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(54) **HEAT SUPPLY APPARATUS**

(57) The present disclosure relates to a heat supply apparatus. The heat supply apparatus according to the present disclosure comprises: a compressor compressing refrigerant; a first heat exchanger being connected to the compressor through a refrigerant pipe and exchanging heat between refrigerant and water; and a second heat exchanger being connected to the compressor through a refrigerant pipe and exchanging heat between refrigerant and outdoor air, wherein the second heat exchanger includes a plurality of pipes through which refrigerant flows; and a valve adjusting the flow of refrigerant through the lowermost pipe of the plurality of pipes, and the valve allows refrigerant to flow only in a first direction that sequentially passes the compressor, the second heat exchanger, and the indoor heat exchanger.

Fig. 1

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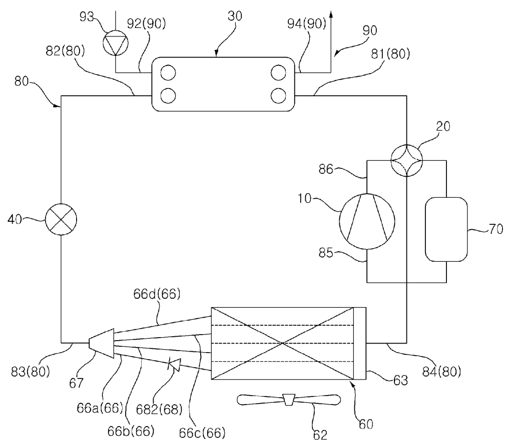

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Description

[0001] The present disclosure relates to a heat supply apparatus and more specifically, to a heat supply apparatus exchanging heat between water and refrigerant for heating an indoor space.

[0002] A heating system including a gas boiler supplies a heat source heated by the gas boiler to a load such as underfloor heating or a hot water tank through pipes. The pipes connecting the gas boiler and the load may be disposed buried within the building.

[0003] However, European countries are replacing gas boilers with heat supply apparatuses that utilize heat exchange between water and refrigerant to reduce carbon emissions and minimize the use of refrigerant.

[0004] The 'heat pump' disclosed in the Korean patent laid-open publication No. 10-2022-0001156 comprises a compressor; a four-way valve; a first heat exchanger in which water and refrigerant exchange heat; a second heat exchanger in which outdoor air and refrigerant exchange heat; and an expansion valve disposed between the first heat exchanger and the second heat exchanger.

[0005] A conventional heat pump has a problem in that frost is formed in the outdoor unit during winter because low-temperature refrigerant passes through the second heat exchanger located outside during heating operation.

[0006] Also, as frost accumulates on the surface of the outdoor unit, the heating efficiency of the heat pump decreases.

[0007] Also, since defrosting operation to remove ice generated in the outdoor unit requires significant time and electrical power, the heating efficiency of the heat pump is reduced.

[0008] Korean patent laid-open publication No. 10-2022-0001156 (publication date: 2022. 01. 05)

[0009] An object of the present disclosure is to provide a heat supply apparatus with improved heat exchange performance.

[0010] Another object of the present disclosure is to provide a heat supply apparatus with improved defrosting performance.

[0011] Yet another object of the present disclosure is to provide a heat supply apparatus with reduced frost accumulation.

[0012] Still another object of the present disclosure is to provide a heat supply apparatus that extends the time before freezing occurs during heating operation.

[0013] Yet still another object of the present disclosure is to provide a heat supply apparatus with improved frosting resistance at the lowermost part of the outdoor unit.

[0014] The technical effects of the present disclosure are not limited to the technical effects described above, and other technical effects not mentioned herein may be understood to those skilled in the art to which the present disclosure belongs from the description below.

[0015] The invention is specified by the independent claim. Preferred embodiments are defined in the dependent claims. According to one aspect of the present disclosure to achieve the object above, a heat supply apparatus may comprise a compressor compressing refrigerant; a first heat exchanger being connected to the compressor through a refrigerant pipe and exchanging heat between refrigerant and water; and a second heat exchanger being connected to the compressor through a refrigerant pipe and exchanging heat between refrigerant and outdoor air, wherein the second heat exchanger includes a plurality of pipes through which refrigerant flows and a valve adjusting the flow of refrigerant through a first pipe located at the lowest position among the plurality of pipes, and the valve allows the refrigerant to flow only in a first direction that sequentially passes the compressor, the second heat exchanger, and the indoor heat exchanger, thereby controlling the refrigerant to flow through the lowermost path during heating operation.

[0016] The valve is a check valve that allows the refrigerant to flow in the first direction and blocks the flow in a second direction, which is opposite to the first direction, controlling the refrigerant to flow in only one direction.

[0017] The second heat exchanger includes a plurality of distribution pipes, each of which is connected to the plurality of pipes, and a distributor that combines the plurality of distribution pipes, wherein the valve may be disposed in a first distribution pipe located at the lowest position among the plurality of distribution pipes and may control the flow of refrigerant flowing through the lowermost path.

[0018] The second heat exchanger includes a plurality of distribution pipes, each of which is connected to one end of the plurality of pipes; a distributor that combines the plurality of distribution pipes, a plurality of connection pipes, each of which is connected to the other end of the plurality of pipes; and a header that combines the plurality of connection pipes, wherein the valve, being disposed in a first connection pipe located at the lowest position among the plurality of connection pipes, may control the flow of refrigerant flowing through the lowermost path.

[0019] The heat supply apparatus further comprises a controller that controls the flow of refrigerant, wherein the valve may be a solenoid valve that is opened or closed according to an electrical signal received from the controller.

[0020] The controller may disable refrigerant to flow through the lowermost path during heating operation by closing the solenoid valve during the heating operation and opening the solenoid valve during defrosting operation.

[0021] The first pipe includes a first pipe inlet tube through which refrigerant discharged from the compressor flows in; and a first pipe outlet tube through which refrigerant flowing into the first pipe inlet tube flows out, wherein the first pipe inlet tube may be separated outward from the first pipe outlet tube, and high-temperature refrigerant discharged from the compressor may flow from the outer side to the inside.

[0022] The first pipe inlet tube is located on the outermost side of the plurality of pipes, and high-temperature refrigerant discharged from the compressor may thaw ice formed on the outermost side.

[0023] The first pipe outlet tube is located on the innermost side of the plurality of pipes, and refrigerant at relatively low-temperature may flow, being separated from the outermost side.

[0024] The first pipe inlet tube is located below the first pipe outlet tube, and high-temperature refrigerant discharged from the compressor may flow upward gradually from the bottom.

[0025] The first pipe outlet tube is located at the bottom of the first pipe, and the first pipe inlet tube is located at the top of the first pipe, wherein refrigerant at a relatively high-temperature may flow to the lowermost part where freezing occurs, and refrigerant at a relatively high temperature may flow to the uppermost part separated from the lowermost part where freezing occurs.

[0026] The plurality of pipes includes a plurality of second pipes excluding the first pipe, wherein each of the plurality of second pipes includes a second pipe inlet tube through which refrigerant discharged from the compressor flows in; and a second pipe outlet tube through which refrigerant flows out to the first heat exchanger, wherein the second pipe inlet tube is spaced inward from the second pipe outlet tube, and during heating operation, low-temperature refrigerant may flow from the outermost side, which is directly affected from cold weather, to the inside.

[0027] The plurality of pipes includes a plurality of second pipes excluding the first pipe.

[0028] The length of a refrigerant flow path of the first pipe is shorter than the length of a refrigerant flow path of the plurality of second pipes, thereby reducing the variation in cooling and heating performance due to opening and closing of the lowermost pipe.

[0029] Specifics of other embodiments are provided in the detailed descriptions and drawings below.

[0030] According to at least one of the embodiments of the present disclosure, a valve disposed on the lowermost pipe among a plurality of pipes of a second heat exchanger enables refrigerant to flow during cooling or defrosting operation and prevents the refrigerant from flowing during heating operation, thereby reducing the frost accumulation occurring in the lowermost part of an outdoor unit. Through the process above, the time for defrosting may be reduced, thereby improving defrosting performance. Also, heating performance may be improved since the time required for defrosting is reduced.

[0031] According to at least one of the embodiments of the present disclosure, a check valve is disposed on the lowermost pipe among a plurality of pipes of the second heat exchanger, thereby controlling refrigerant flow through the lowermost path without involving separate control or a separate pipe. Through the process above, manufacturing and management efficiency of outdoor units may be improved.

[0032] According to at least one of the embodiments of the present disclosure, the lowermost inlet tube through which high-temperature refrigerant flows in during the defrosting operation is disposed on the outermost side, thereby quickly removing ice formed on the surface of the outdoor unit during the heating operation.

[0033] According to at least one of the embodiments of the present disclosure, during the defrosting operation, the lowermost inlet tube through which refrigerant at a relatively high-temperature flows in is disposed on the outermost side, and the lowermost outlet tube through which refrigerant at a relatively low-temperature flows out is disposed on the lowermost side, thereby reducing the effect of low-temperature refrigerant on reducing the defrosting performance.

[0034] According to at least one of the embodiments of the present disclosure, during the defrosting operation, the lowermost inlet tube through which high-temperature refrigerant flows in is disposed, thereby quickly removing ice concentrated on a lower part of the outdoor unit during the heating operation.

[0035] According to at least one of the embodiments of the present disclosure, during the defrosting operation, the lowermost outlet tube through which refrigerant at a relatively low-temperature flows out is disposed at the top of the lowermost tube, thereby minimizing the effect of low-temperature refrigerant on the defrosting of ice concentrated on a lower part of the outdoor unit.

[0036] According to at least one of the embodiments of the present disclosure, an inlet tube of the remaining pipes other than the lowermost pipe among a plurality of pipes is separated inward from an outlet tube, thereby reducing frost accumulation on the surface of the outdoor unit due to the inlet tube through which low-temperature refrigerant flows during the heating operation.

[0037] According to at least one of the embodiments of the present disclosure, the length of the frost flow path of the lowermost pipe is formed to be shorter than the length of the refrigerant flow path of the remaining pipes other than the lowermost pipe, thereby reducing the variation in cooling and heating performance due to opening and closing of the lowermost pipe. Also, the effect of opening and closing of the lowermost pipe on the cooling performance may be reduced.

[0038] The technical effects of the present disclosure are not limited to the technical effects described above, and other technical effects not mentioned herein may be understood to those skilled in the art to which the present disclosure belongs from the description below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039]

FIG. 1 illustrates a cycle of the outdoor unit side of a heat supply apparatus according to one embodiment of the present disclosure.

FIG. 2 is a schematic diagram of an outdoorunit of a heat supply apparatus according to one embodiment of the present disclosure.

FIG. 3 illustrates the heating operation cycle of a heat supply apparatus according to one embodiment of the present disclosure.

FIG. 4 illustrates the refrigerant flow during the heating operation of the outdoor unit of a heat supply apparatus according to one embodiment of the present disclosure.

FIG. 5 illustrates the cooling operation or defrosting operation cycle of a heat supply apparatus according to one embodiment of the present disclosure.

FIG. 6 illustrates the outdoor unit cycle of a heat supply apparatus according to another embodiment of the present disclosure.

FIG. 7 illustrates the outdoor unit cycle of a heat supply apparatus according to another embodiment of the present disclosure.

FIG. 8 is a schematic diagram of the outdoor unit of a heat supply apparatus according to another embodiment of the present disclosure.

FIG. 9 is a schematic diagram of the outdoor unit of a heat supply apparatus according to another embodiment of the present disclosure.

DETAILED DESCRIPTION

[0040] In the following, embodiments disclosed in this document will be described in detail with reference to appended drawings. The same or similar constituting elements are given the same reference number irrespective of their drawing symbols, and repeated descriptions thereof will be omitted.

[0041] The suffixes "module" and "unit" for the constituting elements used in the following descriptions are assigned or used interchangeably only for the convenience of writing the present document and do not have separate meanings or roles distinguished from each other.

[0042] Also, it should be understood that the appended drawings are intended only to help understand embodiments disclosed in the present document and do not limit the technical principles and scope of the present disclosure.

[0043] Also, terms including an ordinal number such as first or second may be used to describe various constituting elements of the present disclosure, but the constituting elements should not be limited by these terms. Those terms are used only for the purpose of distinguishing one constituting element from the others.

[0044] If a constituting element is said to be "connected" or "attached" to other constituting element, the former may be connected or attached directly to the other constituting element, but there may be a case in which another constituting element is present between the two constituting elements. On the other hand, if a constituting element is said to be "directly connected" or "directly attached" to other constituting element, it should be understood that there is no other constituting element between the two constituting elements.

[0045] A singular expression should be understood to indicate a plural expression unless otherwise explicitly stated.

[0046] In the present disclosure, the term "include" or "have" is used to indicate existence of an embodied feature, number, step, operation, constituting element, component, or a combination thereof; and should not be understood to preclude the existence or possibility of adding one or more other features, numbers, steps, operations, constituting elements, components, or a combination thereof.

[0047] The direction indications of up (U), down (D), left (Le), right (Ri), front (F), and rear (R) shown in the accompanying drawings are introduced only for the convenience of description, and it should be understood that the technical principles disclosed in the present disclosure are not limited by the indications.

[0048] Referring to FIG. 1, the heat supply apparatus 1 may comprise a compressor 10 compressing refrigerant, a first heat exchanger 30 exchanging heat between refrigerant and water, a second heat exchanger 60 exchanging heat between refrigerant and outdoor air, and an expansion device 40 disposed between the first heat exchanger 30 and the second heat exchanger 60.

<AWHP>

[0049] The heat supply apparatus 1 may be an Air to Water Heat Pump (AWHP) that exchanges heat between water and refrigerant. The AWHP may warm up the indoor space or supply hot water by using the heat energy from the outdoor air to warm up the water circulating the indoor space. The AWHP may be mainly used for heating and hot water supply in cold regions. Conversely, AWHP may transfer the heat energy in the indoor space to the refrigerant circulating the outdoor unit through water circulating in the indoor space, and the refrigerant may discharge the heat energy transferred from the indoor space to the outdoor space. Through the above process, AWHP may also cool down indoor spaces or supply cold water.

[0050] The compressor 10, the first heat exchanger 30, the second heat exchanger 60, and the expansion device 40 may constitute an outdoor unit. The water pipe 90 through which water circulating in the indoor space flows may be connected to the first heat exchanger 30. The water pipe 90 may include an inlet pipe 92 through which water flows into the first heat exchanger 30 and an outlet pipe 94 through which water is discharged from the first heat exchanger 30. Both the water inlet pipe 92 and the water outlet pipe 94 may be connected to the first heat exchanger 30. The pump 93 that introduces water into the first heat exchanger 30 may be disposed in the water inlet pipe 92. The water circulating the water pipe 90 may exchange heat with the refrigerant circulating the refrigerant pipe 80 in the first heat exchanger 30. Through the above process, the heat supply apparatus 1 may warm up or cool down the indoor space.

<Refrigerant pipe>

[0051] The heat supply apparatus 1 may include a refrigerant pipe 80 connecting the compressor 10, the first heat exchanger 30, and the second heat exchanger 60. The refrigerant pipe 80 may form a closed circuit. The refrigerant discharged from the compressor 10 may circulate through the refrigerant pipe 80.

[0052] The refrigerant pipe 80 may include a first refrigerant pipe 81 connected to the first heat exchanger 30, a second refrigerant pipe 82 connecting the first heat exchanger 30 and the expansion device 40, a third refrigerant pipe 83 connecting the expansion device 40 and the second heat exchanger 60, and a fourth refrigerant pipe 84 connected to the second heat exchanger 60. The first refrigerant pipe 81 may be located between the compressor 10 and the first heat exchanger 30. The fourth refrigerant pipe 84 may be located between the compressor 10 and the second heat exchanger 60.

[0053] The heat supply apparatus 1 may include a four-way valve 20 located between the compressor 10 and the first heat exchanger 30. The four-way valve 20 may be located between the compressor 10 and the second heat exchanger 60. The four-way valve 20 may switch the refrigerant pipe 80 depending on the operation mode. In other words, the four-way valve 20 may connect the compressor 10 and the first heat exchanger 30 during the heating operation and connect the compressor 10 and the second heat exchanger 60 during the cooling operation. For example, during the heating operation, the refrigerant discharged from the compressor 10 may flow to the first heat exchanger 30 through the four-way valve 20, and during the cooling operation, the refrigerant discharged from the compressor 10 may flow to the second heat exchanger 60 through the four-way valve 20.

[0054] The first refrigerant pipe 81 may connect the first heat exchanger 30 and the four-way valve 20. The fourth refrigerant pipe 84 may connect the second heat exchanger 60 and the four-way valve 20.

[0055] The refrigerant pipe 80 may include an inlet pipe 85 through which the refrigerant flowing into the compressor 10 flows. The inlet pipe 85 may be connected to the inlet side of the compressor 10. The inlet pipe 85 may connect the compressor 10 and the four-way valve 20.

[0056] The compressor 10 may be connected to the four-way valve 20. The refrigerant pipe 80 may include an outlet pipe 86 through which the refrigerant discharged from the compressor 10 flows. The outlet pipe 86 may be connected to the outlet side of the compressor 10. The outlet pipe 86 may connect the compressor 10 and the four-way valve 20.

[0057] The heat supply apparatus 1 may include an accumulator 70 located between the four-way valve 20 and the compressor 10. The accumulator 70 may be located in the inlet pipe 85. The accumulator 70 may be located upstream of the compressor 10 in the refrigerant flow path.

[0058] During the heating operation, the outlet pipe 86 may be connected to the first refrigerant pipe 81 through the four-way valve 20, and the inlet pipe 85 may be connected to the fourth refrigerant pipe 84 through the four-way valve 20. Through the above process, the refrigerant discharged from the compressor 10 may flow to the first heat exchanger 30. During the cooling operation, the outlet pipe 86 may be connected to the fourth refrigerant pipe 84 through the four-way valve 20, and the inlet pipe 85 may be connected to the first refrigerant pipe 81 through the four-way valve 20. Through the above process, the refrigerant discharged from the compressor 10 may flow to the second heat exchanger 60.

<Water-refrigerant heat exchanger>

[0059] The first heat exchanger 30 may be a water-refrigerant heat exchanger 30 that exchanges heat between water and refrigerant. For example, the first heat exchanger 30 may be a plate-type heat exchanger through which water and refrigerant flow separately. Water circulating in the indoor space may pass through the first heat exchanger 30. The refrigerant circulating in the outdoor unit may pass through the first heat exchanger 30. The refrigerant may circulate in the outdoor unit and exchange heat with outdoor air in the second heat exchanger 60 and exchange heat with water in the first heat exchanger 30. Through the above process, the water circulating in the indoor space may be heated or cooled. During the heating operation, the heat supply apparatus 1 may heat water passing through the first heat exchanger 30 to warm up the indoor space or supply hot water. During the cooling operation, the heat supply apparatus 1 may cool the water passing through the first heat exchanger 30 to cool down the indoor space or supply cold water. Water and refrigerant passing through the first heat exchanger 30 may flow in opposite directions. In other words, water and refrigerant may form countercurrents.

[0060] During the heating operation, the refrigerant discharged from the compressor 10 may be directed to the first heat exchanger 30. At this time, the first heat exchanger 30 may function as a condenser. The refrigerant that has passed through the first heat exchanger 30 may sequentially flow through the expansion device 40 and the second heat exchanger 60.

[0061] During the cooling operation, the refrigerant discharged from the second heat exchanger 60 may be directed to the first heat exchanger 30. At this time, the first heat exchanger 30 may function as an evaporator.

<Air-refrigerant heat exchanger>

[0062] The second heat exchanger 60 may be an air-refrigerant heat exchanger 60 that exchanges heat between air and refrigerant. For example, the second heat exchanger 60 may be a fin-tube heat exchanger including tubes and fins through which refrigerant flows. Since the first heat exchanger 30 and the second heat exchanger 60 constitute an outdoor unit, the second heat exchanger 60 may exchange heat between outdoor air and refrigerant.

[0063] During the heating operation, the refrigerant discharged from the first heat exchanger 30 may be directed to the second heat exchanger 60. At this time, the second heat exchanger 60 may function as an evaporator.

[0064] During the cooling operation, the refrigerant discharged from the compressor 10 may be directed to the second heat exchanger 60. At this time, the second heat exchanger 60 may function as a condenser.

[0065] The second heat exchanger 60 may include a plurality of pipes (see FIG. 2, 65) through which the refrigerant flows. The refrigerant flowing into the second heat exchanger 60 may flow through each of the plurality of pipes 65. The plurality of pipes includes a first pipe located at the lowest position among the plurality of pipes and a plurality of second pipes excluding the first pipe.

[0066] The second heat exchanger 60 may include a distributor 67 that distributes the refrigerant to a plurality of pipes 65. The distributor 67 may be located on one side of the second heat exchanger 60. For example, the distributor 67 may distribute the refrigerant that has passed through the expansion device 40 to a plurality of pipes 65. The distributor 67 may be connected to a third refrigerant pipe 80. For example, during the heating operation, the refrigerant that passes through the expansion device 40 and flows into the third refrigerant pipe 83 may be distributed to a plurality of pipes 65 through the distributor 67. Conversely, during the cooling operation, the refrigerant discharged from the compressor 10 and passing through the plurality of pipes 65 of the second heat exchanger 60 may pass through a plurality of distribution pipes 66, join at the distributor 67, and flow into the third refrigerant pipe 83.

[0067] The second heat exchanger 60 may include a plurality of distribution pipes 66 connecting the plurality of pipes 65 and the distributor 67. The plurality of distribution pipes 66 may be located on one side of the second heat exchanger 60. For example, the plurality of distribution pipes 66 may include a first distribution pipe 66a, a second distribution pipe 66b, a third distribution pipe 66c, and a fourth distribution pipe 66d. The first distribution pipe 66a may connect the distributor 67 and the first pipe (see FIG. 2, 65a). The second distribution pipe 66b may connect the distributor 87 and the second pipe (see FIG. 2, 65b). The third distribution pipe 66c may connect the distributor 87 and the third pipe (see FIG. 2, 65c). The fourth distribution pipe 66d may connect the distributor 67 and the fourth pipe (see FIG. 2, 65d).

[0068] The second heat exchanger 60 may include a header 63 connected to each of the plurality of pipes 65. The header 63 may be located on the other side of the second heat exchanger 60. For example, the distributor 67 may be located on one side of the second heat exchanger 60, and the header 63 may be located on the other side of the second heat exchanger 60. The header 63 may be connected to the fourth refrigerant pipe 84. For example, during the cooling operation, the refrigerant discharged from the compressor and introduced into the fourth refrigerant pipe 84 may be distributed to the plurality of pipes 65 through the header 63. Conversely, during the heating operation, the refrigerant that has passed through the plurality of pipes 65 of the second heat exchanger 60 may join at the header 63 and flow into the fourth refrigerant pipe 84.

<Valve>

[0069] The second heat exchanger 60 may include a valve 68 that controls the flow of refrigerant in the lowermost pipe (or 'first pipe') among the plurality of pipes 65. The valve 68 may prevent the refrigerant from flowing in the lowermost pipe. The valve 68 may open all of the plurality of pipes 65 to allow the refrigerant to flow through all of the plurality of pipes 65 during the cooling operation and block the lowermost pipe so that the refrigerant flows only through the remaining pipes except the lowermost pipe among the plurality of pipes 65 during the heating operation. For example, the valve may be disposed in the first distribution pipe 66a connected to the first pipe (see FIG. 2, 65a), which is the lowermost pipe among the plurality of pipes 65.

[0070] The valve 68 may be a check valve 682 that allows refrigerant to flow in only one direction. For example, the valve 68 may allow the refrigerant to flow sequentially through the second heat exchanger 60, the expansion device 40, and the first heat exchanger 30.

<Expansion device>

[0071] The expansion device 40 may be located between the first heat exchanger 30 and the second heat exchanger 60. During the heating operation, the refrigerant may pass through the expansion device 40 from the first heat exchanger 30 to the second heat exchanger 60. During the cooling operation, the refrigerant may pass through the expansion device 40 from the second heat exchanger 60 to the first heat exchanger 30. The expansion device 40 may be located between the second refrigerant pipe 82 connected to the first heat exchanger 30 and the third refrigerant pipe 83 connected to the second heat exchanger 60. Both the second refrigerant pipe 82 and the third refrigerant pipe 83 may be connected to the expansion device 40. For example, during the heating operation, the refrigerant may sequentially pass through the second refrigerant pipe 82, the expansion device 40, and the third refrigerant pipe 83, while, during cooling operation, the refrigerant may sequentially pass through the third refrigerant pipe 83, the expansion device 40, and the second refrigerant pipe 82.

[0072] Referring to FIG. 2, the second heat exchanger 60 may include a plurality of connection pipes 64 connecting the plurality of pipes 65 and the header 63, a plurality of distribution pipes 66 connecting the plurality of pipes 65 and the distributor 67, and a plurality of tubes 650 forming the plurality of pipes 65.

[0073] The second heat exchanger 60 may include an outdoor fan 62 that generates an air flow passing through the plurality of pipes 65 and a case 61 that accommodates the outdoor fan 62 and the plurality of pipes 65.

[0074] The second heat exchanger 60 may include the plurality of pipes 65 through which refrigerant flows. The plurality of pipes 65 may be arranged in the longitudinal direction. For example, the plurality of pipes 65 may include a first pipe 65a located at the bottom, a second pipe 65b located above the first pipe 65a, a third pipe 65c located above the second pipe 65b, and a fourth pipe 65d located above the third pipe 65c. The refrigerant that has passed through the header 63 or the distributor 67 may be distributed and introduced into each of the plurality of pipes 65.

[0075] The second heat exchanger 60 may include a plurality of connection pipes 64 connecting the header 63 and the plurality of pipes 65. For example, the plurality of connection pipes 64 may include a first connection pipe 64a connected to the first pipe 65a, a second connection pipe 64b connected to the second pipe 65b, a third connection pipe 64c connected to the third pipe 65c, and a fourth connection pipe 64d connected to the fourth pipe 65d.

[0076] The second heat exchanger 60 may include a plurality of tubes 65 forming a plurality of pipes 65, respectively. The circle shown in the drawing may represent the cross section of the tube 650. For example, the first pipe 65a may include four tubes 650a. The second pipe 65b may include eight tubes 650b. The third pipe 65c may include eight tubes 650c. The fourth pipe 65d may include eight tubes 650d. The plurality of tubes 650 forming the respective pipes 65 may be arranged along a plurality of rows. For example, the plurality of tubes 65 forming the first pipe 65a to the fourth pipe 65d may be arranged side by side in the longitudinal direction along the first row r1 and the second row r2.

[0077] The number of tubes 650a forming the lowermost pipe 65a may be less than the number of tubes 650b, 650c, 650d forming other pipes. For example, the number of tubes 650a forming the first pipe 65a disposed at the bottom may be less than the number of tubes 650b forming the second pipe 65b. The number of tubes 650a forming the first pipe 65a disposed at the bottom may be less than the number of tubes 650c forming the third pipe 65c. The number of tubes 650a forming the first pipe 65a disposed at the bottom may be less than the number of tubes 650d forming the fourth pipe 65d.

[0078] The length of the refrigerant flow path formed in the lowermost pipe 65a may be shorter than the length of the refrigerant flow path formed in other pipes. For example, the length of the refrigerant flow path formed in the first pipe 65a disposed at the bottom may be shorter than the length of the refrigerant flow path formed in the second pipe 65b. The length of the refrigerant flow path formed in the first pipe 65a disposed at the bottom may be shorter than the length of the refrigerant flow path formed in the third pipe 65c. The length of the refrigerant flow path formed in the first pipe 65a disposed at the bottom may be shorter than the length of the refrigerant flow path formed in the fourth pipe 65d. Since the length of the refrigerant flow path of the lowermost pipe is shorter than the length of the refrigerant flow path of other pipes, the effect on the cooling and heating performance of the second heat exchanger may be reduced as the lowermost pipe is opened or closed by the valve.

[0079] The pipe of the second heat exchanger 60 may include an inlet tube 652 connected to the connection pipe 64. Each of the plurality of pipes 65 may include the inlet tube 652 connected to the connection pipe 64. For example, the first pipe 65a may include a first inlet tube 652a (or ‘first pipe inlet tube’) connected to the first connection pipe 64a. The second pipe 65b may include a second inlet tube 652b connected to the second connection pipe 64b. The third pipe 65c may include a third inlet tube 652c connected to the third connection pipe 64c. The fourth pipe 65d may include a fourth inlet tube 652d connected to the fourth connection pipe 64d.

[0080] A plurality of inlet tubes 652 may be arranged in a row located on one side close to the header 63. For example, the first to fourth inlet tubes 652a to 652d may be arranged in a vertical direction in the second row r2 close to the header. A plurality of outlet tubes 658 may be arranged in a row located on the other side close to the distributor 67. For example, the first outlet tube 658a (or ‘first pipe outlet tube’) to fourth outlet tube 658d may be arranged in a vertical direction in the first row r1 close to the distributor 67.

[0081] The inlet tube 652 may form one end of the plurality of tubes 650, and the outlet tube 658 may form the other end of the plurality of tubes 650. For example, the first inlet tube 652a and the first outlet tube 658a may be disposed at one end and the other end of the plurality of tubes 65, respectively, allowing the refrigerant to flow into or out of the plurality of tubes 65. For example, during the heating operation, the refrigerant flowing into the second heat exchanger 60 through the distributor 67 may flow into the plurality of tubes 65 through the plurality of inlet tubes 652 and may flow out from the second heat exchanger 60 through the plurality of outlet tubes 658.

[0082] The valve 68 disposed on the lowermost distribution pipe 66a (or ‘first distribution pipe’) may block the flow of refrigerant flowing into the lowermost pipe 65a. In other words, during the heating operation, the refrigerant may be prevented from flowing through the lowermost pipe 65a. Through the above process, it is possible to reduce freezing of the second heat exchanger as low-temperature refrigerant flows through the lowermost pipe during the heating operation in cold weather.

[0083] The valve disposed on the lowermost distribution pipe 66a may allow the refrigerant to flow out from the lowermost pipe 65a. In other words, during the cooling operation or defrosting operation, refrigerant may flow through the lowermost pipe 65a. This is so because high-temperature refrigerant discharged from the compressor 10 flows through the lowermost pipe during the cooling or defrosting operation, thereby eliminating the risk of freezing.

[0084] Referring to FIGS. 3 and 4, a circulation cycle of the refrigerant during the heating operation will be described.

[0085] During the heating operation, the four-way valve 20 may connect the outlet pipe 86 of the compressor 10 and the first pipe 65a. The refrigerant discharged from the compressor 10 may flow into the first pipe 65a through the four-way valve 20. The high-temperature refrigerant discharged from the compressor 10 may pass through the first heat exchanger 30. The high-temperature refrigerant may exchange heat with water passing through the first heat exchanger 30 while passing through the first heat exchanger 30. In this process, the temperature of the water may increase, while the temperature of the refrigerant may decrease. In other words, the temperature of the water flowing out of the second heat exchanger through the water outlet pipe may be higher than the temperature of the water flowing into the second heat exchanger through the water intake pipe. Through the above process, the heat supply apparatus 1 may warm up the indoor space and supply hot water to the indoor space. At this time, the first heat exchanger 30 may function as a condenser.

[0086] The low-temperature refrigerant that has passed through the first heat exchanger 30 may flow to the expansion device 40 through the second refrigerant pipe 82. The low-temperature refrigerant that has passed through the expansion device 40 may flow into the second heat exchanger 60 through the third refrigerant pipe 83. The low-temperature refrigerant may be distributed to each distribution pipe 66 through the distributor 67 and may flow into each pipe 65 of the second heat exchanger 60. At this time, the refrigerant may not pass through the first distribution pipe 66a and the first pipe 65a connected thereto due to the check valve 682 disposed in the first distribution pipe 66a. During the heating operation in cold weather, since the second heat exchanger 60, through which low-temperature refrigerant flows, functions as an evaporator, frosting or freezing may occur on the surface of the second heat exchanger 60. In particular, freezing may occur most rapidly in the lowermost pipe 65a close to the cold ground surface. The valve 68 may prevent low-temperature refrigerant from flowing into the lowermost pipe 65a, thereby reducing the onset of freezing in the lowermost pipe 65a.

[0087] Among the plurality of pipes 65, the low-temperature refrigerant that has passed through the remaining pipes other than the lowermost pipe 65a may flow to the accumulator 70 and/or compressor 10 through the fourth refrigerant pipe 84. At this time, the four-way valve 20 may connect the fourth refrigerant pipe 84 and the inlet pipe 85. The refrigerant that has passed through the accumulator 70 may flow into the compressor 10 through the inlet pipe 85. The refrigerant flowing into the compressor 10 may be compressed and then flow back to the first heat exchanger 30. Through the circulation process above, the heat supply apparatus 1 may warm up the indoor space and supply hot water to the indoor space.

[0088] With reference to FIG. 5, the circulation cycle of refrigerant during the cooling or defrosting operation will be described.

[0089] During the cooling or defrosting operation, the four-way valve 20 may connect the outlet pipe 86 of the compressor 10 and the fourth pipe 65d. The refrigerant discharged from the compressor 10 may flow into the fourth pipe 65d through the four-way valve 20. The high-temperature refrigerant discharged from the compressor 10 may pass through the second heat exchanger 60. The high-temperature refrigerant may exchange heat with outdoor air while passing through the second heat exchanger 60. Through the process above, the temperature of the refrigerant may decrease. At this time, the refrigerant may flow through all of the plurality of pipes of the second heat exchanger. In other words, the valve opens the lowermost pipe, and the refrigerant may flow through the lowermost pipe. For example, during the defrosting operation, high-temperature refrigerant may flow through the lowermost pipe and remove frost or ice formed on the surface of the second heat exchanger. Refrigerant that has passed through a plurality of pipes may pass through a distribution pipe and join at the distributor. At this time, the second heat exchanger may function as a condenser.

[0090] The low-temperature refrigerant that has passed through the second heat exchanger 60 may flow to the expansion device 40 through the third refrigerant pipe 83. The low-temperature refrigerant that has passed through the expansion device 40 may flow into the first heat exchanger 30 through the second refrigerant pipe 82. The low-temperature refrigerant introduced into the first heat exchanger may exchange heat with water passing through the first heat exchanger. Through the process above, the temperature of the refrigerant may increase, and the temperature of the water may decrease. In other words, the temperature of the water flowing out of the first heat exchanger through the water outlet pipe may be lower than the temperature of the water flowing in through the water inlet pipe. Through the process above, the heat supply apparatus may cool down the indoor space and supply cold water to the indoor space.

[0091] The refrigerant that has passed through the first heat exchanger may flow to the accumulator 70 and/or compressor 10 through the first refrigerant pipe 81. At this time, the four-way valve 20 may connect the first refrigerant pipe 81 and the inlet pipe 85. The refrigerant that has passed through the accumulator 70 may flow into the compressor 10 through the inlet pipe 85. The refrigerant flowing into the compressor 10 may be compressed and then flow back to the second heat exchanger 60. Through the circulation process above, the heat supply apparatus 1 may cool down the indoor space and supply cold water to the indoor space.

[0092] Referring to FIG. 6, the second heat exchanger 60 may include a plurality of connection pipes 64 connecting the header 63 and a plurality of pipes 65, and the valve 68 may be disposed on the lowermost connection pipe (or 'first connection pipe) among the plurality of connection pipes 64. In other words, the valve 68 may be disposed at any point that allows for controlling the flow of refrigerant flowing through the first pipe 65a. For example, the valve 68 may be disposed on the first pipe 65a, which is the lowermost pipe among the plurality of pipes 65.

[0093] During the cooling operation, the refrigerant passing through the fourth refrigerant pipe 84 may be distributed to the plurality of connection pipes 64 while passing through the header 63. The refrigerant distributed to the plurality of connection pipes 64 may flow into the plurality of pipes 65 of the second heat exchanger 60. Conversely, during the heating operation, the refrigerant discharged from the plurality of pipes 65 of the second heat exchanger 60 may pass through the plurality of connection pipes 64 and join the header 63.

[0094] For example, the plurality of connection pipes 64 may include a first connection pipe 64a connected to the first pipe 65a, a second connection pipe 64b connected to the second pipe 65b, a third connection pipe 64c connected to the third pipe 65c, and a fourth connection pipe 64d connected to the fourth pipe 65d.

[0095] The valve 68 may be disposed to at least one of the lowermost distribution pipe among the plurality of distribution pipes 66 and the lowermost connection pipe among the plurality of connection pipes 64. For example, the check valve 682 may be disposed in the first connection pipe 64a disposed at the lowest end of the plurality of connection pipes 64, prevent the refrigerant from flowing through the first pipe during the heating operation, and allow the refrigerant to flow through the first pipe during the cooling or defrosting operation.

[0096] Referring to FIG. 7, the valve 68 may include a solenoid valve 684 that opens and closes according to an electrical signal.

[0097] The solenoid valve 684 may control the flow of refrigerant flowing into the lowermost pipe among the plurality of pipes 65. The solenoid valve 684 may be closed during the heating operation and may be opened during the cooling or defrosting operation. According to FIG. 7, the solenoid valve 684 may be disposed in the first distribution pipe 66a; however, the solenoid valve 684 is not limited to the specific disposition and may be disposed at any point allowing for controlling the flow of refrigerant flowing through the first pipe 65a. For example, the solenoid valve 684 may be disposed in the lowermost connection pipe among the plurality of connection pipes 64 or the lowermost pipe among the plurality of pipes 65.

[0098] The heat supply apparatus 1 may include a controller (not shown) that controls the solenoid valve 684. The controller may close the solenoid valve 684 during the heating operation. The controller (not shown) may open the solenoid valve 684 during the cooling or defrosting operation. Through the process above, it is possible to reduce frosting or freezing that occurs on the surface of the outdoor unit during the heating operation. Also, the defrosting performance of the heat supply apparatus may be improved.

[0099] Referring to FIG. 8, the outlet tube 658 of the pipe disposed at the lowest end among the plurality of pipes 65 may be separated inward from the inlet tube 652.

[0100] The inlet tube 652 of the first pipe 65a disposed at the lowest end among the plurality of pipes 65 may be disposed at the outermost side. For example, the inlet tube 652 of the first pipe 65a may be disposed in the first row r1 disposed at the outermost position among a plurality of rows in which a plurality of tubes 650a are arranged side by side in the longitudinal direction. The outlet tube 658 of the first pipe 65a may be disposed in the second row r2 disposed at the innermost side among the plurality of rows.

[0101] During cooling or defrosting operation, the refrigerant flowing into the first pipe 65a from the first connection pipe 64a through the first inlet tube 652a may flow along the outermost row among a plurality of rows in which the plurality of tubes 65 are disposed and then gradually move toward an inner row. For example, the high-temperature refrigerant flowing into the first inlet tube 652a disposed in the first row r1 may first flow through the tubes disposed in the first row r1 and then sequentially flow into the second row r2. As the high-temperature refrigerant begins to flow from the outermost tube of the first pipe 65a disposed at the lowest end, frost or ice formed on the surface of the second heat exchanger may be quickly removed.

[0102] Among the plurality of pipes 65, each of the remaining pipes (or 'second pipes') other than the lowermost pipe may include an inlet tube 652 (or 'second pipe inlet tube) connected to the connection pipe 64 and an outlet tube 658 (or 'second pipe outlet tube) connected to the distribution pipe 66. For example, the second pipe 65b may include a second inlet tube 652b connected to the second connection pipe 64b and a second outlet tube 658b connected to the second distribution pipe 66b. The third pipe 65c may include a third inlet tube 652c connected to the third connection pipe 64c and a third outlet tube 658c connected to the third distribution pipe 66c. The fourth pipe 65d may include a fourth inlet tube 652d connected to the fourth connection pipe 64d and a fourth outlet tube 658d connected to the fourth distribution pipe 66d.

[0103] The inlet tubes 652 of the pipes 65 other than the lowermost pipe among the plurality of pipes may be separated inwardly from the corresponding outlet tubes 658. For example, the second inlet tube 652b to fourth inlet tube 652d may be located at the innermost side, and the second outlet tube 658b to fourth outlet tube 658d may be located at the outermost side. For example, the second inlet tube 652b to fourth inlet tube 652d may be located in the second row r2, and the second outlet tube 658b to fourth outlet tube 658d are located in the first row r1.

[0104] The inlet tubes 652 of the pipes 65 other than the lowermost pipe among the plurality of pipes may be disposed in the same row together with the outlet tube 658a of the lowermost pipe. For example, the second inlet tube 652b to fourth inlet tube 652d and the first outlet tube 658a of the first pipe 65a, which is the lowermost pipe, may be arranged in the second row r2.

[0105] The outlet tubes 658 of the pipes 65 other than the lowermost pipe among the plurality of pipes may be disposed in the same row together with the inlet tube 652a of the lowermost pipe. For example, the second inlet tube 652b to the fourth outlet tube 658d and the first inlet tube 652a of the first pipe 65a, which is the lowermost pipe, may be arranged in the first row r1.

[0106] Referring to FIG. 9, the outlet tube 658 of the pipe located at the lowest end among the plurality of pipes 65 may be located above the inlet tube 652.

[0107] The first outlet tube 658a of the first pipe 65a located at the lowest end among the plurality of pipes 65 may be located above the first inlet tube 652a. The first inlet tube 652a may be located at the lowest end of the plurality of tubes 650a belonging to the first pipe 65a. The first outlet tube 658a may be located at the top of the plurality of tubes 650a belonging to the first pipe 65a. During the defrosting operation, the high-temperature refrigerant flowing into the first inlet tube 652a may flow upward from the lowest end along the outermost side, move downward to the inside, and then flow upward again. Through the process above, during the defrosting operation, the high-temperature refrigerant flowing into the first inlet tube 652a at the lowest end may quickly remove frost or ice concentrated on the lower side. Also, the refrigerant at a relatively lower temperature while flowing through the first pipe 65a may flow out into the uppermost tube of the first pipe, thereby minimizing the effect on the defrosting performance at the lowest end.

[0108] Referring to FIGS. 1 to 9, a heat supply apparatus according to one aspect of the present disclosure may comprise a compressor compressing refrigerant; a first heat exchanger being connected to the compressor through a refrigerant pipe and exchanging heat between refrigerant and water; and a second heat exchanger being connected to the compressor through a refrigerant pipe and exchanging heat between refrigerant and outdoor air, wherein the second heat exchanger includes a plurality of pipes through which refrigerant flows and a valve adjusting the flow of refrigerant through the lowermost pipe of the plurality of pipes, and the valve allows the refrigerant to flow only in a first direction that sequentially passes the compressor, the second heat exchanger, and the indoor heat exchanger.

[0109] According to another one aspect of the present disclosure, the valve may be a check valve that allows refrigerant to flow in the first direction and blocks the flow in a second direction, which is opposite to the first direction.

[0110] According to another one aspect of the present disclosure, the second heat exchanger may include a plurality of distribution pipes, each of which is connected to the plurality of pipes, and a distributor that combines the plurality of distribution pipes, wherein the valve may be disposed in the lowermost distribution pipe among the plurality of distribution pipes.

[0111] According to another one aspect of the present disclosure, the second heat exchanger may include a plurality of distribution pipes, each of which is connected to one end of the plurality of pipes; a distributor that combines the plurality of distribution pipes; a plurality of connection pipes, each of which is connected to the other end of the plurality of pipes; and a header that combines the plurality of connection pipes, wherein the valve may be disposed in the lowermost connection pipe among the plurality of connection pipes.

[0112] According to another one aspect of the present disclosure, the heat supply apparatus further comprises a controller that controls the flow of refrigerant, wherein the valve may be a solenoid valve that is opened or closed according to an electrical signal received from the controller.

[0113] According to another one aspect of the present disclosure, the controller may close the solenoid valve during heating operation and open the solenoid valve during defrosting operation.

[0114] According to another one aspect of the present disclosure, the lowermost pipe may include the lowermost inlet tube through which refrigerant discharged from the compressor flows in; and the lowermost outlet tube through which refrigerant flowing into the lowermost inlet tube flows out, wherein the lowermost inlet tube may be separated outward from the lowermost outlet tube.

[0115] According to another one aspect of the present disclosure, the lowermost inlet tube may be located on the outermost side of the plurality of pipes.

[0116] According to another one aspect of the present disclosure, the lowermost outlet tube may be located on the innermost side of the plurality of pipes.

[0117] According to another one aspect ofthe present disclosure, the lowermost inlet tube may be located below the lowermost outlet tube.

[0118] According to another one aspect of the present disclosure, the lowermost outlet tube may be located at the bottom of the lowermost pipe, and the lowermost inlet tube may be located at the top of the lowermost pipe.

[0119] According to another one aspect of the present disclosure, among the plurality of pipes, each of the remaining pipes other than the lowermost pipe may include an inlet tube through which refrigerant discharged from the compressor flows in; and an outlet tube through which refrigerant flows out to the first heat exchanger, wherein the inlet tube of each of the remaining pipes is separated inward from the corresponding outlet tube.

[0120] According to another one aspect of the present disclosure, the length of a refrigerant flow path of the lowermost pipe may be shorter than the length of a refrigerant flow path of the remaining pipes other than the lowermost pipe.

[0121] Certain embodiments or other embodiments of the disclosure described above are not mutually exclusive or distinct from each other. Any or all elements of the embodiments of the disclosure described above may be combined with another or combined with each other in configuration or function

[0122] For example, a configuration "A" described in one embodiment of the disclosure and the drawings and a configuration "B" described in another embodiment of the disclosure and the drawings may be combined with each other. Namely, although the combination between the configurations is not directly described, the combination is possible except in the case where it is described that the combination is impossible.

[0123] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

[Detailed Description of Main Elements]

[0124]

10: Compressor
20: Four-way valve
30: First heat exchanger
40: Expansion device
60: Second heat exchanger
62: Outdoor fan
63: Header
66: Distribution pipe
67: Distributor
68: Valve
70: Accumulator
80: Refrigerant pipe

Claims

1. A heat supply apparatus (1) comprising:

a compressor (10) compressing refrigerant;
a first heat exchanger (30) being connected to the compressor (10) through a refrigerant pipe (80) and configured to exchange heat between refrigerant and water; and
a second heat exchanger (60) being connected to the compressor (10) through a refrigerant pipe (80) and configured to exchange heat between refrigerant and outdoor air,
wherein the second heat exchanger (60) includes:

a plurality of pipes (65) through which refrigerant flows; and
a valve (68) configured to adjust the flow of refrigerant through a first pipe (65a) located at the lowest position among the plurality of pipes (65), and
the valve (68) configured to allow refrigerant to flow only in a first direction that sequentially passes the compressor (10), the second heat exchanger (60), and the indoor heat exchanger ().

2. The apparatus (1) of claim 1, wherein the valve (68) is a check valve (682) that allows refrigerant to flow in the first direction and blocks the flow in a second direction, which is opposite to the first direction.

3. The apparatus (1) of claim 1 or 2, wherein the second heat exchanger (60) includes:

a plurality of distribution pipes (66), each of which is connected to the plurality of pipes (65); and
a distributor (67) that combines the plurality of distribution pipes (66),
wherein the valve (68) is disposed in a first distribution pipe (66a) located at the lowest position among the plurality of distribution pipes (66).

4. The apparatus (1) of claim 1 or 2, wherein the second heat exchanger (60) includes:

a plurality of distribution pipes (66), each of which is connected to one end of the plurality of pipes (65);
a distributor (67) that combines the plurality of distribution pipes (66);
a plurality of connection pipes (64), each of which is connected to the other end of the plurality of pipes (66); and
a header (63) that combines the plurality of connection pipes (64),
wherein the valve (68) is disposed in a first connection pipe (64a) located at the lowest position among the plurality of connection pipes (64).

5. The apparatus (1) of claim 1, further comprising:

a controller that is configured to control the flow of refrigerant,
wherein the valve (68) is a solenoid valve (684) that is opened or closed according to an electrical signal received from the controller.

6. The apparatus (1) of claim 5, wherein the controller is configured to close the solenoid valve (684) during heating operation and open the solenoid valve (684) during defrosting operation.

7. The apparatus (1) of claim 1, wherein the first pipe (65a) includes:

a first pipe inlet tube (652a) through which refrigerant discharged from the compressor (10) flows in; and
a first pipe outlet tube (658a) through which refrigerant flowing into the first inlet tube (652a) flows out,
wherein the first pipe inlet tube (652a) is separated outward from the first pipe outlet tube (658a).

8. The apparatus (1) of claim 7, wherein the first pipe inlet tube (652a) is located on the outermost side of the plurality of pipes (65).

9. The apparatus (1) of claim 7 or 8, wherein the first pipe outlet tube (658a) is located on the innermost side of the plurality of pipes (65).

10. The apparatus (1) of claim 7, wherein the first pipe inlet tube (652a) is located below the first pipe outlet tube (658a).

11. The apparatus (1) of claim 10, wherein the first pipe outlet tube (658a) is located at the bottom of the first pipe (65a), and the first pipe inlet tube (652a) is located at the top of the first pipe (65a).

12. The apparatus (1) according to any one of claims 1 to 10, wherein, the plurality of pipes (65) further includes a plurality of second pipes (65b, 65c, 65d).

13. The apparatus (1) of claim 12, wherein each of the plurality of second pipes (65b, 65c, 65d) includes:

a second pipe inlet tube (652b, 652c, 652d) through which refrigerant discharged from the compressor (10) flows in; and
a second pipeoutlet tube (658b, 658c, 658d) through which refrigerant flows out to the first heat exchanger (30),
wherein the second pipe inlet tube (652b, 652c, 652d) is spaced inwardly from the second pipe outlet tube (658b, 658c, 658d).

14. The apparatus of claim 12 or 13, wherein the length of a refrigerant flow path of the first pipe (65a) is shorter than the length of a refrigerant flow path of the plurality of second pipes (65b, 65c, 65d).

15. The apparatus of claim 12 or 13, wherein the length of the refrigerant flow path formed in the first pipe (65a) is shorter than the length of the refrigerant flow path formed in the second pipe (65b), the length of the refrigerant flow path formed in the first pipe (65a) is shorter than the length of the refrigerant flow path formed in the third pipe (65c), and/or the length of the refrigerant flow path formed in the first pipe (65a) is shorter than the length of the refrigerant flow path formed in the fourth pipe (65d).

Fig. 1

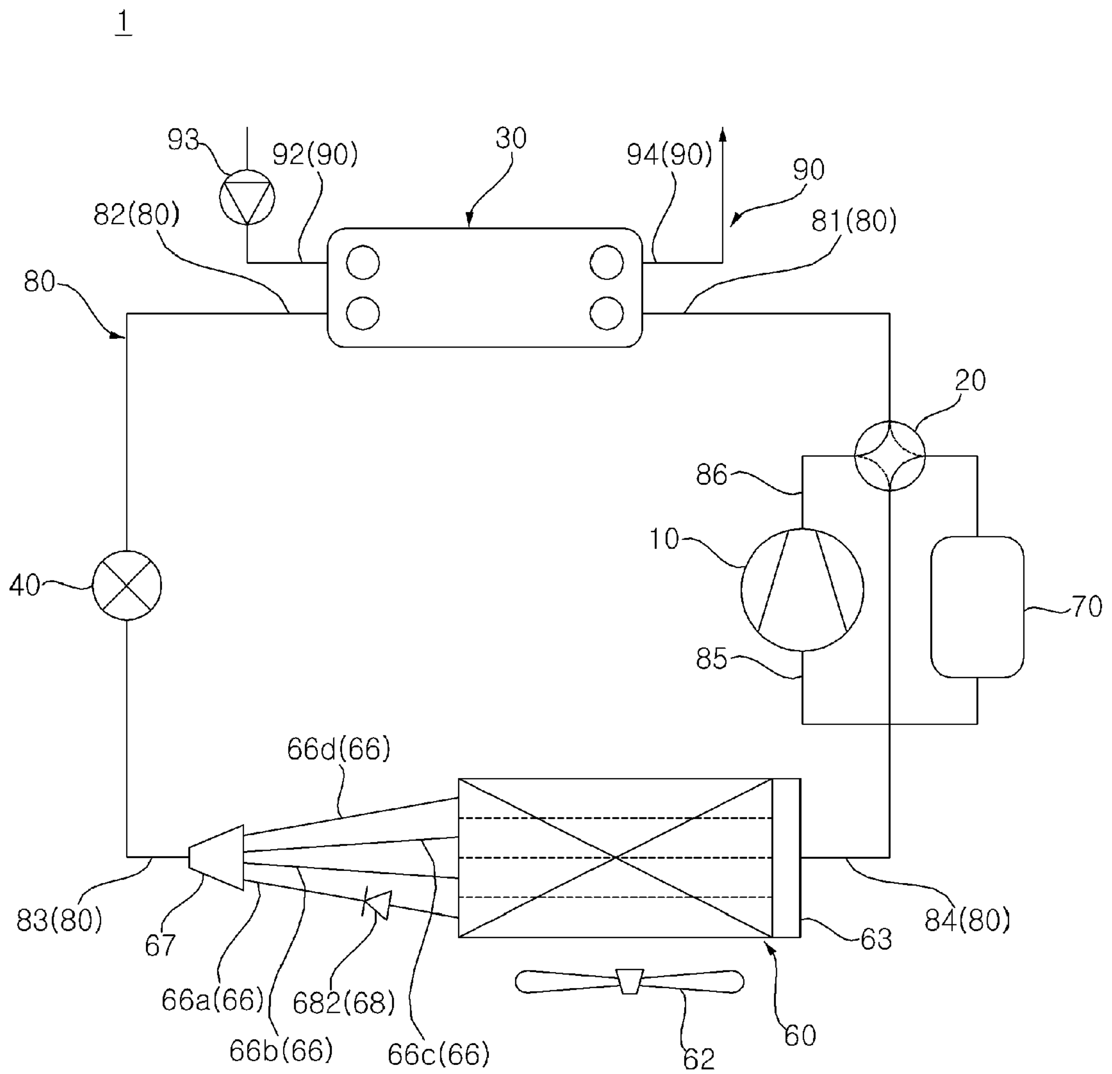
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Fig. 2

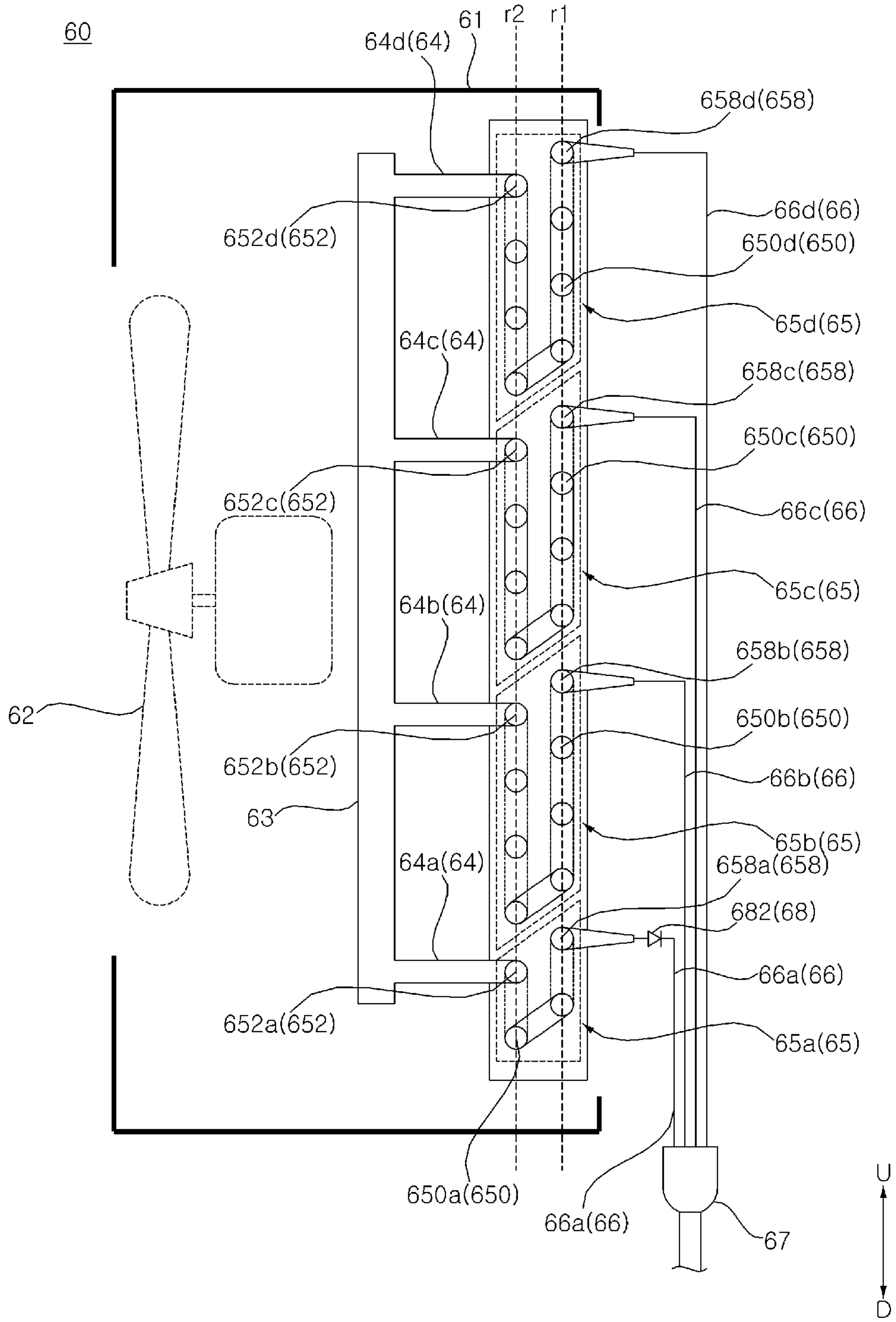
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Fig. 3

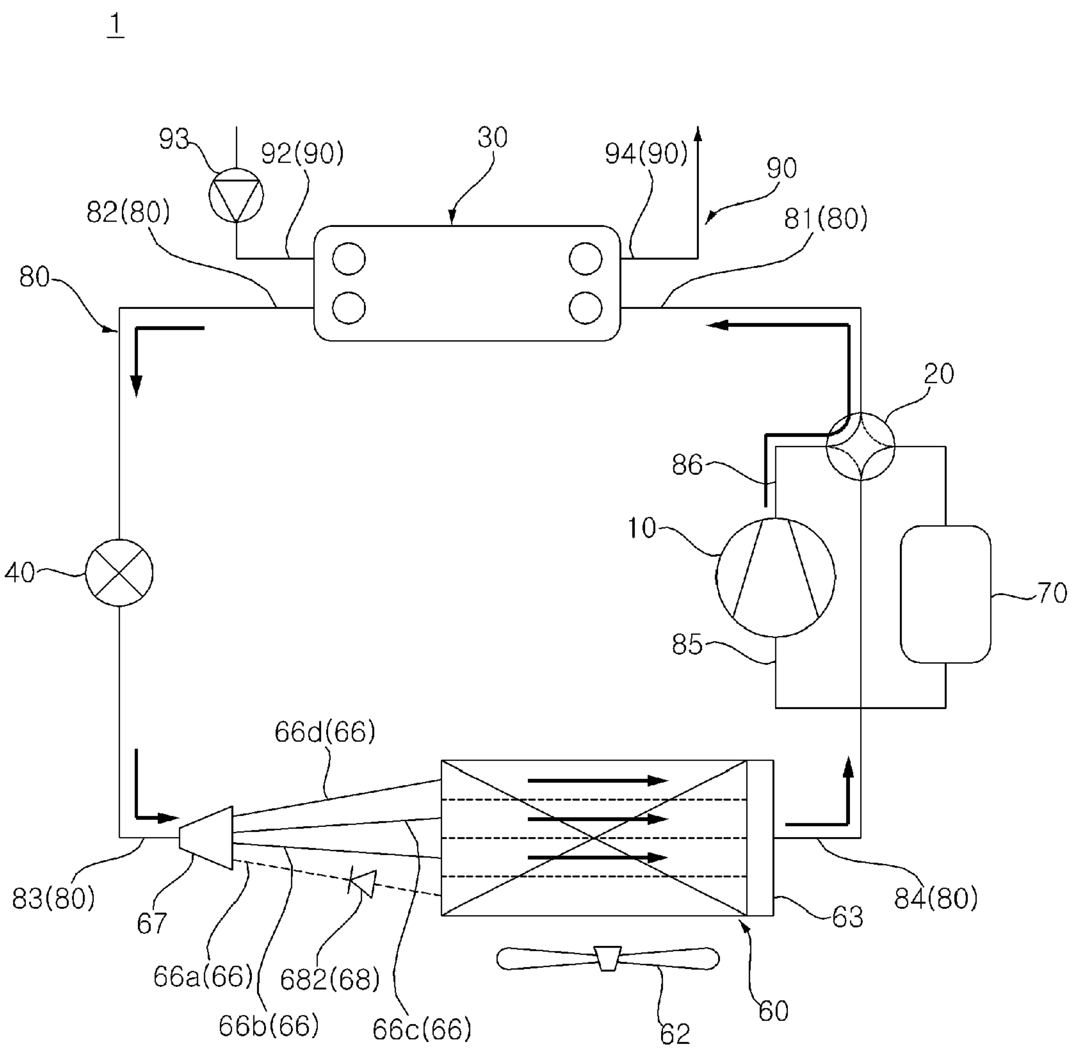
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Fig. 4

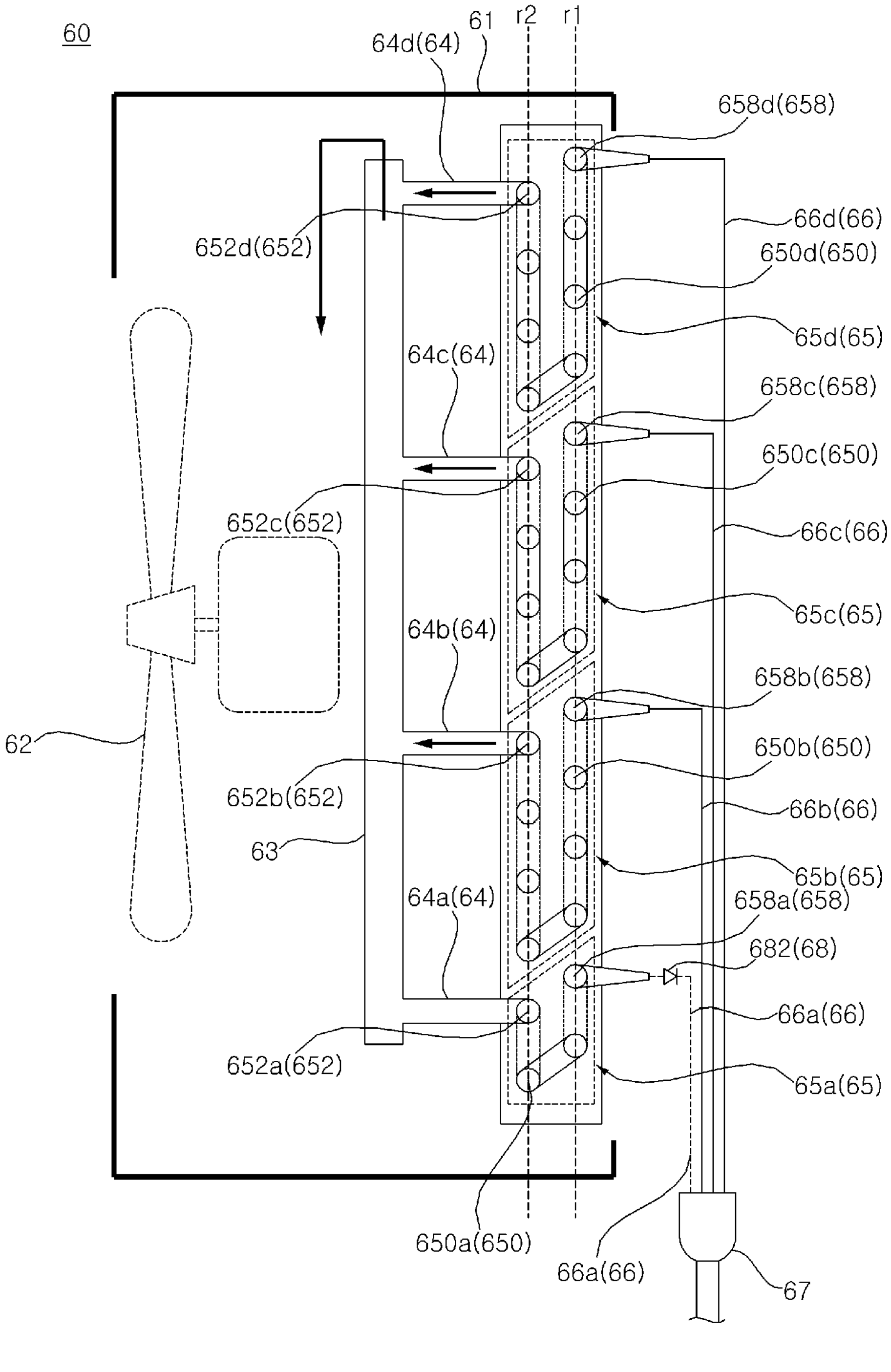
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Fig. 5

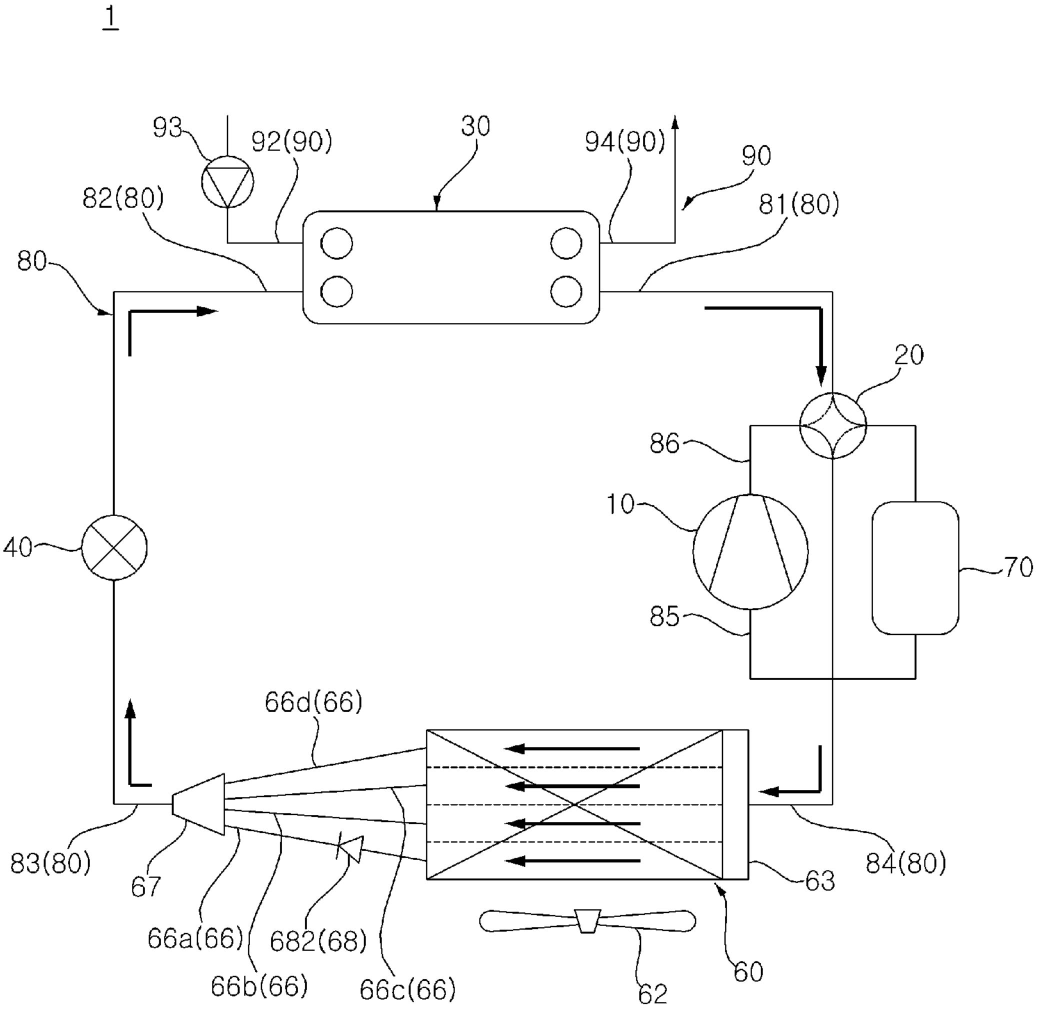
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Fig. 6

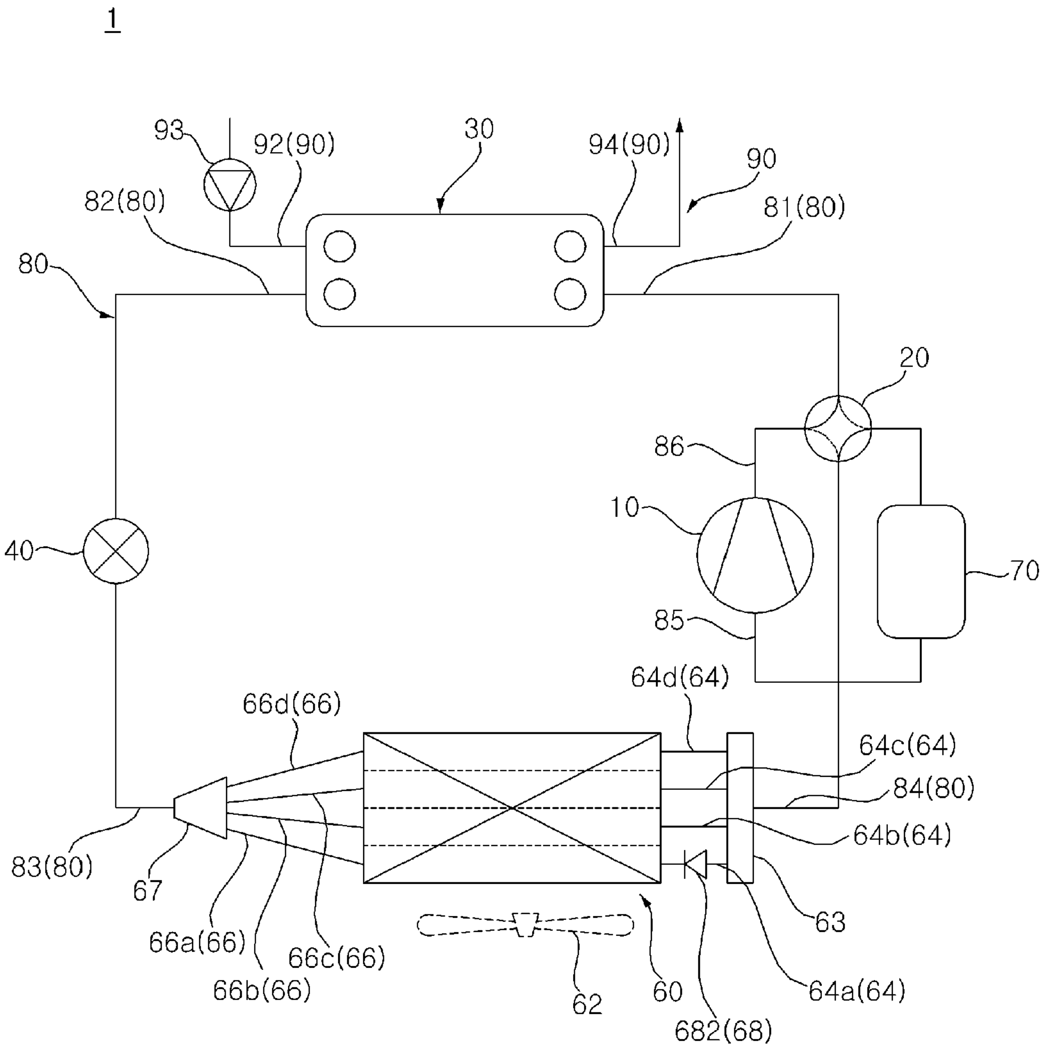
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Fig. 7

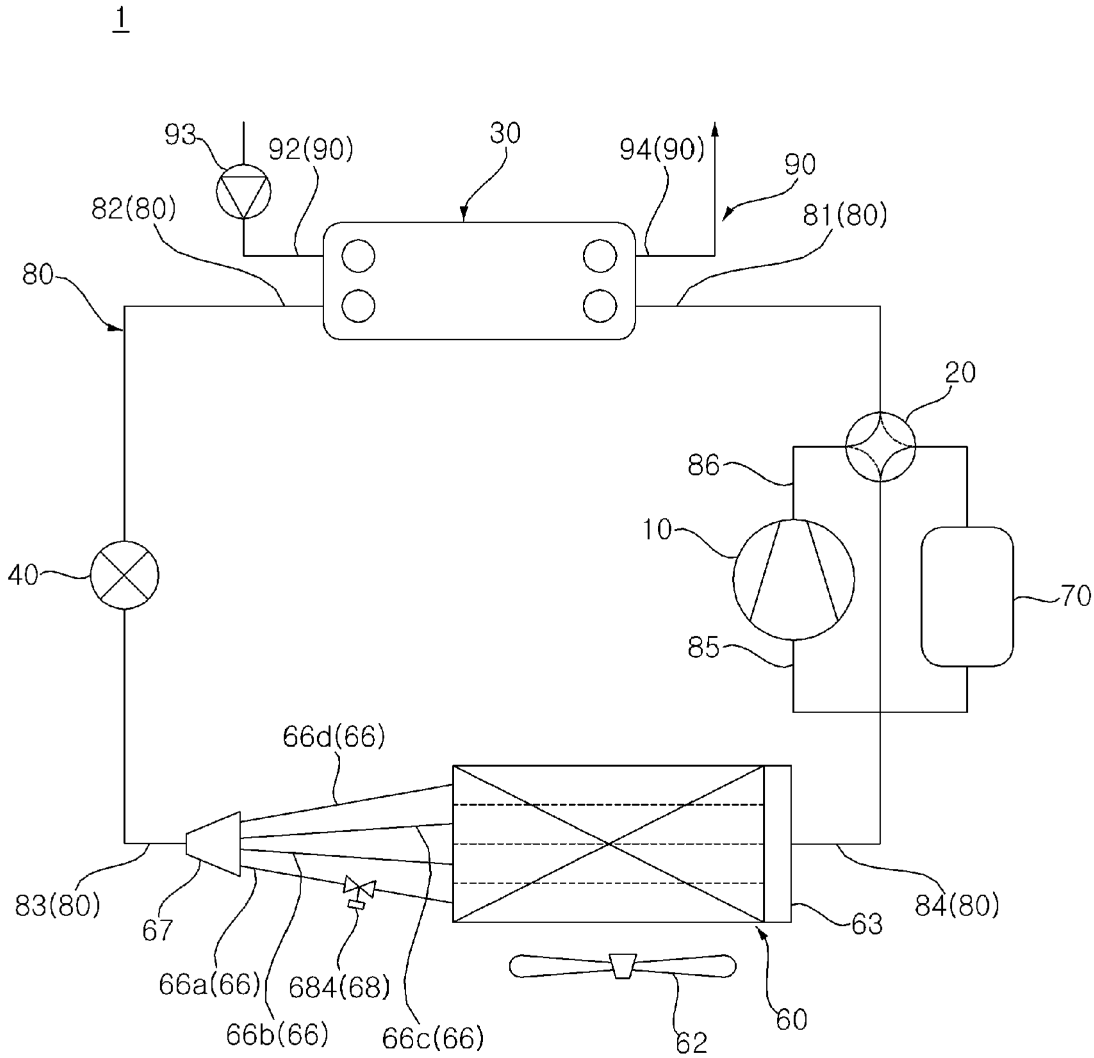
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Fig. 8

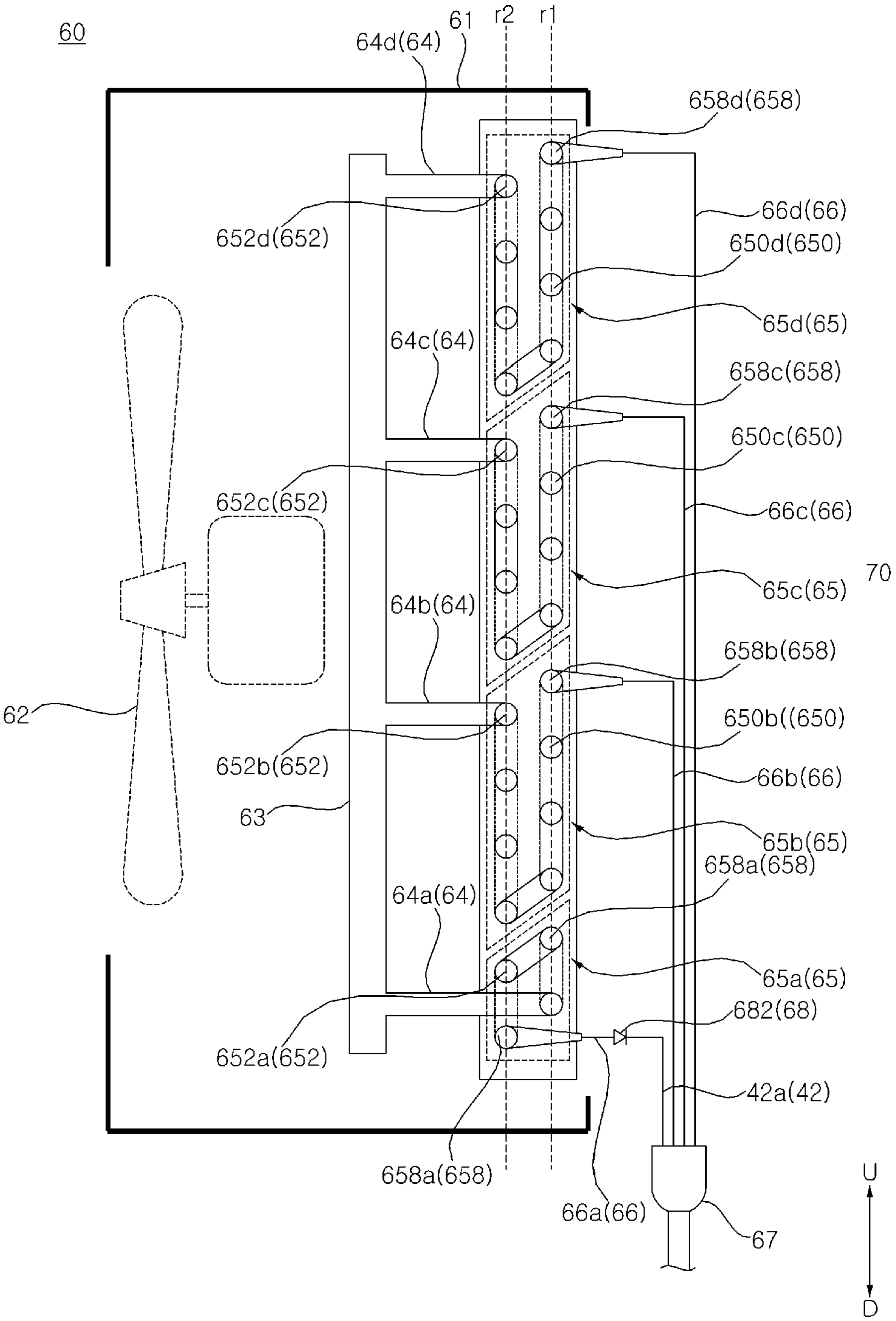
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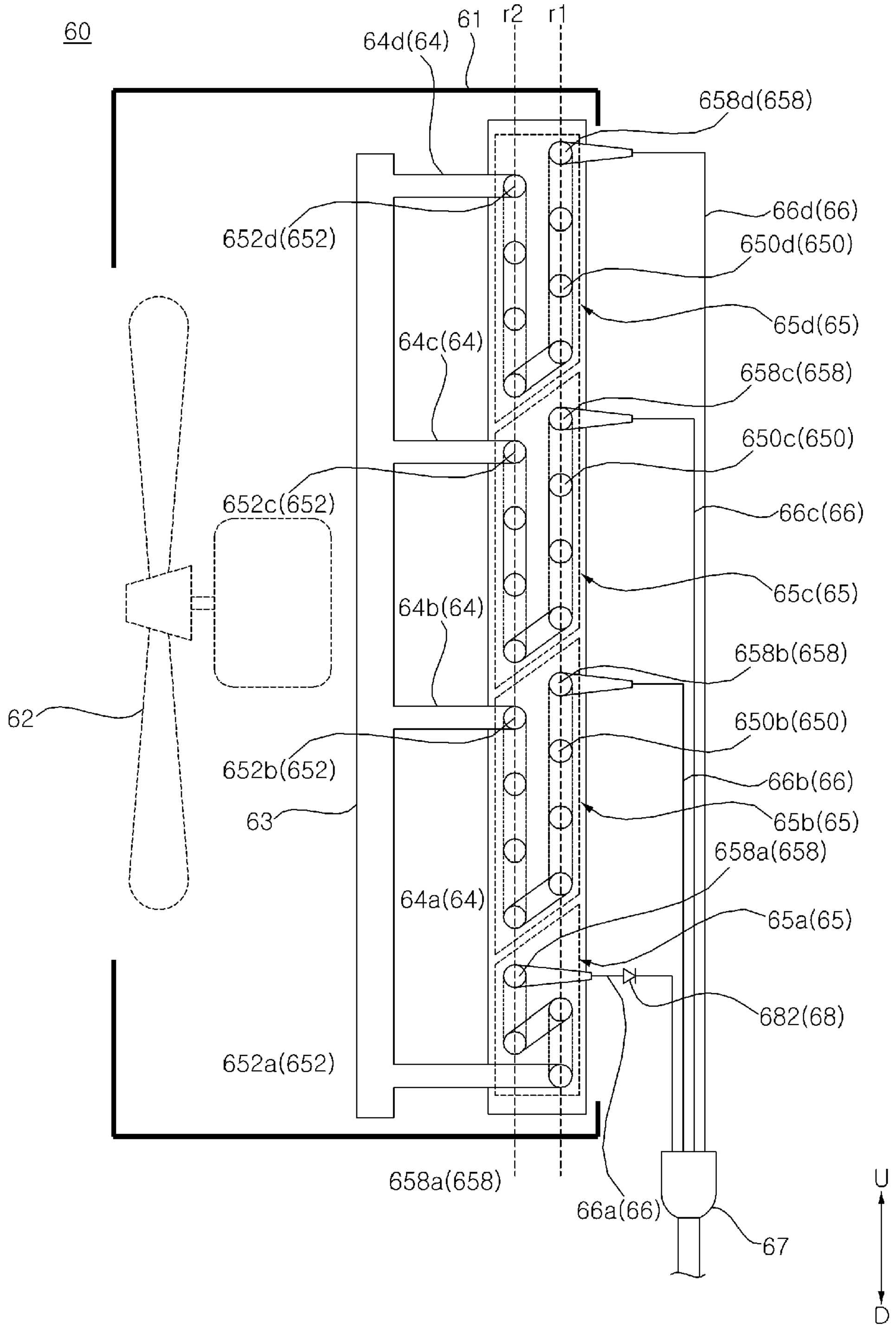
Fig. 9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EUROPEAN SEARCH REPORT

Application Number
EP 24 18 9102

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	EP 3 751 211 B1 (LG ELECTRONICS INC [KR]) 8 March 2023 (2023-03-08) * & associated description; figures 1,2 *	1-15	INV. F25B13/00 F25B39/02 F25B41/20
Y	EP 2 940 407 B1 (DAIKIN IND LTD [JP]; DAIKIN EUROPE NV [BE]) 14 November 2018 (2018-11-14) * & associated description; figures 1-3 *	1-15	
Y	CN 212 746 959 U (TIANPU NEW ENERGY TECH CO LTD ET AL.) 19 March 2021 (2021-03-19) * & associated description; figure 1 *	1-15	
Y	US 2020/149751 A1 (CHO EUNJUN [KR] ET AL) 14 May 2020 (2020-05-14) * & associated description; figures 1-3 *	1-15	TECHNICAL FIELDS SEARCHED (IPC)
Y	US 2014/318168 A1 (MORIMOTO KOUSUKE [JP] ET AL) 30 October 2014 (2014-10-30) * & associated description; figure 10 *	1-15	F25B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	15 November 2024	Gasper, Ralf

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EP 24 18 9102

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

15-11-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 3751211 B1	08-03-2023	EP 3751211 A1	16-12-2020
		KR 20190094539 A	14-08-2019
		US 2019242617 A1	08-08-2019
		WO 2019151815 A1	08-08-2019
EP 2940407 B1	14-11-2018	EP 2940407 A1	04-11-2015
		ES 2710923 T3	29-04-2019
		JP 6190388 B2	30-08-2017
		JP WO2014102934 A1	12-01-2017
		WO 2014102934 A1	03-07-2014
CN 212746959 U	19-03-2021	NONE	
US 2020149751 A1	14-05-2020	EP 3650764 A1	13-05-2020
		KR 20200053269 A	18-05-2020
		US 2020149751 A1	14-05-2020
US 2014318168 A1	30-10-2014	AU 2012361845 A1	24-07-2014
		CN 104011472 A	27-08-2014
		EP 2803914 A1	19-11-2014
		JP 5459303 B2	02-04-2014
		JP 2013133982 A	08-07-2013
		KR 20140116431 A	02-10-2014
		US 2014318168 A1	30-10-2014
		WO 2013099733 A1	04-07-2013

EPO FORM P0459

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- KR 1020220001156 **[0004] [0008]**