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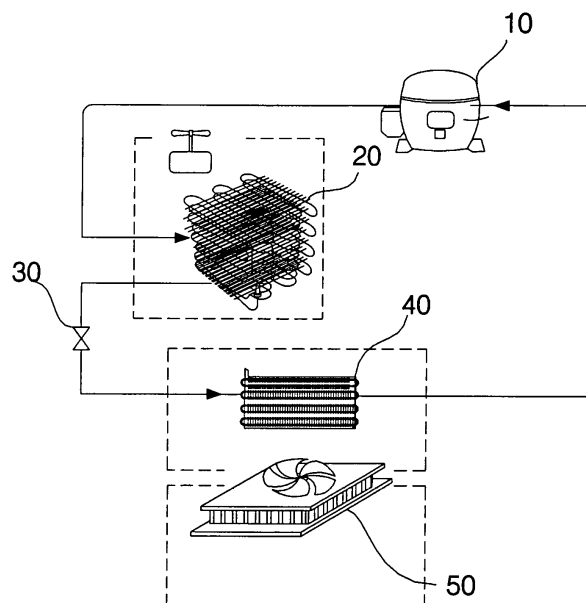
(54) Hybrid cooling system, and refrigerator and freezer using the same

(57) A hybrid cooling system comprising a compressor (10) for compressing a gas refrigerant, a condenser (20) for condensing the refrigerant compressed in the compressor to a liquid state, an expansion (30) device for expanding the refrigerant condensed in the condenser, and an evaporator (40) for heat-exchanging the expanded refrigerant with ambient air, thereby evaporating the refrigerant. This hybrid cooling system further com-

prises a thermoelectric module (50) for re-cooling the air, which has been cooled in accordance with the heat exchange in the evaporator, using a Peltier effect generated in accordance with an electrical co-operation of P-type and N-type semiconductor elements (53, 54) included in the thermoelectric module with current flowing through the semiconductor elements.

The invention also relates to the application of such a cooling system in a freezer or a refrigerator.

FIG. 2



Description

[0001] The present invention relates to a hybrid cooling system that provides a cooling effect at a low temperature, and a refrigerator and a freezer which use the hybrid cooling system.

[0002] Generally, refrigerators include a compressor, a condenser, an expansion device, and an evaporator which form a cooling cycle to perform operations for compressing, condensing, and evaporating a refrigerant.

[0003] In such a refrigerator, however, it is difficult to lower the temperature of the freezing compartment in the refrigerator to -30°C or below. In order to cool the freezing compartment to ultra-low temperatures, two cooling cycles are conventionally formed in the refrigerator.

[0004] FIG. 1 is a schematic view illustrating a conventional cooling cycle for cooling a refrigerator to ultra-low temperatures.

[0005] As shown in FIG. 1, the conventional refrigerator cooling cycle includes a first cooling cycle which is constituted by a first compressor 1, a first condenser 2, a first expansion device 3, and an intermediate heat exchanger 4, and a second cooling cycle which is constituted by a second compressor 5, an intermediate heat exchanger 6, a second expansion device 7, and an evaporator 8.

[0006] In the first cooling cycle, a refrigerant is compressed through the first compressor 1, condensed through the first condenser 2, expanded to a low-temperature and low-pressure liquid state through the first expansion device 3, and then evaporated through the intermediate heat exchanger 4 to generate a cooling effect.

[0007] Meanwhile, in the second cooling cycle, a refrigerant is compressed through the second compressor 5, and then condensed through the intermediate heat exchanger 6 which functions as a second condenser. In the intermediate heat exchanger 6, the refrigerant is cooled to a temperature lower than the cooling temperature of the first condenser 2 in accordance with the cooling effect of the intermediate heat exchanger 4 in the first cycle. The condensed refrigerant is expanded through the second expansion device 7, and is then evaporated through the evaporator 8 to generate a cooling effect at an ultra-low temperature of -30 to -80°C.

[0008] Thus, the first cooling cycle is driven to enable the intermediate heat exchanger 6 of the second cooling cycle to attain a desired ultra-low condensing temperature.

[0009] Also, the refrigerant of the second cooling cycle must have a condensing temperature lower than that of the refrigerant of the first cooling cycle.

[0010] However, where two cooling cycles are driven to enable the evaporator 8 to attain an ultra-low cooling temperature of -30 to -80°C under an ambient temperature condition of 20 to 40°C, as in the above-mentioned case, it is necessary to use a higher number of constituent elements reaching about two times that of the case in

which a single cooling cycle is used. Furthermore, there is a problem of considerable degradation in the thermal efficiency required to obtain the desired ultra-low cooling temperature.

[0011] In addition, it is necessary to use two different refrigerants for the two cooling cycles. There is also a problem in that the compressors 1 and 5 of the first and second cycles must be controlled independently of each other.

[0012] For these reasons, where two cooling cycles are used, as mentioned above, there are problems of higher costs, an increase in the number of processes, and a reduction in refrigerator inner space caused by an increase in the number of constituent elements.

[0013] The present invention has been made in view of the above-mentioned problems, and it is an object of the invention to provide a hybrid cooling system for a refrigerator in which a single cooling cycle is formed, and a thermoelectric module is used to attain an ultra-low cooling temperature of -30 to -80°C.

[0014] More particularly, the present invention relates to a hybrid cooling system wherein air heat-exchanged in an evaporator is re-cooled using a thermoelectric module having an electrical function to generate a cooling effect, so that the hybrid cooling system obtains a cooling effect at a lower temperature.

[0015] In accordance with a first aspect, the present invention provides a cooling system as recited in claim 1.

[0016] In accordance with a second aspect, the present invention provides a freezer as recited in claim 4.

[0017] In accordance with a third aspect, the present invention provides a refrigerator comprising a freezer as recited in claim 9.

[0018] In accordance with a fourth aspect, the present invention provides a cooling system as recited in claim 11.

[0019] Other features of these aspects are recited in the dependant claims.

[0020] The above objects, and other features and advantages of the present invention will become more apparent after reading the following detailed description when taken in conjunction with the drawings, in which:

FIG. 1 is a schematic view illustrating a conventional cooling cycle for cooling a refrigerator to ultra-low temperatures;

FIG. 2 is a schematic view illustrating a hybrid cooling system of a refrigerator according to the present invention;

FIG. 3 is a sectional view illustrating a hybrid cooling structure in a refrigerator according to a first embodiment of the present invention;

FIG. 4 is a schematic view illustrating a general thermoelectric module;

FIG. 5 is a sectional view illustrating a hybrid cooling structure of a refrigerator according to a second embodiment of the present invention;

FIG. 6 is a sectional view illustrating a freezer ac-

cording to a third embodiment of the present invention; and

FIG. 7 is a sectional view illustrating a freezer according to a fourth embodiment of the present invention.

[0021] Hereinafter, exemplary embodiments of a refrigerator according to the present invention will be described with reference to the annexed drawings.

[0022] Although there may be various embodiments associated with the refrigerator according to the present invention, the following description will be given in conjunction with preferred embodiments. In the following description, detailed description of basic configurations of the refrigerator or freezer according to the present invention will be omitted because those configurations are identical to those of the above-mentioned related art.

[0023] FIG. 2 is a schematic view illustrating a hybrid cooling system of a refrigerator according to the present invention. FIG. 3 is a sectional view illustrating a hybrid cooling structure in a refrigerator according to a first embodiment of the present invention. FIG. 4 is a schematic view illustrating a general thermoelectric module.

[0024] As shown in FIG. 2, the refrigerator according to the present invention includes a refrigerant circulation type cooling system using circulation of a refrigerant to generate a cooling effect, and a thermoelectric module type cooling system using an electrical co-operation, namely, a Peltier effect.

[0025] The refrigerant circulation type cooling system includes a compressor 10 for compressing a gas refrigerant, a condenser 20 for condensing the refrigerant compressed in the compressor 10 to a liquid state, an expansion device 30 for expanding the refrigerant condensed in the condenser 20 to a fine mist state, and an evaporator 40 for heat-exchanging the expanded refrigerant with ambient air, thereby evaporating the refrigerant. On the other hand, the thermoelectric module type cooling system includes a thermoelectric module 50 for generating a thermoelectric effect to re-cool the air cooled in accordance with the heat exchange thereof in the evaporator 40.

[0026] As shown in FIG. 2 or 3, the refrigerator according to the present invention includes a machine compartment 100 in which the compressor 10, the condenser 20, and the expansion device 30 are installed. The refrigerator also includes a freezing chamber 110 and a refrigerating chamber 120 which are provided in a space defined separately from the machine compartment 100.

[0027] The evaporator 40 is arranged between the freezing compartment 110 and the refrigerating compartment 120.

[0028] A blower 60 is installed inside the refrigerator to circulate air heat-exchanged in the evaporator 40 through the freezing compartment 110 and the refrigerating compartment 120. A flow path is defined in the refrigerator to allow the air blown by the blower 60 to be circulated along the flow path, as shown by arrows in

FIG. 3.

[0029] Meanwhile, a cryogenic compartment 130 is defined in the freezing compartment 110, independently of the freezing compartment 110.

[0030] As shown in FIG. 4, the thermoelectric module 50 is an electric cooling system which does not include a mechanical configuration, contrary to refrigerant circulation type cooling systems.

[0031] The thermoelectric module 50 has a structure in which at least two P-type thermoelectric semiconductor devices 53 and at least two N-type thermoelectric semiconductor elements 54 are fixed between two ceramic substrates 51 and 52 by means of solder.

[0032] When DC current flows through the P-type and N-type thermoelectric elements 53 and 54, heat absorption and discharge phenomena occur at opposite ends of the thermoelectric module 50 in accordance with a Peltier effect. That is, when electrons migrate from the P-type element 53 to the N-type element 54, heat absorption occurs at the upper side of the thermoelectric module 50, and heat discharge occurs at the lower side of the thermoelectric module 50 when viewed in FIG. 4.

[0033] The Peltier effect, discovered by Jean Peltier in 1834, is a phenomenon wherein, when a DC voltage is applied across a junction of different materials, heat absorption occurs at one side of the junction, and heat discharge occurs at the other side of the junction. Thermoelectric modules using a Peltier effect have been developed and made commercially available.

[0034] The thermoelectric module 50 is installed in the cryogenic compartment 130 such that the heat absorption surface of the thermoelectric module 50 is directed to the cryogenic compartment 130, and the heat discharge surface of the thermoelectric module 50 is directed to the freezing compartment 110.

[0035] It is preferred that the thermoelectric module 50 be arranged in a path along which air blown by the blower 60 is circulated in the refrigerator, in order to directly receive the air.

[0036] Meanwhile, when the direction of current applied to the thermoelectric module 50 is changed, the positions of the heat absorption surface and heat discharge surface are inverted.

[0037] Also, it is preferred that blowers 70 and 75 be arranged at both surfaces of the thermoelectric module 50, respectively, in order to selectively circulate air cooled by the thermoelectric module 50 through the cryogenic chamber 130 or freezing compartment 110.

[0038] Hereinafter, operation of the first embodiment of the present invention will be described in detail with reference to FIGS. 2 and 3.

[0039] First, the refrigerant compressed by the compressor 10 is condensed to a liquid state by the condenser 20. The condensed refrigerant is then changed to a mist state by the expansion device 30. Subsequently, the mist refrigerant is evaporated by the evaporator 40.

[0040] Air passing the evaporator 40 during the evaporation of the refrigerant is cooled by the evaporator 40.

The cooled air is then fed to the freezing compartment 110 and refrigerating compartment 120 by the blower 60.

[0041] In particular, it is preferred that the blower 60 comprise a centrifugal blower adapted to centrally suck air, and to circumferentially discharge the sucked air, in order to enable the air cooled by the evaporator 40 to be supplied to both the freezing compartment 110 and the refrigerating compartment 120.

[0042] A fraction of the air introduced into the freezing compartment 110 by the blower 60 is fed to the thermoelectric module 50 which is installed to be exposed to the cryogenic compartment 130.

[0043] The thermoelectric module 50 is selectively driven in accordance with user's desire. When the user desires to maintain the interior of the cryogenic compartment 130 at a temperature lower than that of the freezing compartment 110, the user operates a controller (not shown) for operation of the thermoelectric module 50.

[0044] When the thermoelectric module 50 operates, a heat absorption phenomenon occurs in the cryogenic compartment 130 by the thermoelectric module 50. At this time, a heat discharge phenomenon occurs outside the cryogenic compartment 130 by the thermoelectric module 50.

[0045] When the thermoelectric module 50 operates in the above-described manner, the freezing compartment 110 is maintained at a temperature of about -18°C, and the cryogenic compartment 130 is maintained at a temperature of about -30 to -40°C.

[0046] Since the blowers 70 and 75 are arranged at opposite sides of the thermoelectric module 50, respectively, convection current of air cooled or heated around the thermoelectric module 50 by the Peltier effect is generated in an associated one of the cryogenic compartment 130 and freezing compartment 110. Accordingly, an enhanced cooling effect is generated in the cryogenic compartment 130.

[0047] Also, it is possible to more actively control the temperature of the freezing compartment 110 or cryogenic compartment 130 by controlling the thermoelectric module 50. For example, when the temperature of the cryogenic compartment 130 is lower than a temperature desired by the user, a control operation is performed to change the polarity of current applied to the thermoelectric module 50, and thus, to increase the temperature of the cryogenic compartment 130. Of course, the operation reverse to the above-described operation is also possible.

[0048] FIG. 5 is a sectional view illustrating a hybrid cooling structure of a refrigerator according to a second embodiment of the present invention.

[0049] The second embodiment of the present invention is similar to the first embodiment, except that the thermoelectric module 50 is attached to the evaporator 40.

[0050] That is, the evaporator 40 is installed in the freezing compartment 110, and the thermoelectric module 50 is directly attached to the surface of the evaporator

40. In this case, air cooled by the evaporator 40 is re-cooled by the thermoelectric module 50.

[0051] In accordance with this arrangement, there is an advantage in that it is possible to directly control the temperature of the evaporator 40 through the thermoelectric module 50.

[0052] The remaining configuration according to the second embodiment of the present invention is similar to that of the first embodiment, and, accordingly, no detailed description thereof will be given.

[0053] FIG. 6 is a sectional view illustrating a freezer according to a third embodiment of the present invention.

[0054] Although the third embodiment of the present invention is similar to the first embodiment, the third embodiment provides a freezer which does not include the refrigerating compartment 120, but includes only the freezing compartment 110 and cryogenic compartment 130.

[0055] In accordance with this arrangement, air blown by the blower 60 is circulated only through the freezing compartment 110. The blowers 70 and 75 arranged around the thermoelectric module 50 operate at opposite sides of the thermoelectric module 50, respectively, to generate convection current of cooled air.

[0056] A door 135 is mounted to a front side of the cryogenic compartment 130, in order to prevent the cooled air in the cryogenic compartment 130 from being leaked into the freezing compartment 110. Accordingly, the temperature of the cryogenic compartment 130 can be maintained at a more uniform temperature.

[0057] The remaining configuration according to the third embodiment of the present invention is similar to that of the first embodiment, and, accordingly, no detailed description thereof will be given.

[0058] FIG. 7 is a sectional view illustrating a freezer according to a fourth embodiment of the present invention.

[0059] The fourth embodiment of the present invention is similar to the third embodiment, except that the thermoelectric module 50 is attached to the evaporator 40.

[0060] In this case, a fraction of air cooled by the evaporator 40 is fed to and circulated through the freezing compartment 110 by the blower 60. The remaining fraction of the cooled air is re-cooled by the thermoelectric module 50, and is then circulated through the cryogenic compartment 130 by the blower 70.

[0061] As apparent from the above description, the refrigerator and freezer, each of which is configured by a combination of a refrigerant circulation type cooling system and a thermoelectric module type cooling system using a Peltier effect. Accordingly, it is possible to operate only the thermoelectric module, if necessary, and thus, to locally cool only the cryogenic compartment.

[0062] In the refrigerator and freezer including the hybrid cooling structure according to the present invention, air cooled by the thermoelectric module, which operates independently, is re-cooled. Accordingly, the refrigerator and freezer have a simple structure, as compared to the

conventional cases using two independent cooling cycles.

[0063] In the refrigerator and freezer including the hybrid cooling structure according to the present invention, the thermoelectric module re-cooling the cooled air generates a cooling effect using an electrical co-operation of the P-type and N-type semiconductor elements included in the thermoelectric module with current flowing through the semiconductor elements, namely, a Peltier effect. Accordingly, there are effects of a reduction in noise and a reduction in vibration, as compared to the conventional cases using two independent cooling cycles.

[0064] In the refrigerator and freezer including the hybrid cooling structure according to the present invention, the thermoelectric module operates independently of the refrigerant circulation type cooling system. Accordingly, the thermoelectric module can be installed at a desired position of either the refrigerator or the freezer. Since the thermoelectric module is electrically controlled, it is possible to easily achieve temperature control.

[0065] Although the preferred embodiments of the invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

Claims

1. A cooling system comprising:

a compressor (10) for compressing a gas refrigerant;
a condenser (20) for condensing the refrigerant compressed in the compressor to a liquid state;
an expansion (30) device for expanding the refrigerant condensed in the condenser; and
an evaporator (40) for heat-exchanging the expanded refrigerant with ambient air, thereby evaporating the refrigerant;

characterized in that the cooling system further comprises:

a thermoelectric module (50) for re-cooling the air, which has been cooled in accordance with the heat exchange in the evaporator, using a Peltier effect generated in accordance with an electrical co-operation of P-type and N-type semiconductor elements (53, 54) included in the thermoelectric module with current flowing through the semiconductor elements.

2. The cooling system according to claim 1, wherein the thermoelectric module (50) is attached to the evaporator (40).

3. The cooling system according to any one of claims 1 and 2, further comprising:

a blower (70, 75) arranged at at least one of a heat absorption surface and a heat discharge surface of the thermoelectric module (50).

4. A freezer comprising:

a freezing compartment (110); and
a cryogenic compartment (130) which occupies a fraction of the freezing compartment;

characterized in that the freezer further comprises:

a thermoelectric module (50) installed in the cryogenic compartment, and adapted to re-cool air, which has been cooled by being heat-exchanged with a refrigerant in an evaporating operation of an evaporator (40) included in a cooling cycle formed in the freezer, using a Peltier effect generated in accordance with an electrical co-operation of P-type and N-type semiconductor elements (53, 54) included in the thermoelectric module with current flowing through the semiconductor elements.

5. The freezer according to claim 4, further comprising:

a blower (70, 75) arranged at at least one of a heat absorption surface and a heat discharge surface of the thermoelectric module (50).

6. The freezer according to any one of claims 4 and 5, wherein the thermoelectric module (50) is mounted to a wall partitioning the cryogenic compartment (130) from the freezing compartment (110) to extend through the wall such that a heat absorption surface of the thermoelectric module is exposed to the cryogenic compartment, and a heat discharge surface of the thermoelectric module is exposed to the freezing compartment.

7. The freezer according to any one of claims 4 to 6, further comprising:

an evaporator (40) for evaporating the refrigerant in accordance with a refrigerant circulation method, thereby generating a cooling effect; and
a blower (60) arranged in the vicinity of the evaporator, and adapted to circulate the refrigerant cooled by the evaporator through the freezing compartment (110),

wherein the thermoelectric module (50) is arranged in a circulation path of the cooled air such that the cooled air circulated by the blower is directly supplied to the thermoelectric module.

8. The freezer according to any one of claims 4 to 7, further comprising:

an evaporator (40) for evaporating the refrigerant in accordance with a refrigerant circulation method, thereby generating a cooling effect, 5

wherein the thermoelectric module (50) is attached to the evaporator. 10

9. A refrigerator comprising a freezer according to any one of claims 4 to 8 and a refrigerating compartment (120) partitioned from the freezing compartment (110) of the freezer. 15

10. The refrigerator according to claim 9, further comprising:

an evaporator (40) for evaporating the refrigerant in accordance with a refrigerant circulation method, thereby generating a cooling effect; and a blower (60) arranged in the vicinity of the evaporator, and adapted to circulate the refrigerant cooled by the evaporator through the freezing compartment (110) or through the refrigerating compartment (120), 20 25

wherein the thermoelectric (50) module is arranged in a circulation path of the cooled air such that the cooled air circulated by the blower is directly supplied to the thermoelectric module. 30

11. A cooling system comprising:

a cooling cycle adapted to perform operations for compressing, condensing, and evaporating a refrigerant which passes through the cooling cycle; 35

characterized in that the cooling system further comprises: 40

a thermoelectric module (50) adapted to re-cool air, which has been cooled by being heat-exchanged with the refrigerant in an evaporating operation of the cooling cycle, using a Peltier effect generated in accordance with an electrical co-operation of P-type and N-type semiconductor elements (53, 54) included in the thermoelectric module with current flowing through the semiconductor elements. 45 50

12. The cooling system according to claim 11, wherein the thermoelectric module (50) is arranged in a circulation path of the cooled air. 55

FIG. 1 (Prior Art)

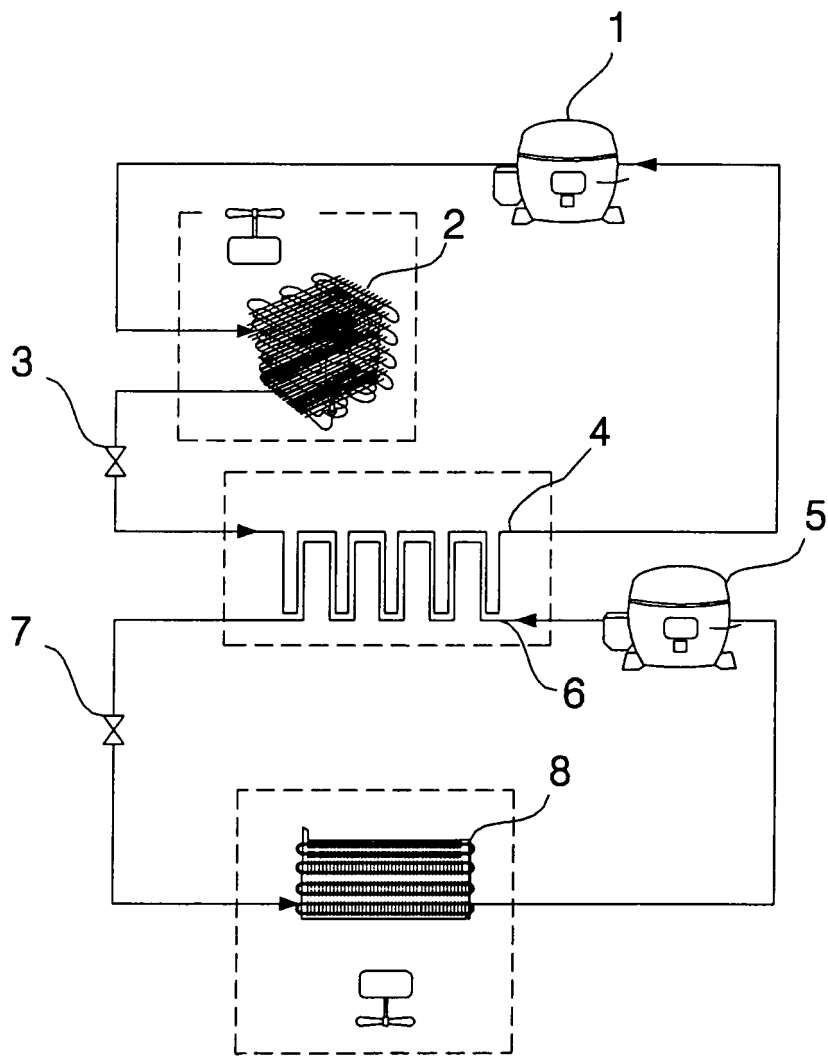


FIG. 2

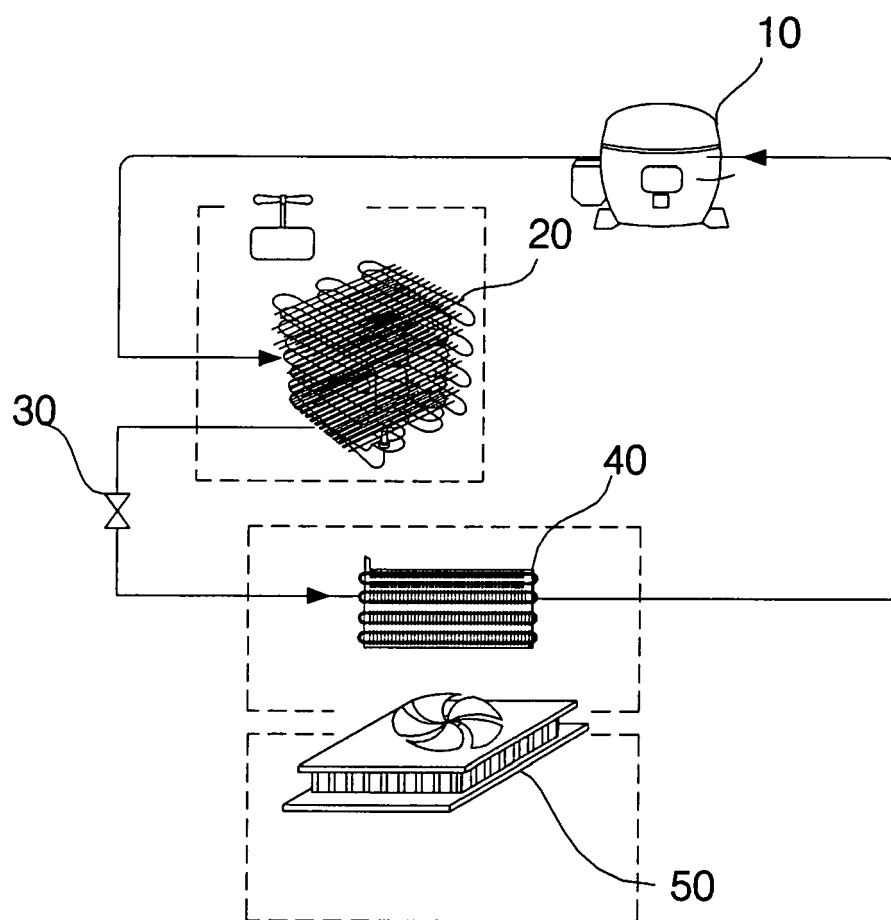


FIG. 3

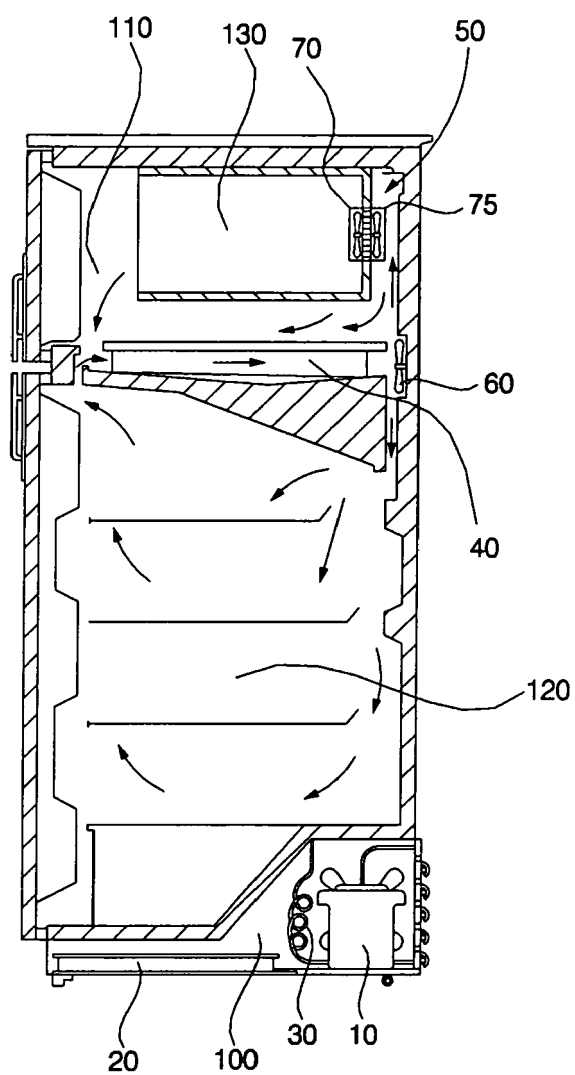


FIG. 4

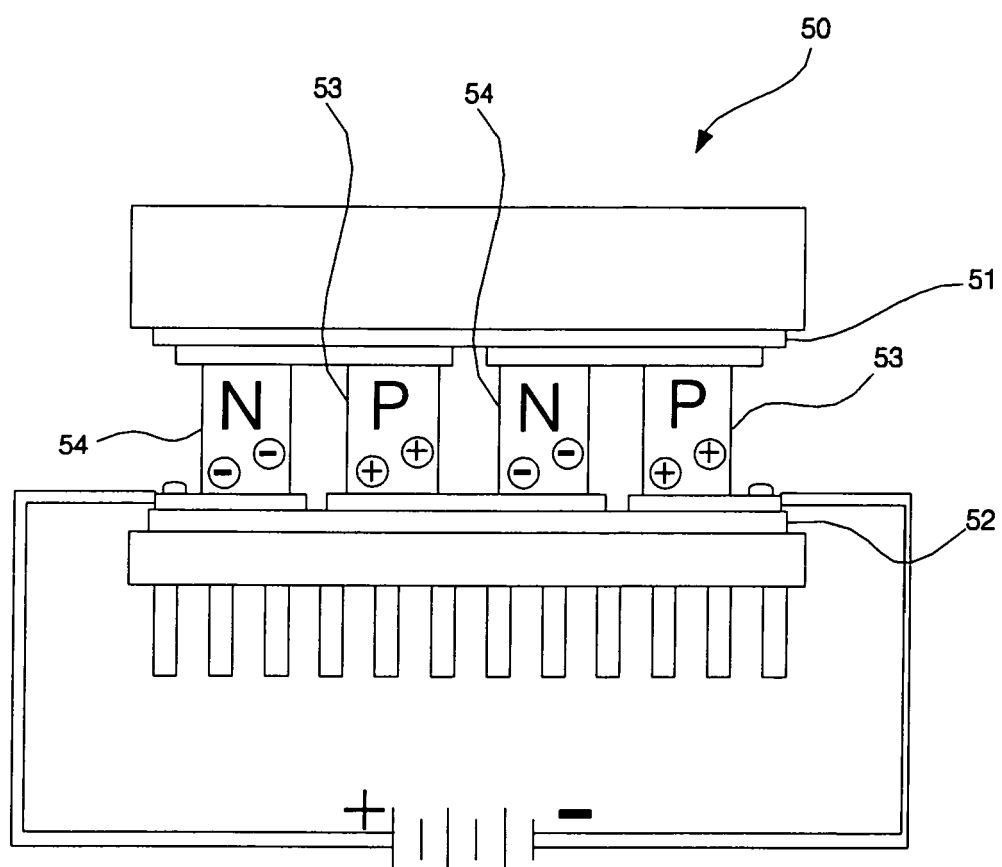


FIG. 5

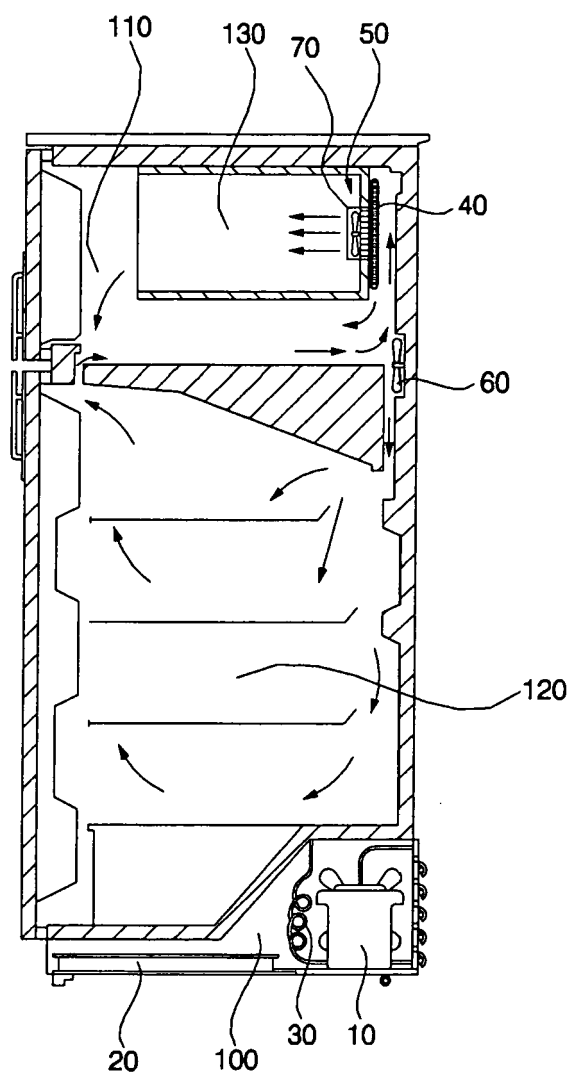


FIG. 6

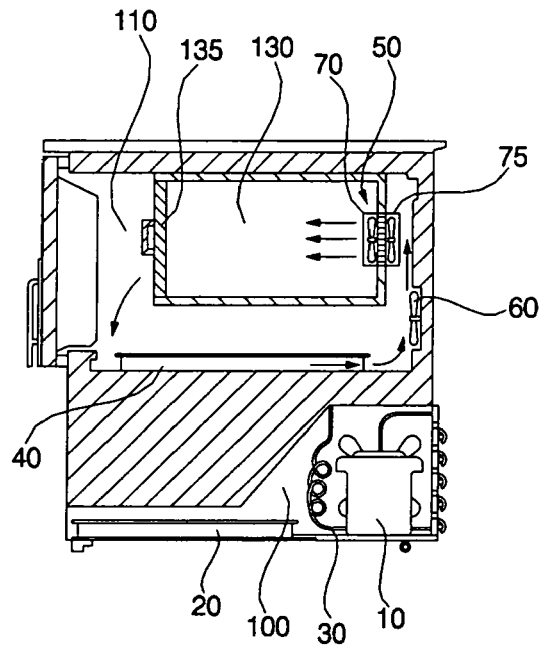


FIG. 7

