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**Park et al.**(10) **Pub. No.: US 2011/0271703 A1**(43) **Pub. Date: Nov. 10, 2011**(54) **REFRIGERATOR****Publication Classification**

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(52) **U.S. Cl. .... 62/291; 62/498; 62/441**(57) **ABSTRACT**

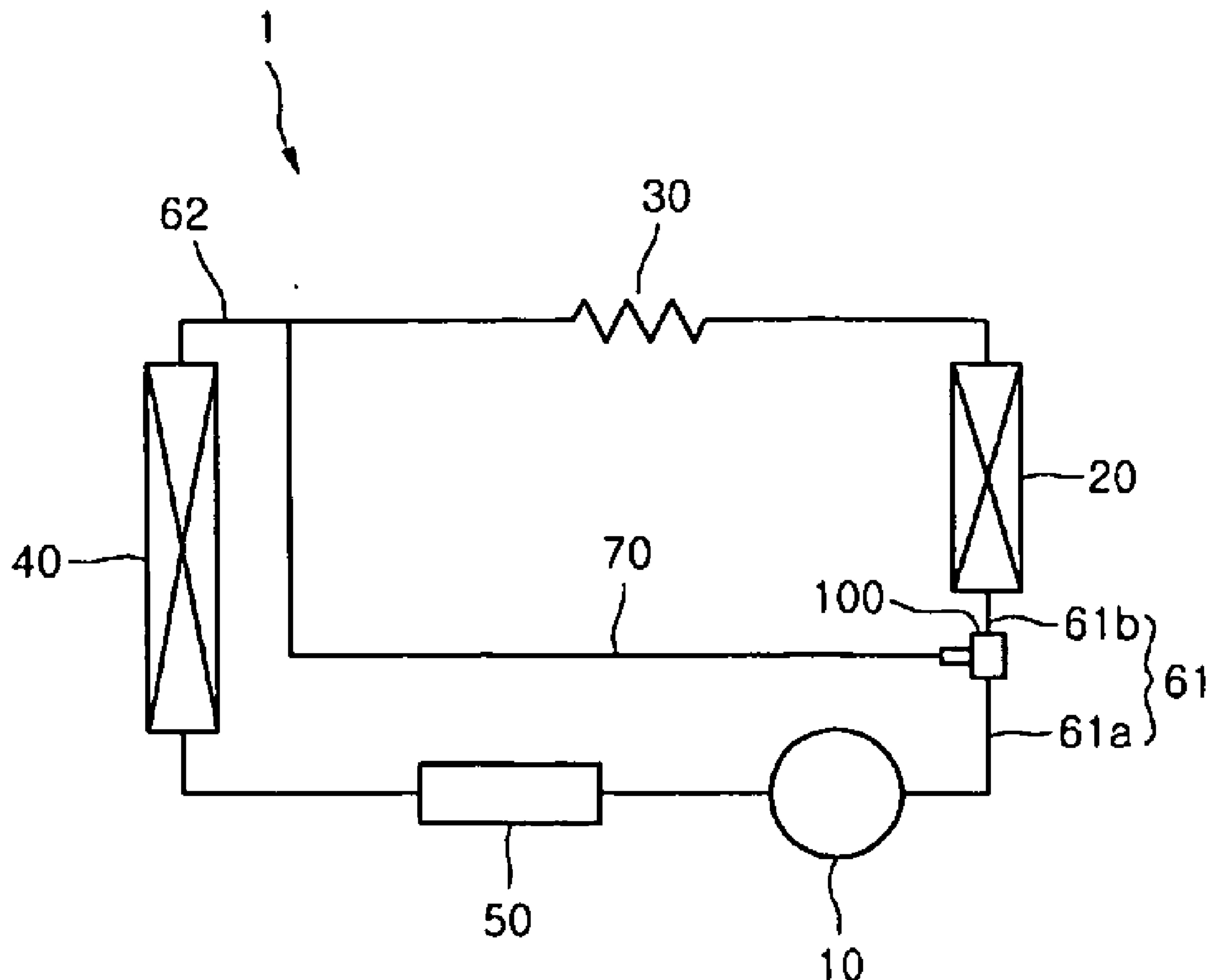
A refrigerator is provided. The refrigerator includes a compressor, a condenser, an expansion valve, an evaporator, a bypass pipe, and a valve device. The condenser condenses refrigerant discharged from the compressor, and the expansion valve expands the refrigerant condensed in the condenser. The evaporator evaporates the refrigerant expanded in the expansion valve, and the bypass pipe allows the refrigerant discharged from the compressor to move toward an inlet of the evaporator. The valve device allows the refrigerant discharged from the compressor to selectively move toward the bypass pipe or the condenser. The valve device comprises an inlet, a first outlet, and a second outlet. The refrigerant discharged from the compressor flows into the inlet. The refrigerant is discharged toward the condenser through the first outlet, and is discharged toward the bypass pipe through the second outlet. The first outlet has a diameter larger than that of the second outlet.

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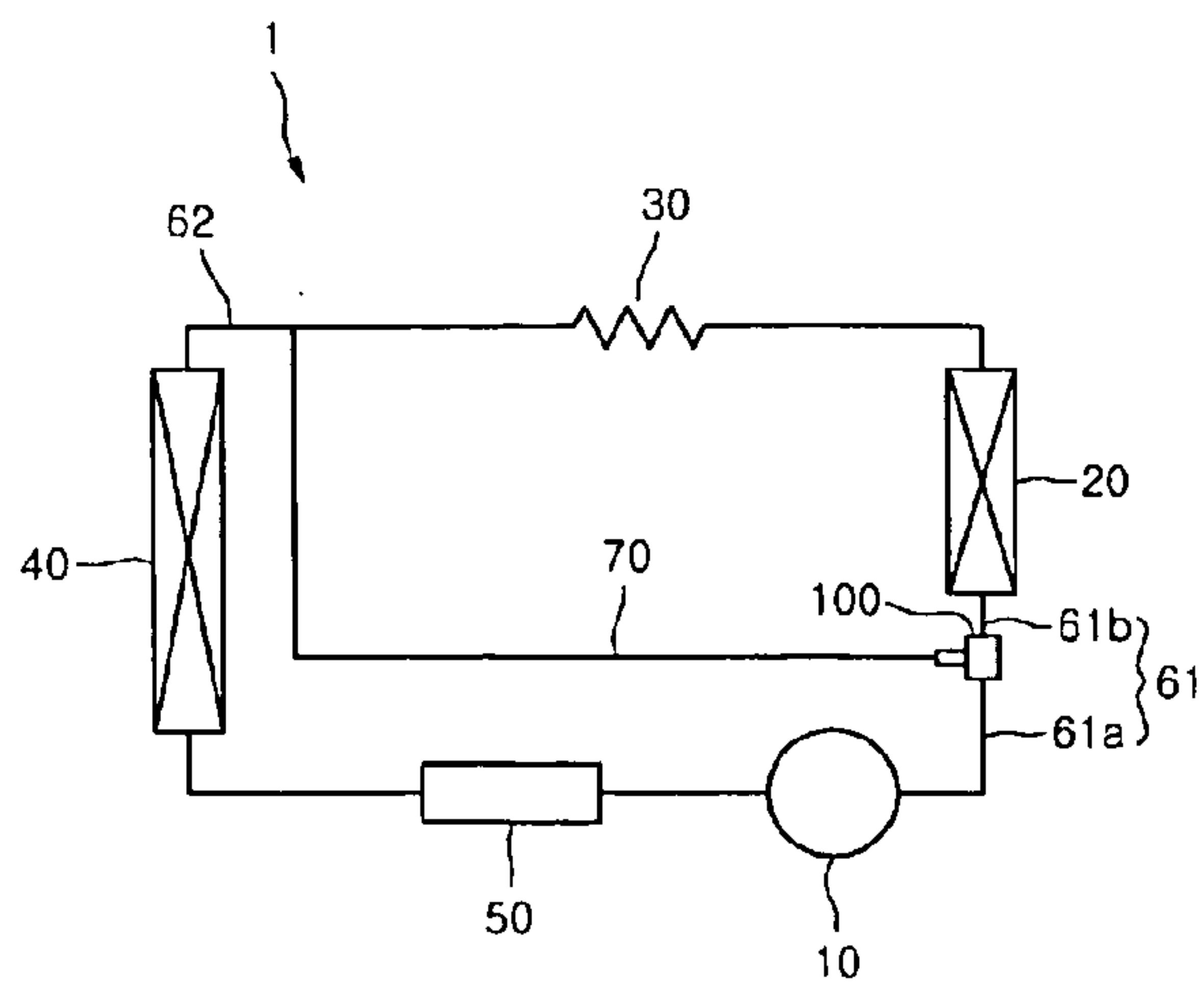
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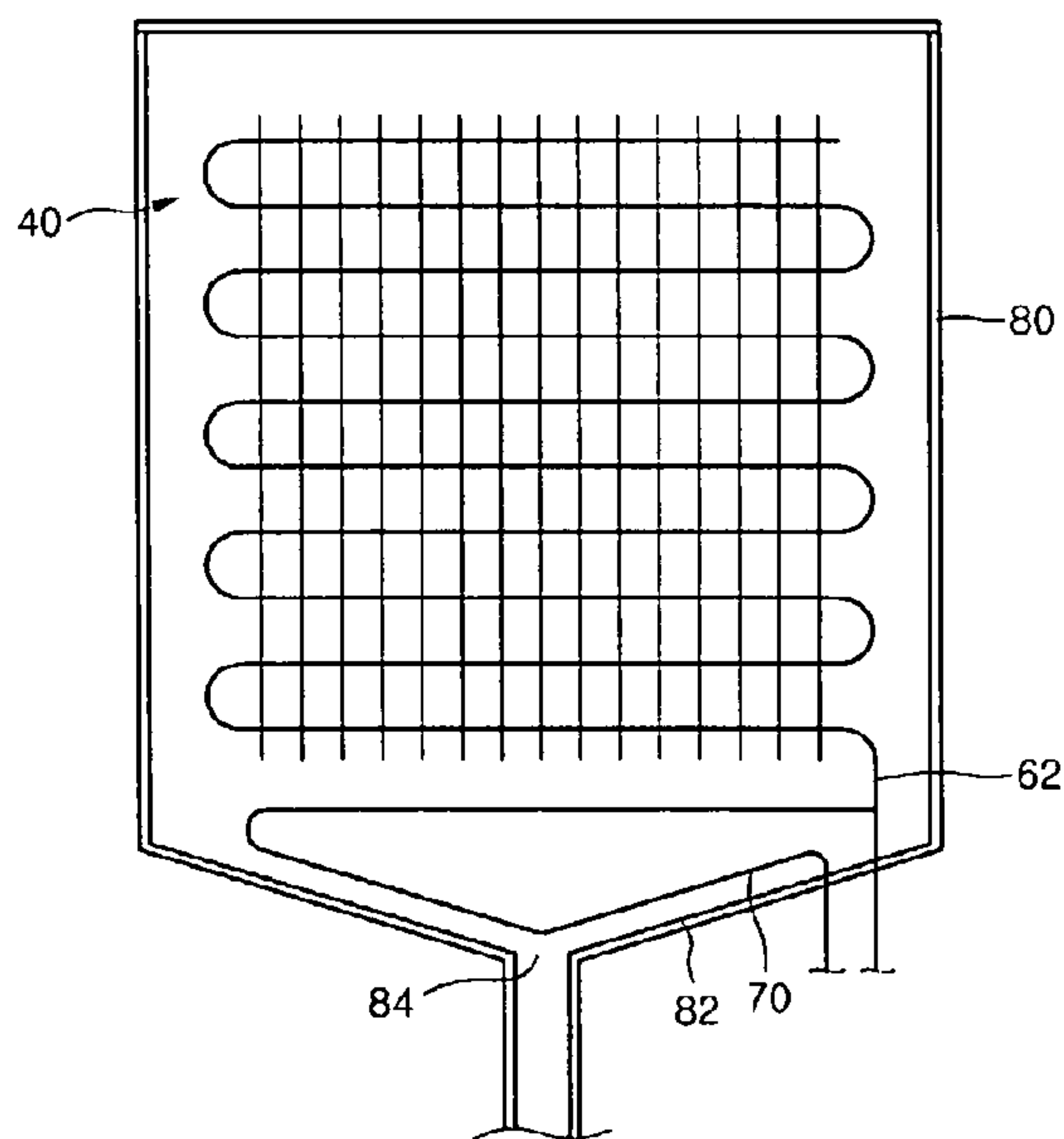
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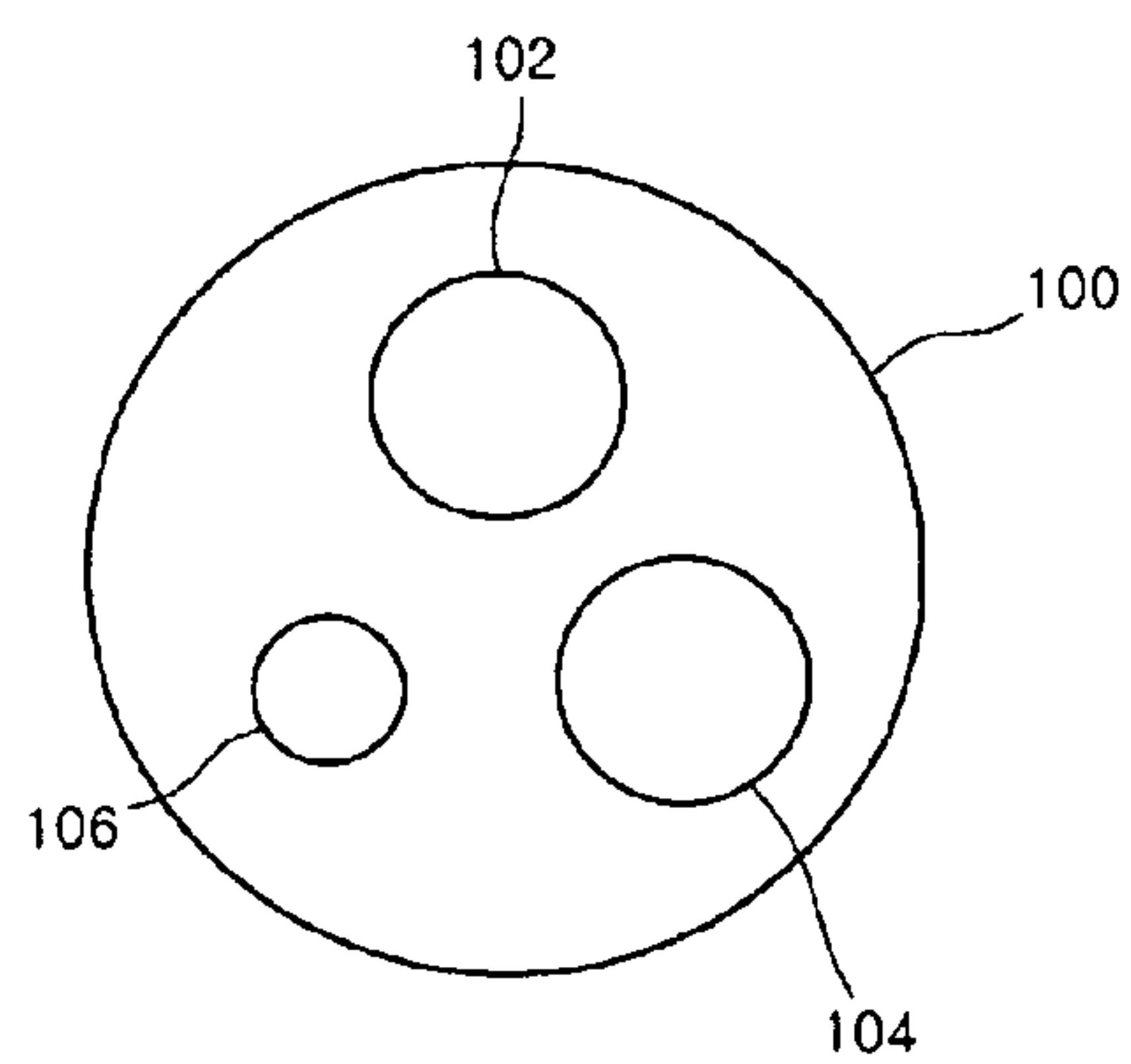
[Fig. 1]



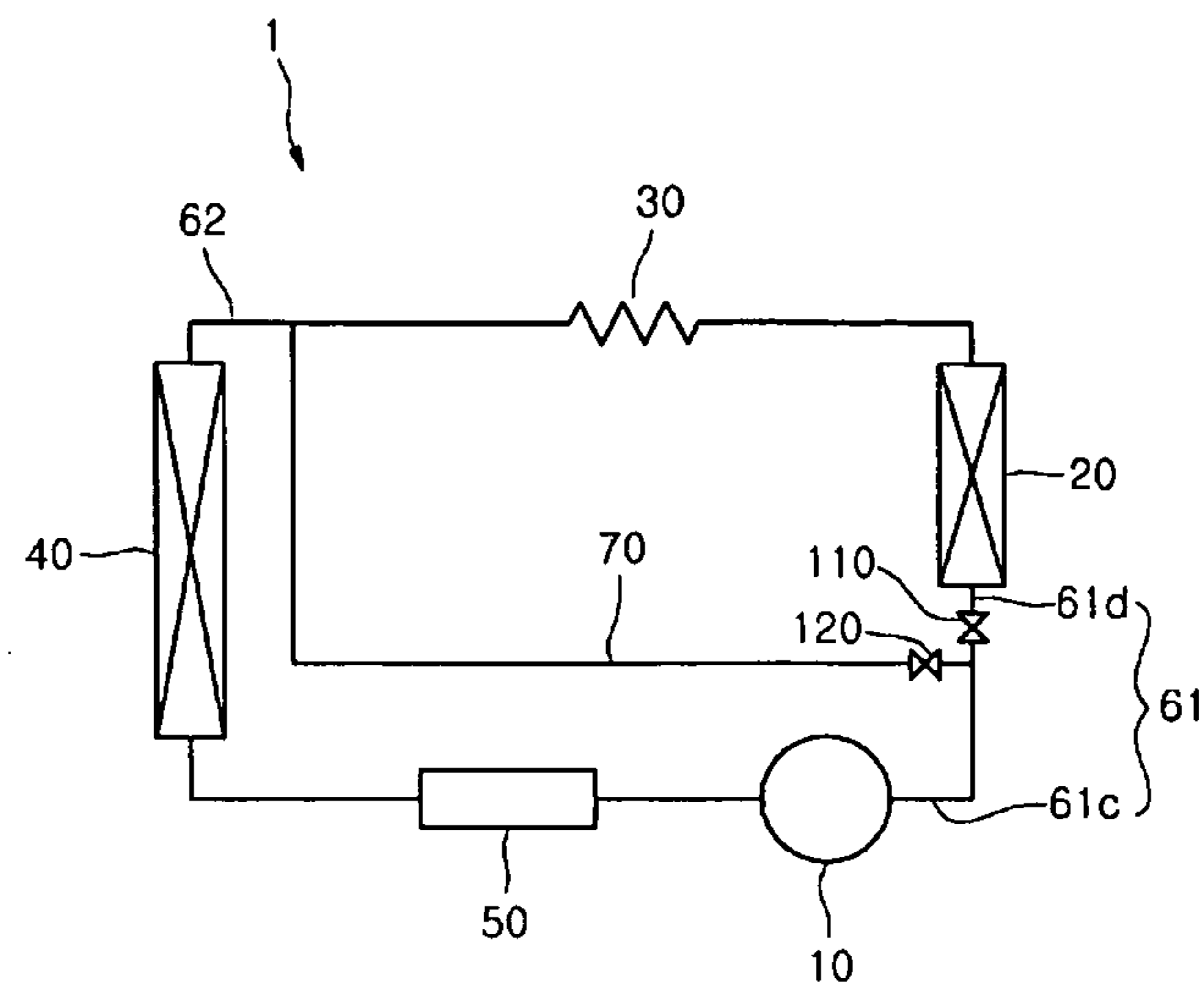
[Fig. 2]



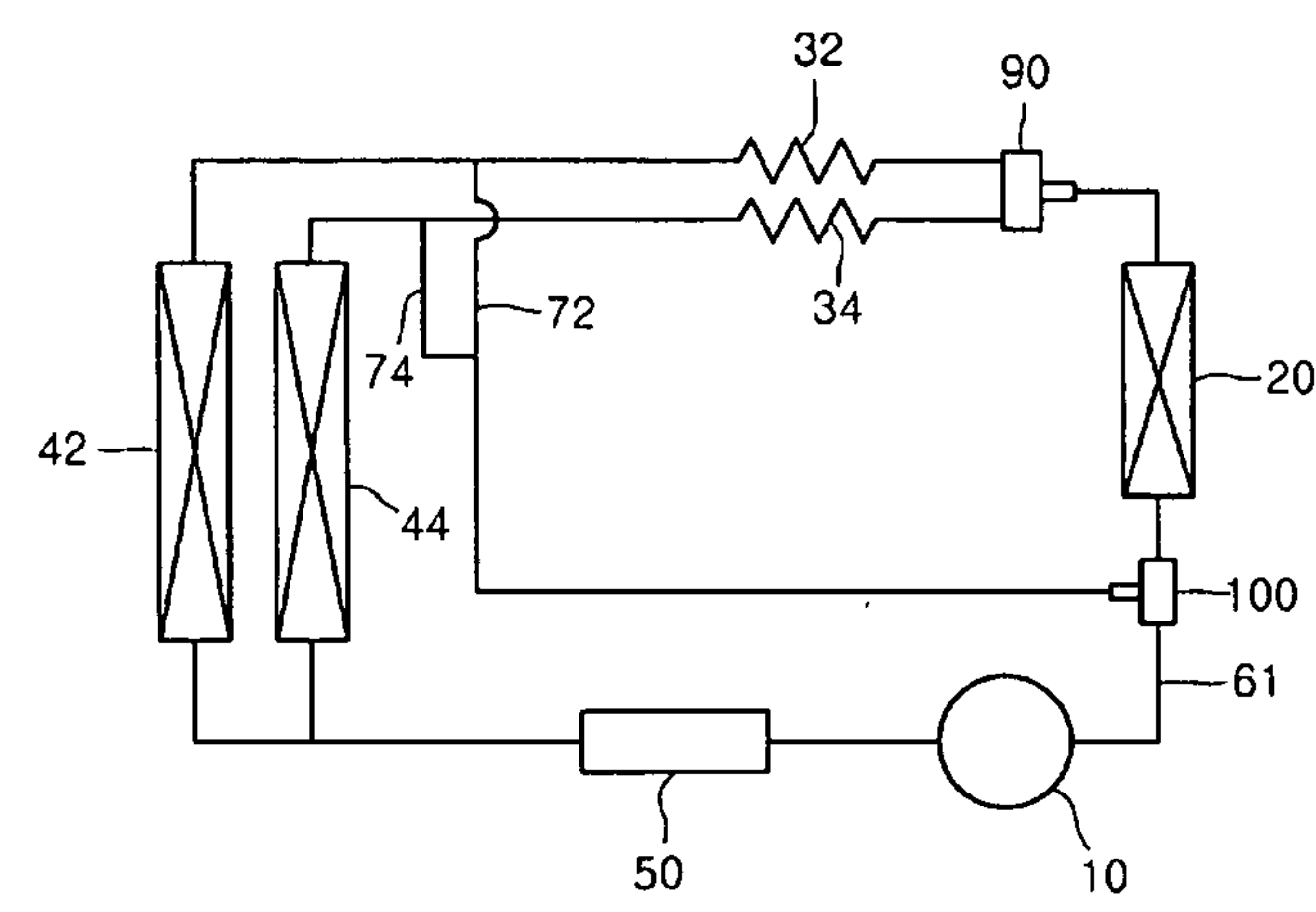
[Fig. 3]



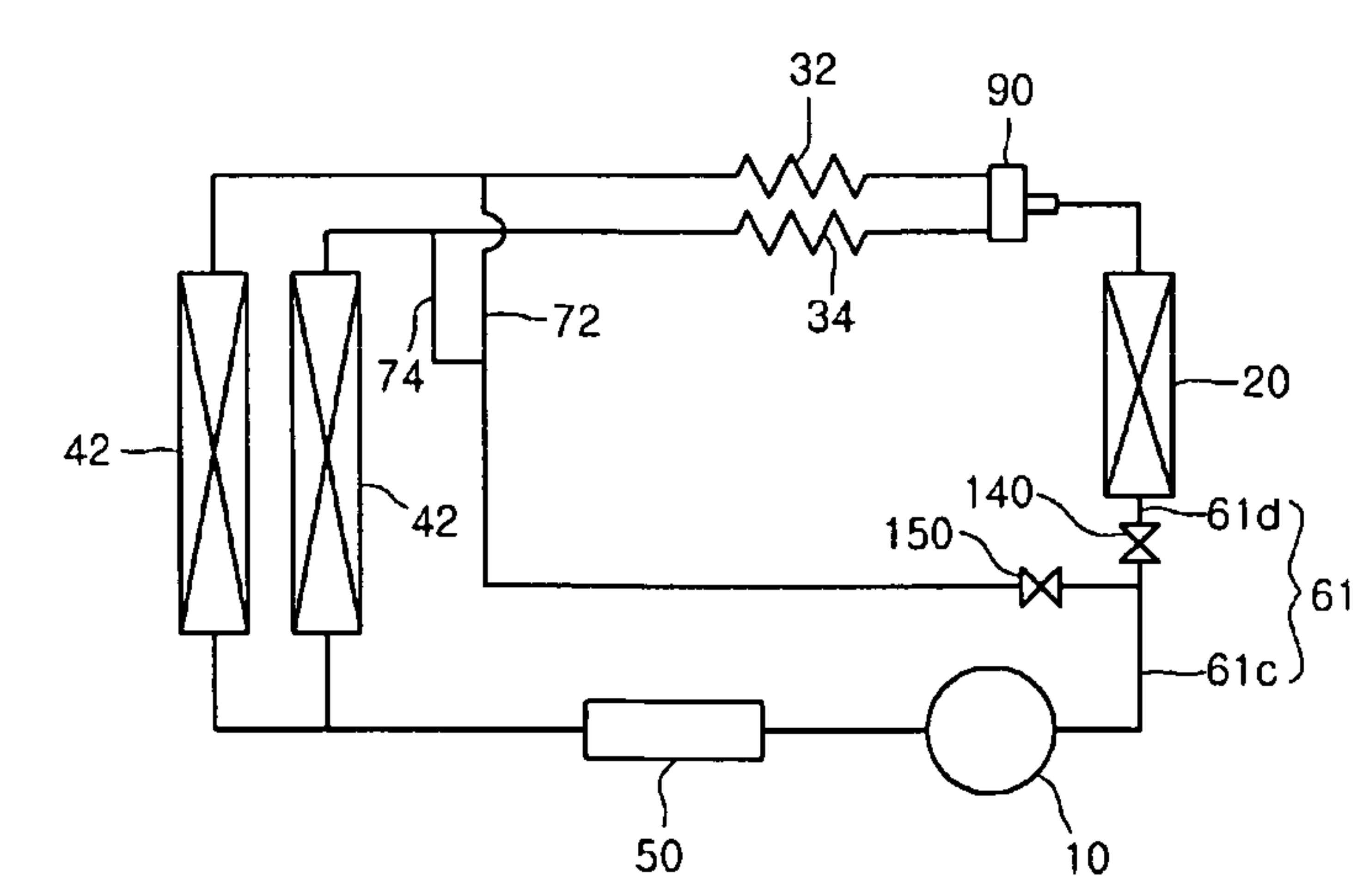
[Fig. 4]



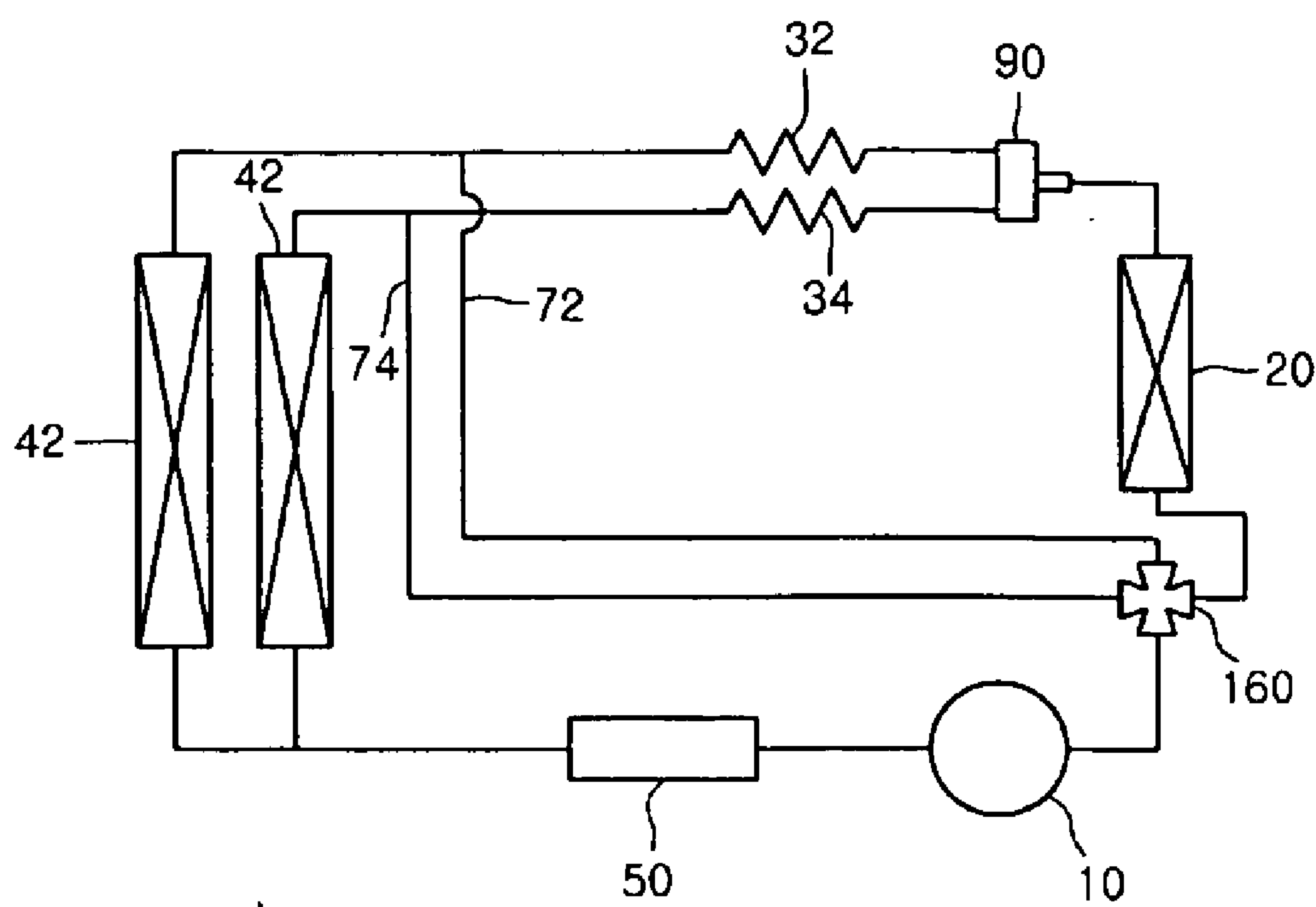
[Fig. 5]



[Fig. 6]



[Fig. 7]





**REFRIGERATOR****TECHNICAL FIELD**

[0001] The present disclosure relates to a refrigerator.

**BACKGROUND ART**

[0002] A refrigerator supplies cold air to a freezer compartment and a refrigeration compartment through a refrigerant system so as to store foods at a low temperature.

[0003] The refrigerant system includes a compressor, a condenser, an expansion unit, and an evaporator. Air is cooled while passing through the evaporator, and then is supplied to the freezer compartment and the refrigeration compartment.

[0004] Cold air, which has circulated inside the freezer compartment and the refrigeration compartment, moves to a heat exchange chamber including the evaporator through a predetermined path.

[0005] Here, moisture included in the air circulating inside the refrigerator becomes frost on a surface of the evaporator.

[0006] A large amount of frost greatly affects heat exchange efficiency of the evaporator and increases a flow resistance of air passing through the evaporator. Therefore, when frost of more than a predetermined amount is generated, a defrosting operation is performed using a defrost heater.

[0007] When power is applied to the defrost heater for a defrosting operation, the defrost heater radiates heat to melt frost generated on a surface of the evaporator adjacent to the defrost heater. Heat from the defrost heater is gradually transferred to an upper portion of the evaporator and removes the frost generated on the surface of the evaporator.

[0008] However, power should be additionally applied to the defrost heater, thereby leading to high power consumption. Also, the heat of the defrost heater causes a temperature increase in the refrigerator.

[0009] In addition, because the defrost heater is provided at one portion of the evaporator and heats only the portion of the evaporator, it takes a long time to defrost.

**DISCLOSURE OF INVENTION****Technical Problem**

[0010] Embodiments provide a refrigerator in which a defrost time is reduced and an internal temperature in the refrigerator is prevented from increasing during a defrosting operation.

[0011] Embodiments also provide a refrigerator in which frost removed from an evaporator is prevented from blocking an outlet formed in a tray.

**Technical Solution**

[0012] In one embodiment, a refrigerator includes a compressor; a condenser condensing refrigerant discharged from the compressor; an expansion valve expanding the refrigerant condensed in the condenser; an evaporator evaporating the refrigerant expanded in the expansion valve; a bypass pipe allowing the refrigerant discharged from the compressor to move toward an inlet of the evaporator; and a valve device allowing the refrigerant discharged from the compressor to selectively move toward the bypass pipe or the condenser, wherein the valve device comprises: an inlet into which the refrigerant discharged from the compressor flows; a first outlet through which the refrigerant is discharged toward the condenser; and a second outlet through which the refrigerant

is discharged toward the bypass pipe, the first outlet having a diameter larger than that of the second outlet.

[0013] In another embodiment, a refrigerator includes a compressor; a condenser condensing refrigerant discharged from the compressor; an expansion valve expanding the refrigerant condensed in the condenser; a plurality of evaporators evaporating the refrigerant expanded in the expansion valve; a bypass pipe allowing the refrigerant discharged from the compressor to move toward an inlet of the evaporator; a valve device allowing the refrigerant discharged from the compressor to selectively move toward the bypass pipe or the condenser; and a condenser intake-side pipe allowing the refrigerant having passed through the valve device to move to the condenser, the condenser intake-side pipe having a diameter larger than that of the bypass pipe.

**Advantageous Effects**

[0014] According to the embodiments, since frost generated on an evaporator can be removed by high-temperature refrigerant discharged from a condenser without an additional defrost heater, power consumption can be reduced.

[0015] Also, since high-temperature refrigerant having passed through the compressor moves inside the evaporator, frost generated on an entire surface of the evaporator can be quickly removed.

[0016] In addition, a flow resistance of refrigerant can be minimized in a normal operation of a refrigerator by adjusting the size of an inlet and an outlet of a valve device.

[0017] Furthermore, since a portion of a bypass pipe is disposed adjacent to a tray for receiving water generated by defrosting, frost can be prevented from blocking an outlet formed in the tray.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0018] FIG. 1 is a schematic view of a refrigerant system of a refrigerator according to a first embodiment.

[0019] FIG. 2 is a view illustrating a position of a bypass pipe.

[0020] FIG. 3 is a schematic view illustrating an internal structure of a valve device according to the first embodiment.

[0021] FIG. 4 is a schematic view of a refrigerant system according to a second embodiment.

[0022] FIG. 5 is a schematic view of a refrigerant system according to a third embodiment.

[0023] FIG. 6 is a schematic view of a refrigerant system according to a fourth embodiment.

[0024] FIG. 7 is a schematic view of a refrigerant system according to a fifth embodiment.

**MODE FOR THE INVENTION**

[0025] Reference will now be made in detail to the embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings.

[0026] FIG. 1 is a schematic view of a refrigerant system of a refrigerator according to a first embodiment.

[0027] Referring to FIG. 1, a refrigerator 1 including a refrigerant system according to the first embodiment includes a compressor 10, a condenser 20, an expansion valve 30, an evaporator 40, and a vapor-liquid separator 50. The compressor 10 compresses refrigerant to high temperature and pressure, and the condenser 20 condenses the compressed refrigerant. The expansion valve 30 expands the condensed refrigerant. The evaporator 40 evaporates the refrigerant



expanded through the expansion valve 30. The vapor-liquid separator 50 is disposed between the evaporator 40 and the compressor 10 to separate the liquid refrigerant and the vapor refrigerant having passed through the evaporator 40.

[0028] In detail, the compressor 10 is connected with the condenser 20 through a first connecting pipe 61. The expansion pipe 30 is connected with the evaporator 40 through a second connecting pipe 62.

[0029] The first connecting pipe 61 is connected with the second connecting pipe 62 through a bypass pipe 70. When it is necessary to defrost the evaporator 40, the bypass pipe 70 provides a path that allows high-temperature refrigerant discharged from the compressor 10 to move toward an inlet of the evaporator 40, i.e., toward the second connecting pipe 62.

[0030] A valve device 100 is provided in the first connecting pipe 61 such that high-temperature refrigerant discharged from the compressor 10 selectively flows into the bypass pipe 70. For example, a 3-way valve may be used as the valve device 100.

[0031] The first connecting pipe 61 may be divided into a compressor discharge-side pipe 61a and a condenser intake-side pipe 61b by the valve device 100. The compressor discharge-side pipe 61a may be connected with the condenser intake-side pipe 61b or the bypass pipe 70 by operation of the valve device 100.

[0032] An operation of the refrigerator 1 having the above construction will now be described.

[0033] During a normal operation of the refrigerator 1, the compressor discharge-side pipe 61a is connected with the condenser intake-side pipe 61b by the valve device 100.

[0034] In such a connection state, refrigerant is compressed through the compressor 10. The compressed refrigerant flows into the condenser 20 through the compressor discharge-side pipe 61a and the condenser intake-side pipe 61b. The refrigerant is condensed through the condenser 20. The condensed refrigerant flows into the expansion valve 30 and then is expanded through the expansion valve 30. The expanded refrigerant flows into the evaporator 40 and is evaporated through the evaporator 40. The evaporated refrigerant is separated into liquid refrigerant and vapor refrigerant through the vapor-liquid separator 50, and the vapor refrigerant flows into the compressor 10.

[0035] Air blown by a blower fan (not shown) is cooled through heat exchange while passing through the evaporator 40, and then is supplied to a freezer compartment and a refrigeration compartment.

[0036] Frost is generated on the evaporator 40 due to the heat exchange of air in the evaporator 40. When more than a predetermined amount of frost is generated, the frost should be removed. In this case, the refrigerator 1 performs a defrosting operation.

[0037] When the refrigerator 1 performs a defrosting operation, the compressor discharge-side pipe 61a is connected with the bypass pipe 70 by the valve device 100. Therefore, high-temperature refrigerant discharged from the compressor 10 does not flow into the condenser 20, but flows into the second connecting pipe 62 through the bypass pipe 70. Then, the high-temperature refrigerant flows into the evaporator 40. Therefore, as the high-temperature refrigerant flows inside the evaporator 40, the frost generated on the evaporator 40 is removed.

[0038] According to the first embodiment, the frost generated on the evaporator 40 can be removed without an additional defrost heater, thereby reducing power consumption. In

addition, since the refrigerant from the compressor 10 flows inside the evaporator 40, the frost generated on an entire surface of the evaporator 40 can be quickly removed.

[0039] FIG. 2 is a view illustrating a position of a bypass pipe.

[0040] Referring to FIG. 2, a heat exchange chamber 80, where the evaporator 40 is located, is provided at a rear side of the refrigerator 1. A tray 82 is disposed under the evaporator 40, and an outlet 84 is formed in a central portion of the tray 82. Water generated by defrosting for the evaporator 40 falls down into the tray 82, and the water having fallen into the tray 82 is discharged through the outlet 84.

[0041] Here, the tray 82 and the outlet 84 may be formed integrally with the heat exchange chamber 80. A water pan (not shown) may be further formed under the outlet 84 to receive the water generated by defrosting.

[0042] A portion of the bypass pipe 70 is disposed between the evaporator 40 and the tray 82, and may be disposed adjacent to the tray 82.

[0043] In detail, when high-temperature refrigerant bypassed by the bypass pipe 70 flows inside the evaporator 40, frost generated on the evaporator 40 is melted by the high-temperature refrigerant. In this case, melted frost or lumped frost falls down into the tray 82. Here, when the lumped frost falls down into the tray 82, the outlet 84 may be blocked by the lumped frost.

[0044] In the first embodiment, a portion of the bypass pipe 70 is disposed adjacent to the tray 82 so that the frost falling down into the tray 82 can be melted by the high-temperature refrigerant that flows in the bypass pipe 70. Accordingly, the outlet 84 can be prevented from being blocked.

[0045] FIG. 3 is a schematic view illustrating an internal structure of a valve device according to a first embodiment.

[0046] Referring to FIG. 3, as described above, a 3-way valve may be used as the valve device 100. The 3-way valve includes an inlet 102, a first outlet 104, and a second outlet 106. The refrigerant discharged from the compressor 10 flows into the inlet 102. The refrigerant flowing into the inlet 102 is discharged to the condenser intake-side pipe 61b through the first outlet 104, and is discharged to the bypass pipe 70 through the second outlet 106.

[0047] In detail, the inlet 102 has a diameter equal to that of the first outlet 104. The second outlet 106 has a diameter smaller than that of the inlet 102 and the first outlet 104.

[0048] In general, two outlets of a 3-way valve have the same diameter. However, in this case, a flow resistance becomes higher in a normal operation of the refrigerator compared with the refrigerator without having the 3-way valve. Therefore, the efficiency of a freezing cycle decreases, thereby increasing power consumption.

[0049] Therefore, in the first embodiment, the inlet 102 and the first outlet 104 have a diameter larger than that of the second outlet 106 so as to minimize the flow resistance of the refrigerant in a normal operation of the refrigerator.

[0050] Here, since the first outlet 104 has a diameter larger than that of the second outlet 106, the condenser intake-side pipe 61b may be formed to a diameter larger than that of the bypass pipe 70.

[0051] FIG. 4 is a schematic view of a refrigerant system according to a second embodiment.

[0052] Since the second embodiment is the same as the first embodiment except the structure of a valve device, detailed description will be omitted herein.



[0053] Referring to FIG. 4, a valve device according to the second embodiment includes a first valve 110 and a second valve 120. The first valve 110 is provided in a first connecting pipe 61 that connects the compressor 10 with the condenser 20. The second valve 120 is provided in the bypass pipe 70.

[0054] In detail, the bypass pipe 70 diverges from the first connecting pipe 61. The first connecting pipe 61 may be divided into a compressor discharge-side pipe 61c and a condenser intake-side pipe 61d by the bypass pipe 70. The first valve 110 is provided in the condenser intake-side pipe 61d.

[0055] The first valve 110 is opened and the second valve 120 is closed in a normal operation of the refrigerator. In this case, high-temperature refrigerant discharged from the compressor 10 flows into the condenser 20.

[0056] On the other hand, the first valve 110 is closed and the second valve 120 is opened in a defrosting operation of the refrigerator. In this case, high-temperature refrigerant discharged from the compressor 10 flows into the evaporator 40 through the bypass pipe 70. The high-temperature refrigerant removes frost generated on the evaporator 40. When the defrosting operation is ended, the first valve 110 is opened and the second valve 120 is closed.

[0057] FIG. 5 is a schematic view of a refrigerant system according to a third embodiment.

[0058] Referring to FIG. 5, the refrigerant system according to the third embodiment includes a compressor 10, a condenser 20, a plurality of evaporators, expansion valves of the same number as the evaporators, and a plurality of bypass pipes. The bypass pipes allow refrigerant discharged from the compressor 10 to flow into the evaporators.

[0059] In detail, the evaporators include an evaporator 42 for a freezing compartment and an evaporator 44 for a refrigeration compartment. The expansion valves include a first expansion valve 32 for expanding refrigerant to flow into the evaporator 42 and a second expansion valve 34 for expanding refrigerant to flow into the evaporator 44.

[0060] The bypass pipes include a first bypass pipe 72 and a second bypass pipe 74. The first bypass pipe 72 allows high-temperature refrigerant discharged from the compressor 10 to move toward an inlet of the evaporator 42. The second bypass pipe 74 diverges from the first bypass pipe 72 and allows high-temperature refrigerant to move toward an inlet of the evaporator 44.

[0061] A 3-way valve 90 is disposed between the condenser 20 and the evaporators 42 and 44 and determines a flow direction of the condensed refrigerant. A valve device 100 is disposed between the compressor 10 and the condenser 20 such that high-temperature refrigerant discharged from the compressor 10 can selectively flow into the bypass pipes 72 and 74. For example, a 3-way valve may be used as the valve device 100.

[0062] According to the above-construction, when a freezing cycle operates, refrigerant compressed in the compressor 10 is condensed through the condenser 20. The refrigerant discharged from the condenser 20 flows into the first expansion valve 32 by operation of the 3-way valve 90.

[0063] The refrigerant is expanded through the first expansion valve 32 and flows into the evaporator 42 for a freezer compartment. The refrigerant evaporated in the evaporator 42 flows into the vapor-liquid separator 50, and vapor refrigerant of the refrigerant flows into the compressor 10.

[0064] On the other hand, when a refrigeration cycle operates, refrigerant compressed in the compressor 10 is condensed through the condenser 20. The refrigerant discharged

from the condenser 20 flows into the second expansion valve 34 by operation of the 3-way valve 90.

[0065] The refrigerant is expanded through the second expansion valve 34 and flows into the evaporator 44 for a refrigeration compartment. The refrigerant evaporated in the evaporator 44 flows into the vapor-liquid separator 50, and vapor refrigerant of the refrigerant flows into the compressor 10.

[0066] Meanwhile, when the refrigerator performs a defrosting operation, high-temperature refrigerant compressed in the compressor 10 flows into the first and second bypass pipes 72 and 74 by operation of the valve device 100, and then flows into the evaporators 42 and 44. The high-temperature refrigerant removes frost generated on the evaporators 42 and 44.

[0067] According to the second embodiment, the high-temperature refrigerant discharged from the compressor 10 can remove frost generated on the evaporators 42 and 44 at the same time.

[0068] Here, the first bypass pipe 72 provides a flow passage of high-temperature refrigerant toward the evaporator 42, and the second bypass pipe 74 diverges from the first bypass pipe 72, and vice-versa.

[0069] FIG. 6 is a schematic view of a refrigerant system according to a fourth embodiment.

[0070] Since the fourth embodiment is the same as the third embodiment except the structure of a valve device, detailed description will be omitted herein.

[0071] Referring to FIG. 6, a valve device according to the fourth embodiment includes a first valve 140 and a second valve 150. The first valve 140 is provided in a first connecting pipe 61 that connects the compressor 10 to the condenser 20. The second valve 150 is provided in the first bypass pipe 72.

[0072] In detail, the first bypass pipe 72 diverges from the first connecting pipe 61. The first connecting pipe 61 may be divided into a compressor discharge-side pipe 61c and a condenser intake-side pipe 61d by the first bypass pipe 72. The first valve 140 is provided in the condenser intake-side pipe 61d.

[0073] Therefore, the first valve 140 is opened and the second valve 150 is closed in a normal operation of the refrigerator. On the other hand, the first valve 140 is closed and the second valve 150 is opened in a defrosting operation of the refrigerator.

[0074] FIG. 7 is a schematic view of a refrigerant system according to a fifth embodiment.

[0075] Since the fifth embodiment is the same as the third embodiment except the structure of a valve device, detailed description will be omitted herein.

[0076] Referring to FIG. 7, a 4-way valve is used as a valve device 160 according to the fifth embodiment. A first bypass pipe 72 connected to an inlet of the evaporator 42 is separately formed a second bypass pipe 74 connected to an inlet of the evaporator 44. One end of each of the bypass pipes 72 and 74 is connected to the valve device 160.

[0077] Therefore, in a normal operation of the refrigerator, high-temperature refrigerant discharged from the compressor 10 flows into the condenser 20 by operation of the valve device 160.

[0078] In order to defrost the evaporator 42 for a freezing compartment, high-temperature refrigerant discharged from the compressor 10 flows into the first bypass pipe 72 by operation of the valve device 160. On the other hand, in order to defrost the evaporator 44 for a refrigeration compartment,



high-temperature refrigerant discharged from the compressor **10** flows into the second bypass pipe **74** by operation of the valve device **160**.

[0079] Therefore, according to the fifth embodiment, the evaporators **42** and **44** can be selectively defrosted.

[0080] A pair of evaporators are provided in the third to fifth embodiments, however, the number of the evaporators is not limited thereto. Even in the case where three or more evaporators are provided, the evaporators can be defrosted using the above-described structure.

1. A refrigerator comprising:

- a compressor;
- a condenser condensing refrigerant discharged from the compressor;
- an expansion valve expanding the refrigerant condensed in the condenser;
- an evaporator evaporating the refrigerant expanded in the expansion valve;
- a bypass pipe allowing the refrigerant discharged from the compressor to move toward an inlet of the evaporator; and
- a valve device allowing the refrigerant discharged from the compressor to selectively move toward the bypass pipe or the condenser,

wherein the valve device comprises:

- an inlet into which the refrigerant discharged from the compressor flows;
- a first outlet through which the refrigerant is discharged toward the condenser; and
- a second outlet through which the refrigerant is discharged toward the bypass pipe, the first outlet having a diameter larger than that of the second outlet.

2. The refrigerator according to claim 1, wherein the inlet has a diameter larger than that of the second outlet.

3. The refrigerator according to claim 1, wherein water generated by defrosting falls down into a tray under the evaporator, and a portion of the bypass pipe is disposed between the tray and the evaporator.

4. A refrigerator comprising:

- a compressor;
- a condenser condensing refrigerant discharged from the compressor;

an expansion valve expanding the refrigerant condensed in the condenser;

a plurality of evaporators evaporating the refrigerant expanded in the expansion valve;

a bypass pipe allowing the refrigerant discharged from the compressor to move toward an inlet of the evaporator;

a valve device allowing the refrigerant discharged from the compressor to selectively move toward the bypass pipe or the condenser; and

a condenser intake-side pipe allowing the refrigerant having passed through the valve device to move to the condenser, the condenser intake-side pipe having a diameter larger than that of the bypass pipe.

5. The refrigerator according to claim 4, further comprising a compressor discharge-side pipe connecting the valve device with the compressor, the compressor discharge-side pipe having a diameter larger than that of the bypass pipe.

6. The refrigerator according to claim 4, wherein the plurality of evaporators comprises a freezer compartment evaporator and a refrigeration compartment evaporator, and the bypass pipe comprises a first bypass pipe selectively connected with one of the plurality of evaporators and a second bypass pipe selectively connected with the other of the plurality of evaporators.

7. The refrigerator according to claim 6, wherein the first bypass pipe is connected with the valve device and the second bypass pipe diverges from the first bypass pipe.

8. The refrigerator according to claim 6, wherein the valve device comprises:

- a first valve provided in the a condenser intake-side pipe to selectively communicated the compressor with the condenser; and

- a second valve provided in the first bypass pipe to selectively connect the compressor with each of the evaporators, and

the second bypass pipe diverges from the first bypass pipe.

9. The refrigerator according to claim 6, wherein each of the bypass pipes is separately connected with the valve device such that refrigerant discharged from the compressor flows selectively to each of bypass pipes.

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