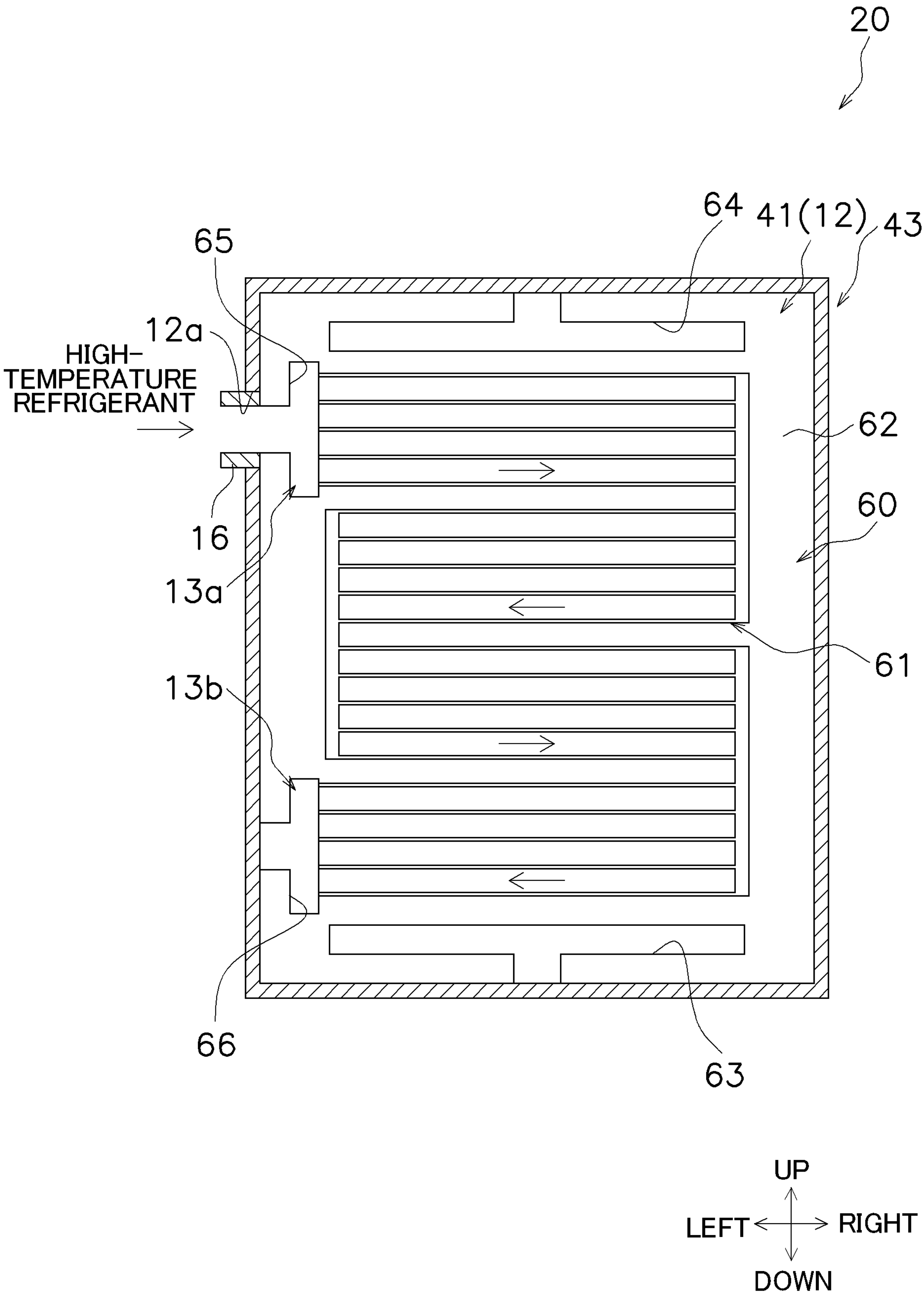
20
64
41(12)
43
65
12a
HIGH-
TEMPERATURE
REFRIGERANT
62
60
16
13a
61
13b
66
63
UP
LEFT
RIGHT
DOWN

FIG. 19

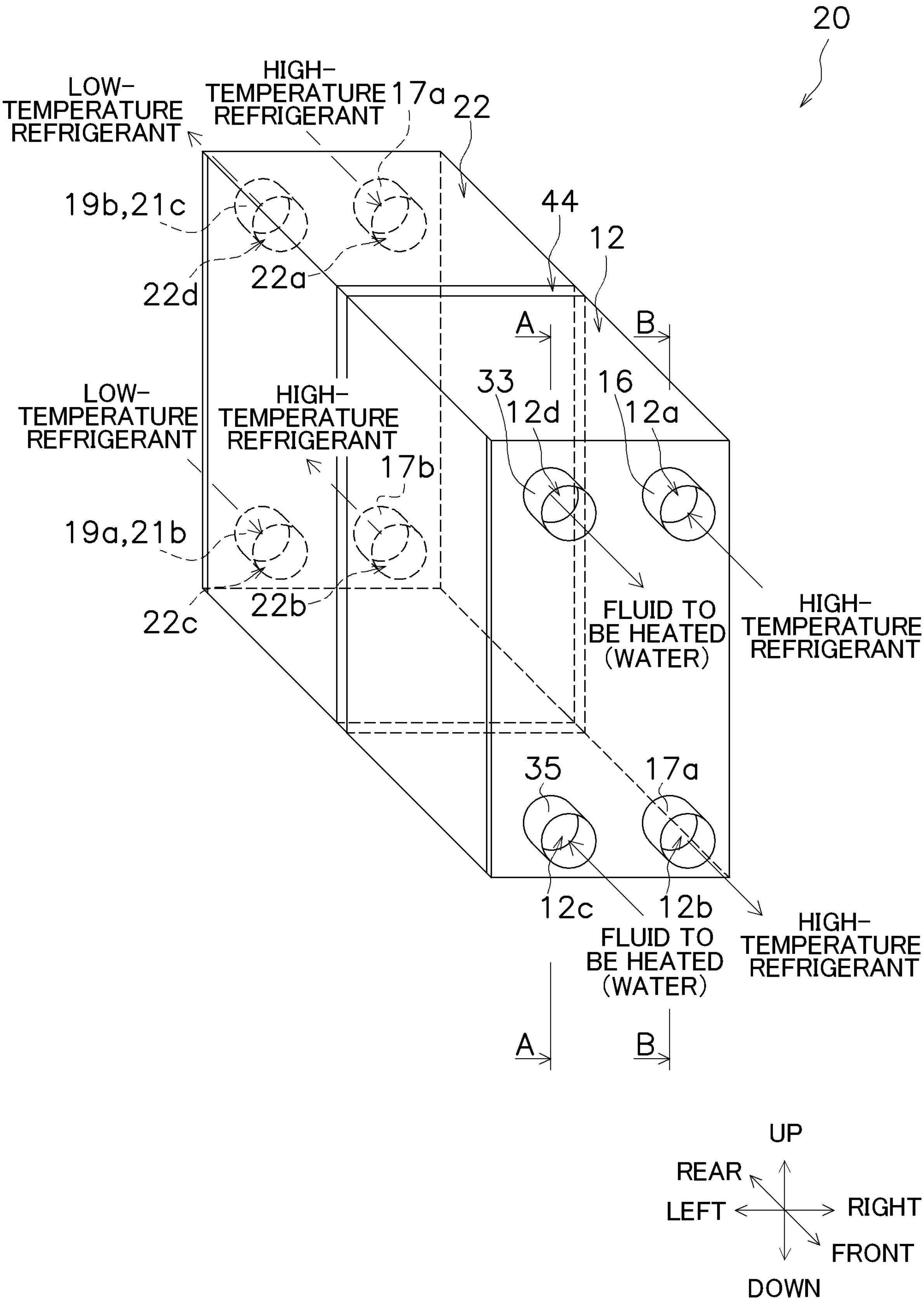
20
LOW-
TEMPERATURE
REFRIGERANT
HIGH-
TEMPERATURE
REFRIGERANT
17a
22
19b,21c
44
12
22a
22d
A
B
33
16
12d
12a
LOW-
TEMPERATURE
REFRIGERANT
HIGH-
TEMPERATURE
REFRIGERANT
17b
19a,21b
22b
22c
FLUID TO
BE HEATED
(WATER)
HIGH-
TEMPERATURE
REFRIGERANT
35
17a
12c
12b
FLUID TO
BE HEATED
(WATER)
HIGH-
TEMPERATURE
REFRIGERANT
A
B
UP
REAR
LEFT
RIGHT
FRONT
DOWN

FIG. 20

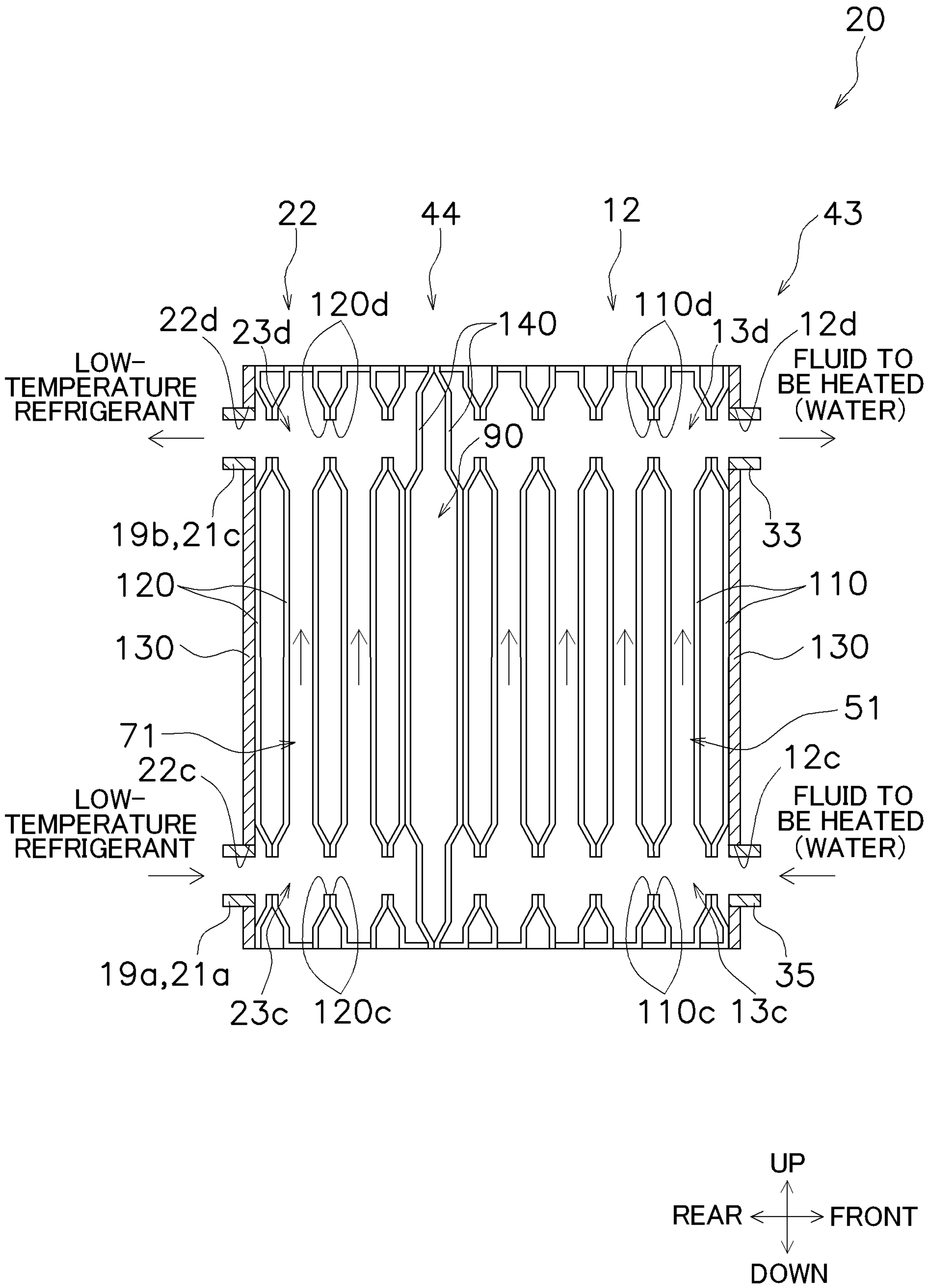
20
22
44
12
43
120d
110d
22d
23d
140
13d
12d
LOW-
TEMPERATURE
REFRIGERANT
FLUID TO
BE HEATED
(WATER)
90
19b,21c
33
120
110
130
130
71
51
22c
12c
LOW-
TEMPERATURE
REFRIGERANT
FLUID TO
BE HEATED
(WATER)
19a,21a
35
23c
120c
110c
13c
UP
REAR
FRONT
DOWN

FIG. 21

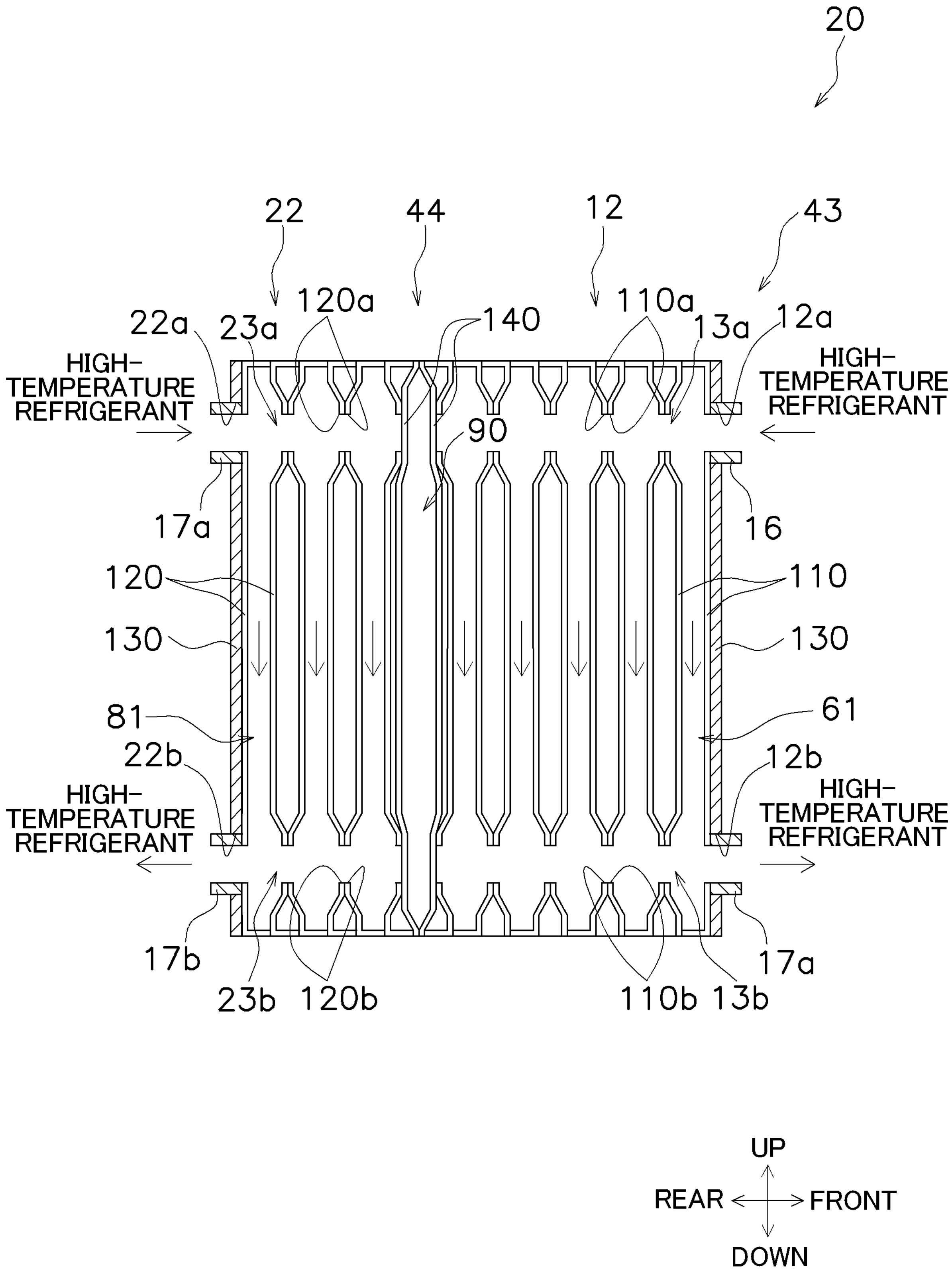
20
22
44
12
43
120a
110a
22a
23a
140
13a
12a
HIGH-TEMPERATURE REFRIGERANT
HIGH-TEMPERATURE REFRIGERANT
90
17a
16
120
110
130
130
81
61
22b
12b
HIGH-TEMPERATURE REFRIGERANT
HIGH-TEMPERATURE REFRIGERANT
17b
17a
23b
120b
110b
13b
UP
REAR
FRONT
DOWN

FIG. 22

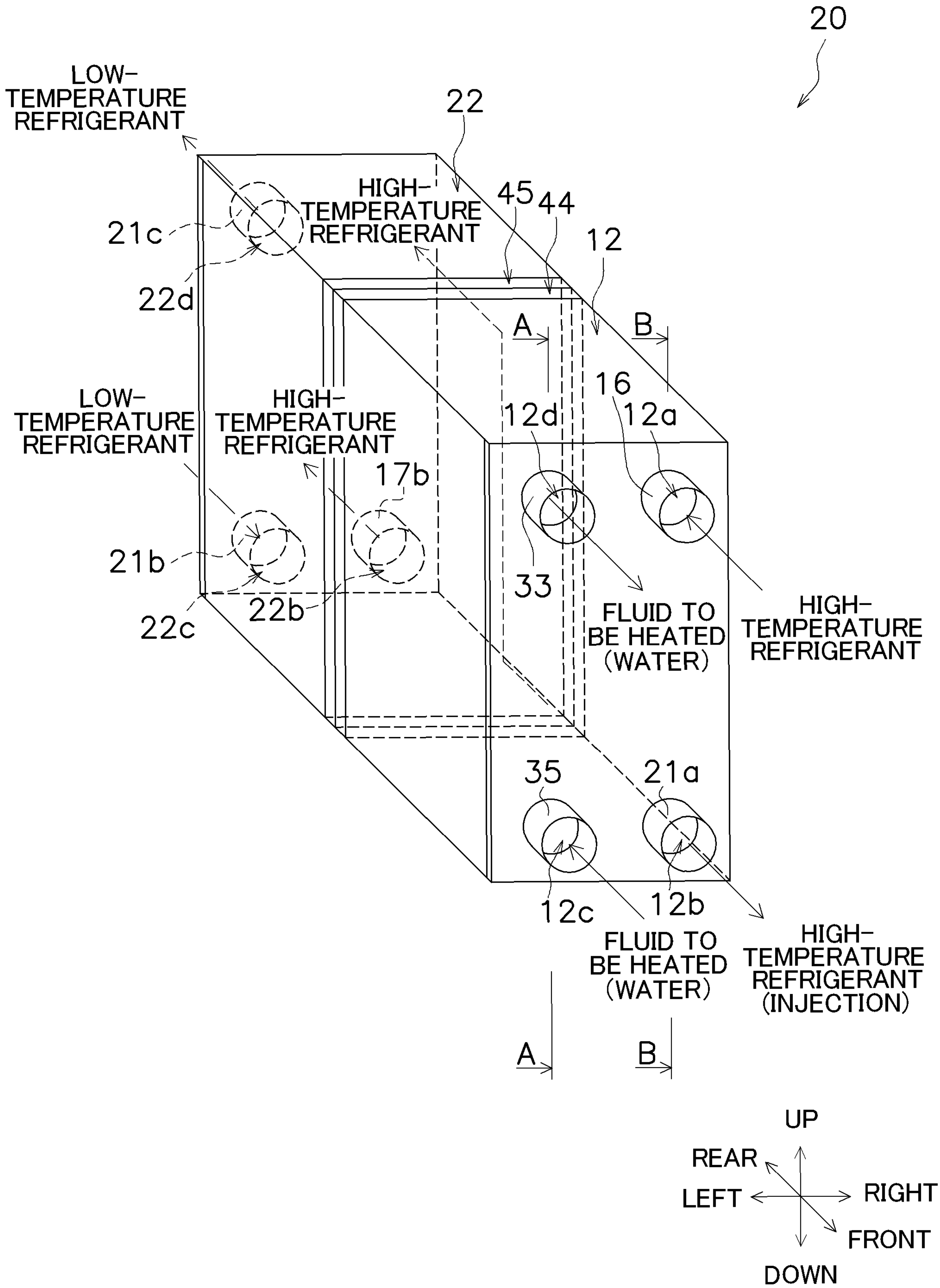
20
LOW-TEMPERATURE REFRIGERANT
22
HIGH-TEMPERATURE REFRIGERANT
45
44
12
21c
22d
A
B
16
12d
12a
LOW-TEMPERATURE REFRIGERANT
HIGH-TEMPERATURE REFRIGERANT
17b
21b
33
22c
22b
FLUID TO BE HEATED (WATER)
HIGH-TEMPERATURE REFRIGERANT
35
21a
12c
12b
FLUID TO BE HEATED (WATER)
HIGH-TEMPERATURE REFRIGERANT (INJECTION)
A
B
UP
REAR
LEFT
RIGHT
FRONT
DOWN

FIG. 23

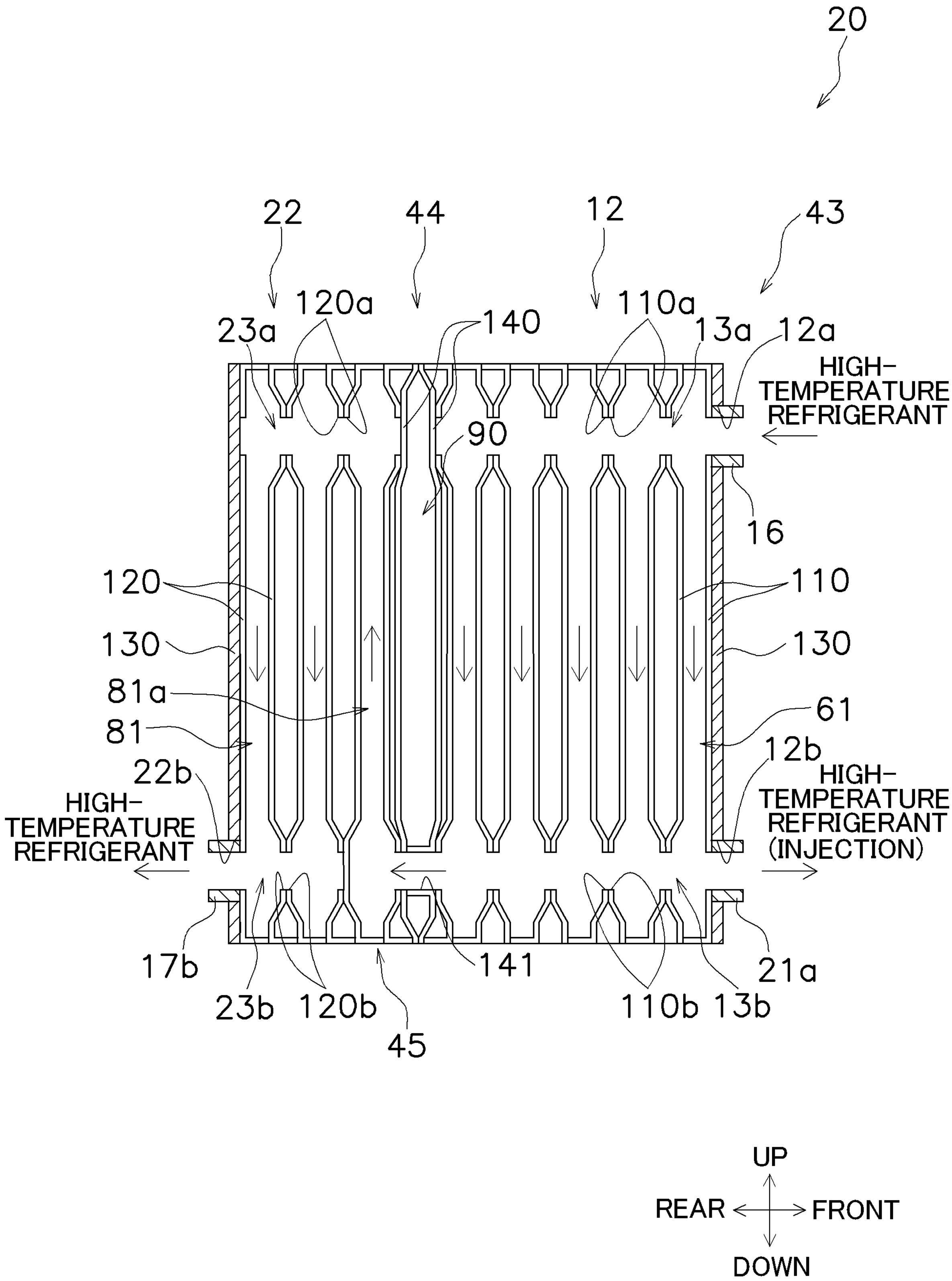
20
22
44
12
43
120a
140
110a
23a
13a
12a
HIGH-TEMPERATURE REFRIGERANT
90
16
120
110
130
130
81a
61
81
12b
22b
HIGH-TEMPERATURE REFRIGERANT
HIGH-TEMPERATURE REFRIGERANT
HIGH-TEMPERATURE REFRIGERANT (INJECTION)
17b
141
21a
23b
120b
110b
13b
45
UP
REAR
FRONT
DOWN

FIG. 24

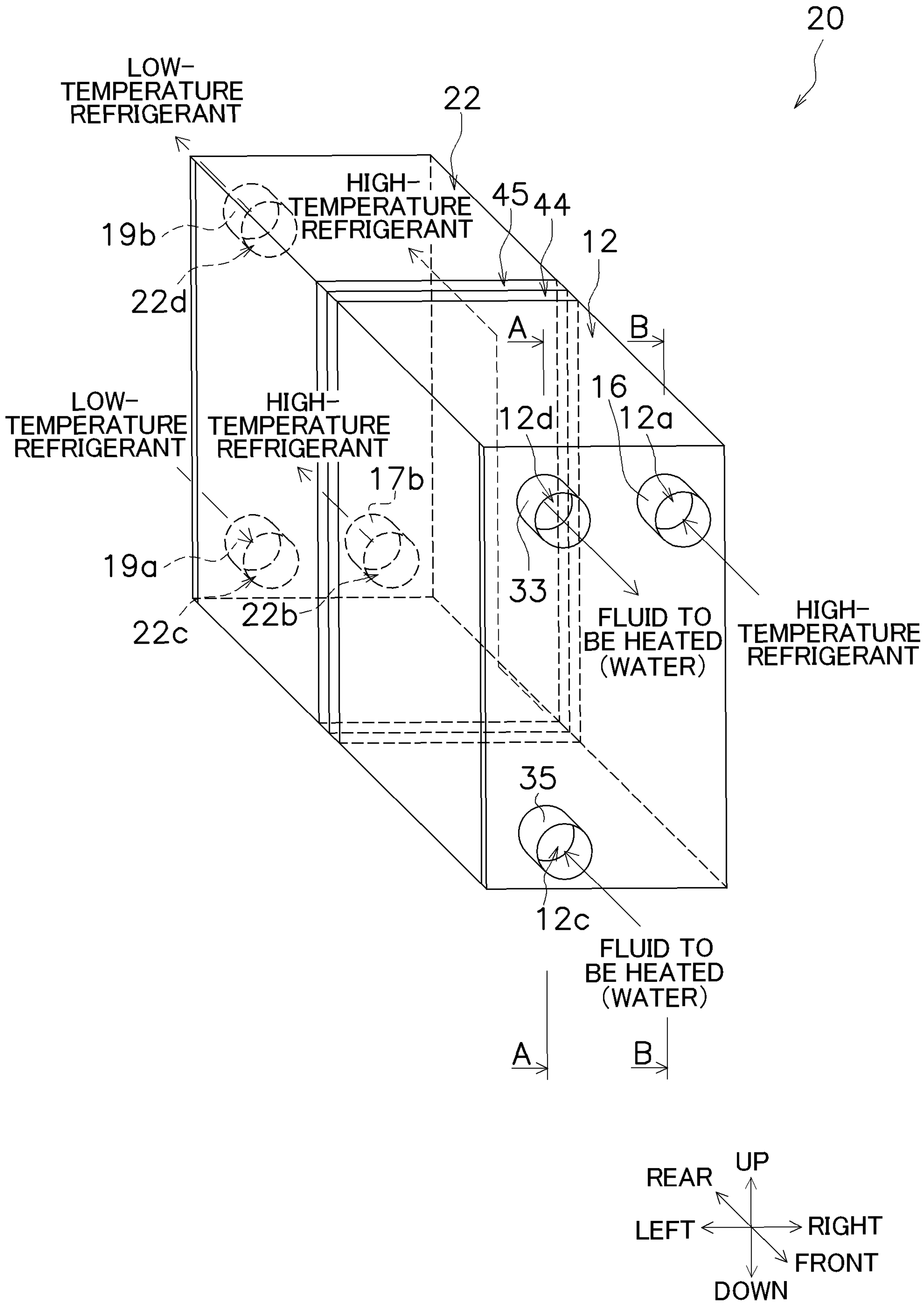
20
LOW-
TEMPERATURE
REFRIGERANT
22
HIGH-
TEMPERATURE
REFRIGERANT
45
44
12
19b
22d
A
B
16
12d
12a
LOW-
TEMPERATURE
REFRIGERANT
HIGH-
TEMPERATURE
REFRIGERANT
17b
19a
33
22c
22b
FLUID TO
BE HEATED
(WATER)
HIGH-
TEMPERATURE
REFRIGERANT
35
12c
FLUID TO
BE HEATED
(WATER)
A
B
REAR
UP
LEFT
RIGHT
FRONT
DOWN

FIG. 25

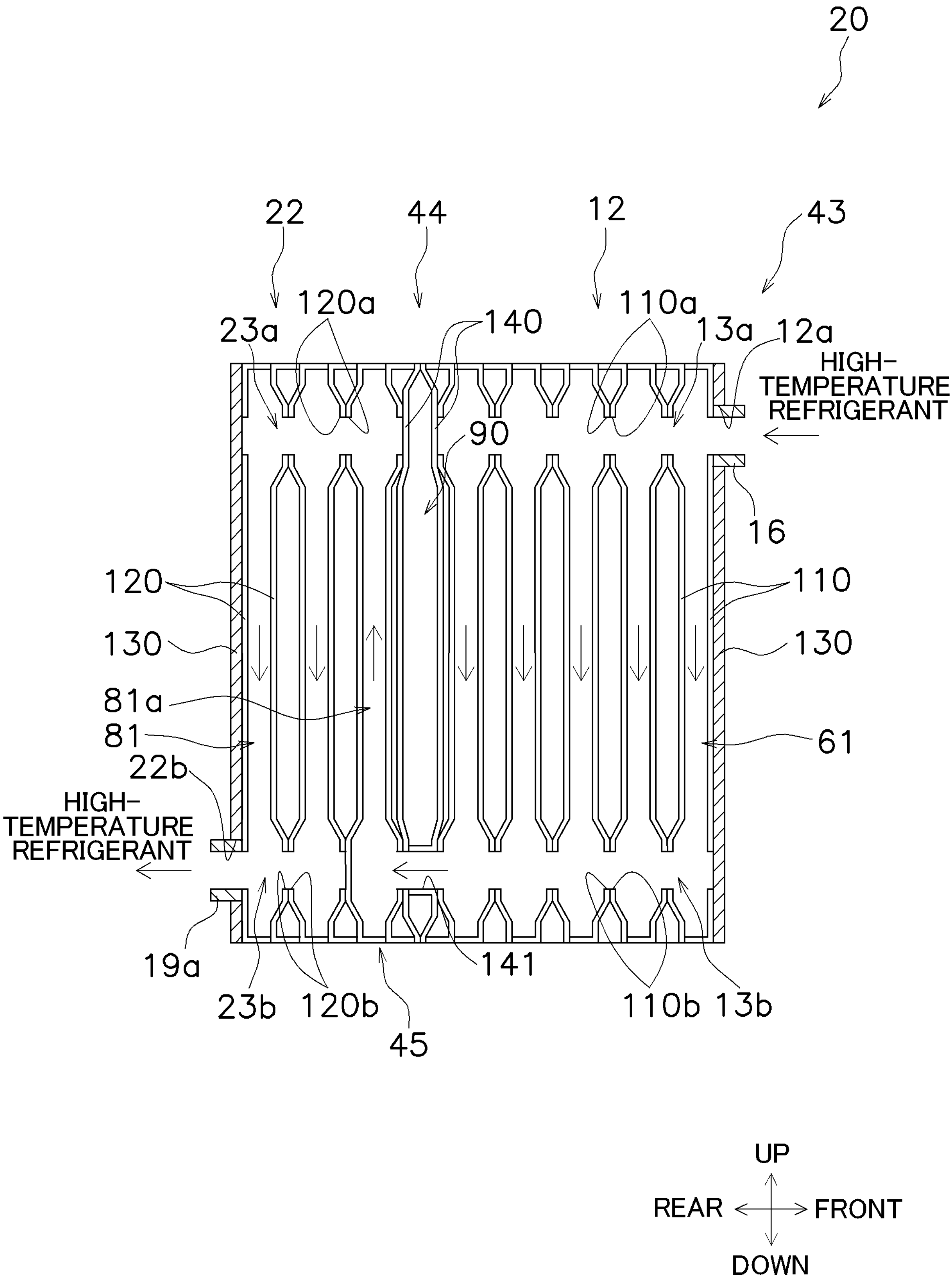
20
22
44
12
43
23a
120a
140
110a
13a
12a
HIGH-TEMPERATURE REFRIGERANT
90
16
120
110
130
130
81a
81
61
22b
HIGH-TEMPERATURE REFRIGERANT
19a
23b
120b
45
141
110b
13b
UP
REAR
FRONT
DOWN

FIG. 26

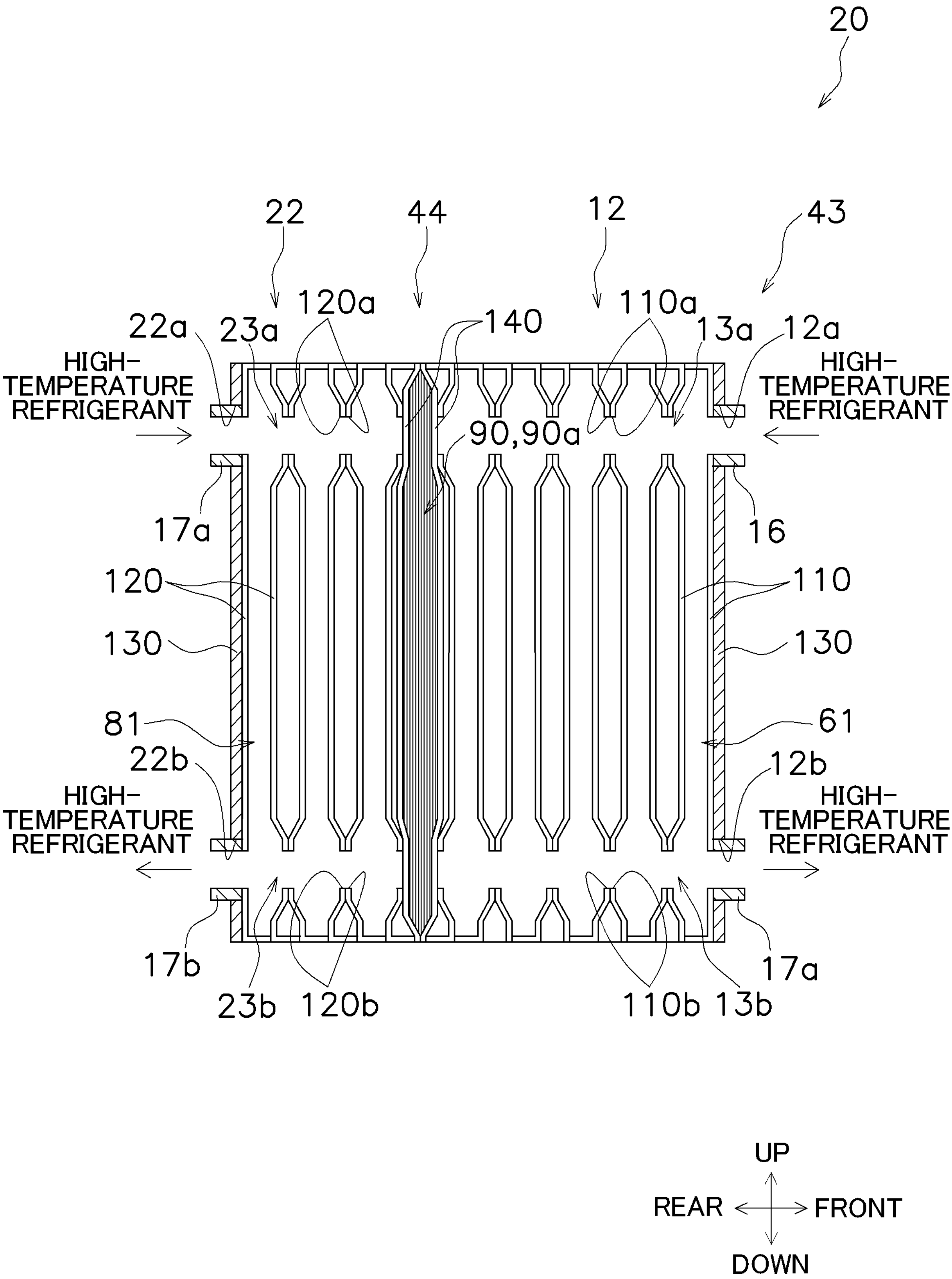
20
22
44
12
43
22a
23a
120a
140
110a
13a
12a
HIGH-TEMPERATURE REFRIGERANT
HIGH-TEMPERATURE REFRIGERANT
90,90a
17a
16
120
110
130
130
81
61
22b
12b
HIGH-TEMPERATURE REFRIGERANT
HIGH-TEMPERATURE REFRIGERANT
17b
17a
23b
120b
110b
13b
UP
REAR
FRONT
DOWN

FIG. 27

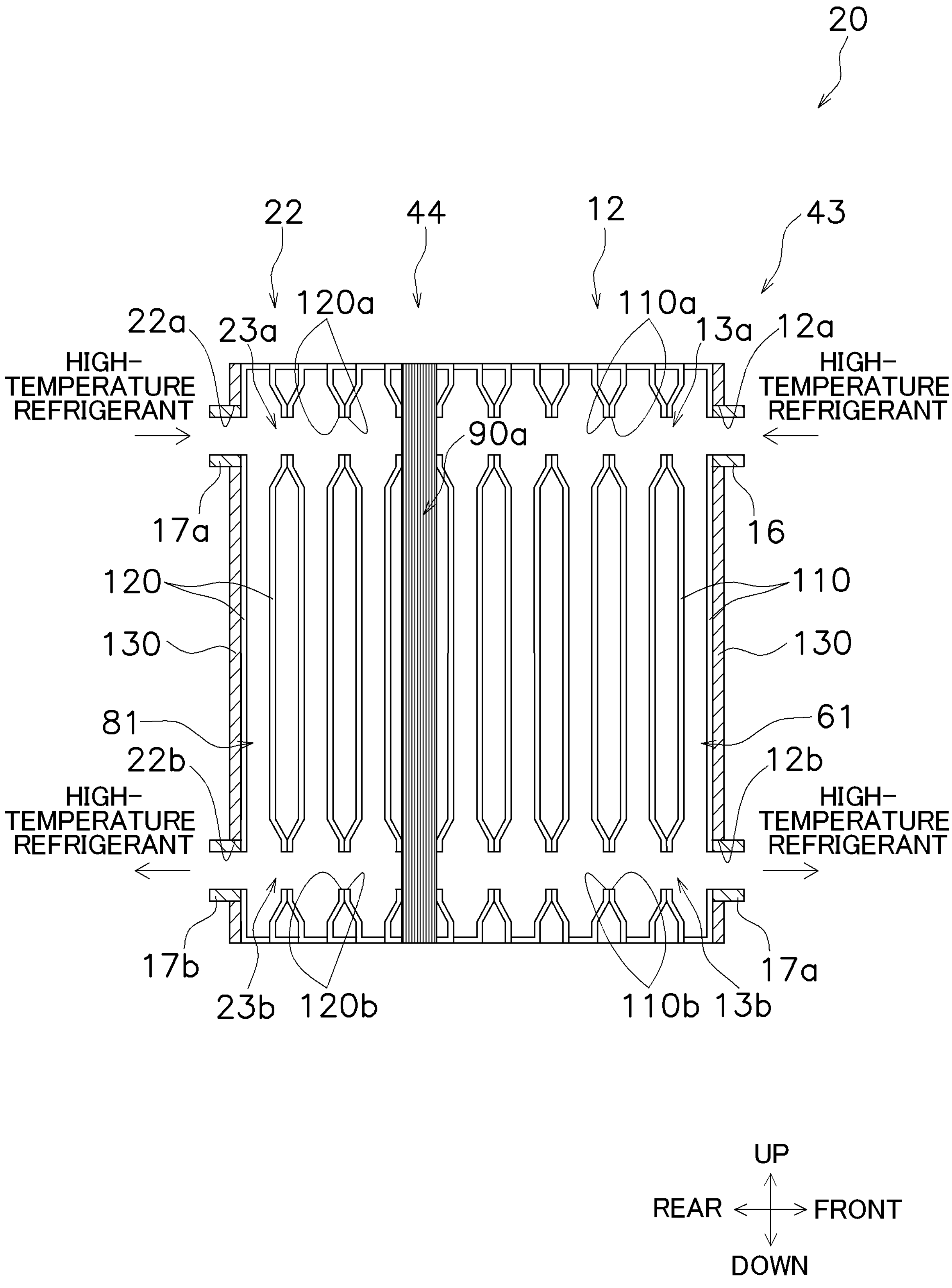
20
22
44
12
43
22a
23a
120a
110a
13a
12a
HIGH-
TEMPERATURE
REFRIGERANT
HIGH-
TEMPERATURE
REFRIGERANT
90a
17a
16
120
110
130
130
81
61
22b
12b
HIGH-
TEMPERATURE
REFRIGERANT
HIGH-
TEMPERATURE
REFRIGERANT
17b
17a
23b
120b
110b
13b
UP
REAR
FRONT
DOWN

FIG. 28

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/015135

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F25B1/00(2006.01)i, F25B30/02(2006.01)i, F25B40/02(2006.01)i

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)
Int.Cl. F25B1/00, F25B30/02, F25B40/02

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	1971-2019
Registered utility model specifications of Japan	1996-2019
Published registered utility model applications of Japan	1994-2019

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.
X Y	JP 2017-20680 A (CALSONIC KANSEI CORPORATION) 26 January 2017, paragraphs [0012]-[0043], fig. 1-7 (Family: none)	1, 3 2, 4-7
Y	JP 2008-111624 A (DAIKIN INDUSTRIES, LTD.) 15 May 2008, paragraph [0039], fig. 5 (Family: none)	2
Y	JP 2005-201536 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 28 July 2005, paragraph [0039], fig. 4 (Family: none)	4-7

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
"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
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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	Date of mailing of the international search report
24 June 2019 (24.06.2019)	02 July 2019 (02.07.2019)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/015135

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 62-212055 A (SHOWA ALUMINUM CORP.) 18 September 1987, page 2, upper left column, lines 3-5 (Family: none)	5-7
Y	JP 2015-158315 A (FUJITSU GENERAL LTD.) 03 September 2015, paragraphs [0014], [0017], fig. 1-2 (Family: none)	5-7
A	JP 2004-218983 A (JAPAN CLIMATE SYSTEMS CORPORATION) 05 August 2004, entire text, all drawings (Family: none)	1-7
A	JP 2017-9149 A (TOSHIBA CARRIER CORPORATION) 12 January 2017, entire text, all drawings (Family: none)	1-7
A	JP 2013-15233 A (DAIKIN INDUSTRIES, LTD.) 24 January 2013, entire text, all drawings (Family: none)	1-7

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Patent documents cited in the description

- EP 2952832 A **[0002] [0104]**