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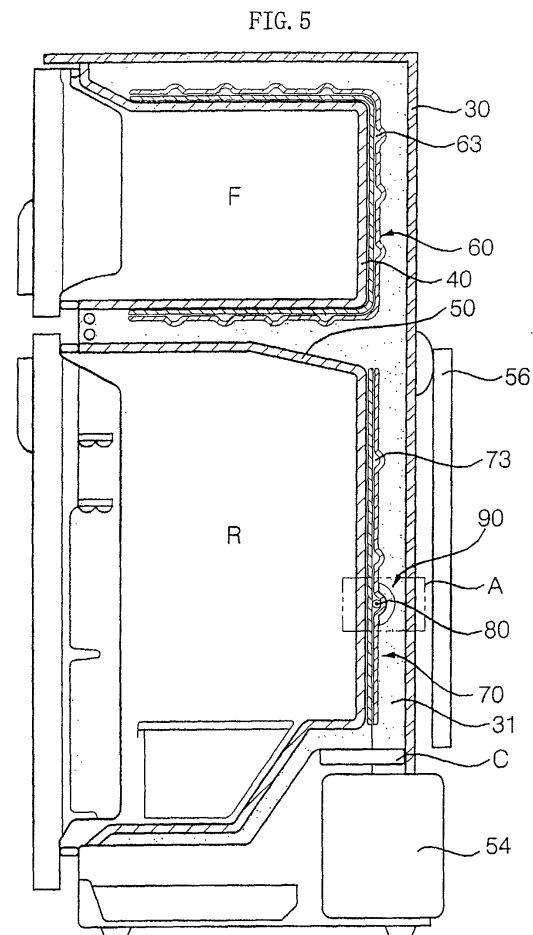
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(54) **Direct cooling type refrigerator**

(57) Disclosed is a direct cooling type refrigerator in which heat transfer promoting means (90) having a high thermal diffusivity is installed at a portion of an evaporator (70) where a temperature sensor (80) adapted to sense the temperature of the evaporator (70), in order to rapidly transfer a variation in the temperature of a thermal insulator (31) filled in the refrigerator. Accordingly, the temperature sensor (80) can rapidly sense an increase in the temperature of the thermal insulator (31) occurring in the OFF state of a compressor (54), thereby allowing the compressor (54) to be accurately and rapidly controlled.



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a direct cooling type refrigerator, and more particularly to a direct cooling type refrigerator capable of accurately and rapidly sensing a variation in the temperature of a thermal insulator provided at the refrigerator by a temperature sensor installed at an evaporator in order to control a compressor based on the sensed result.

Description of the Related Art

[0002] In accordance with cooling type, refrigerators may be classified into a direct cooling type, in which an inner case defined with a freezing chamber and a refrigerating chamber is directly cooled by an evaporator in order to cool the freezing and refrigerating chambers, and an indirect cooling type, in which cold air generated in accordance with a heat exchanging operation conducted by the evaporator is supplied into the interiors of the freezing and refrigerating chambers by a cooling fan.

[0003] Referring to Figs. 1 and 2, a typical direct cooling type refrigerator is illustrated. As shown in Figs. 1 and 2, the refrigerator includes a freezing chamber F, a refrigerating chamber R arranged beneath the freezing chamber F, a compressor 4 adapted to compress a refrigerant, and a condenser 6 for condensing a high-pressure refrigerant gas emerging from the compressor 4. The refrigerator also includes a capillary tube (not shown) for reducing the pressure of the refrigerant emerging from the condenser 6, a freezing chamber evaporator 10 for exchanging heat with an inner case 11 defining the freezing chamber F, thereby cooling the freezing chamber F, a refrigerating chamber evaporator 20 for exchanging heat with an inner case 21 defining the refrigerating chamber R, thereby cooling the refrigerating chamber R, a temperature sensor 26 for measuring the temperature of the refrigerating chamber evaporator 20, and a control unit 30 for turning on the compressor 4 when the temperature sensed by the temperature sensor 26 is equal to or higher than a predetermined temperature, for example, 5 °C, while turning off the compressor 4 when the sensed temperature is equal to or lower than a predetermined temperature, for example, -30 °C.

[0004] As shown in Figs. 1 and 3, each of the freezing and refrigerating chamber evaporators 10 and 20 includes inner and outer plate members 15 and 16 joined to each other. In order to form refrigerant passages 12 and 22, convex portions 17 and 18 are provided at the outer plate member 16. The inner and outer plate members 15 and 16 are interposed between the inner case 11 or 21 of the associated freezing or refrigerating chamber F or R and a thermal insulator 13.

[0005] The refrigerant passages 12 and 22 are formed to allow the refrigerant to pass through the freezing chamber evaporator 10, the refrigerant chamber evaporator 20, and then again through the freezing chamber evaporator 10. A space 19, which is adapted to receive the temperature sensor 26, is defined between the inner and outer plate members 15 and 16 at a region where the lower portions of the inner and outer plate members 15 and 16 are disposed.

[0006] In the illustrated case, the space 19 is formed by outwardly protruding an associated portion of the outer plate member 16 to form a convex structure.

[0007] The temperature sensor 26 includes a closed tube 27 received in the space 19, a gas 28 contained in the tube 27 and adapted to increase/decrease in pressure in accordance with a variation in the temperature of the tube 27, and a thermistor (not shown) adapted to output, to the control unit 30, a temperature signal corresponding to the increased/decreased pressure of the gas 28.

[0008] Now, the operation of the conventional direct cooling type refrigerator having the above described configuration will be described.

[0009] After the refrigerant is changed into a vapor phase of high temperature and high pressure as it is compressed by the compressor 4, it is introduced into the condenser 6. In the condenser 6, the refrigerant discharges its heat, so that it is changed into a liquid phase of normal temperature and high pressure. That is, the refrigerant is condensed by the condenser 6. The condensed refrigerant is then reduced in pressure as it passes through the capillary tube 8. Subsequently, the refrigerant exchanges heat with the inner cases 11 and 21 of the freezing and refrigerating chambers F and R while passing through the refrigerant passage 12 of the freezing chamber evaporator 10 and the refrigerant passage 22 of the refrigerating chamber evaporator 20. Thus, the freezing and refrigerating chambers F and R are cooled.

[0010] Meanwhile, the temperature sensor 26 installed at the refrigerating chamber evaporator 20 senses the temperature of the refrigerating chamber evaporator 20 at the lower portion of the refrigerating chamber evaporator 20, and sends a sensing signal indicative of the sensed temperature. When the control unit 30 determines, based on the sensing signal, that the temperature of the refrigerating chamber evaporator 20 is equal to or lower than a predetermined value, it outputs an OFF signal to the compressor 4 so as to stop the operation of the compressor 4. On the other hand, when the control unit 30 determines that the temperature of the refrigerating chamber evaporator 20 is equal to or higher than the predetermined value, it outputs an ON signal to the compressor 4 so as to operate the compressor 4.

[0011] The thermal insulator 13 of the conventional refrigerator is increased in temperature under the influence of ambient heat in a state in which the compressor 4 is in its OFF state. However, such a variation in the

temperature of the thermal insulator 13 is not rapidly transmitted to the temperature sensor 26 because the outer plate member 16 of the refrigerating chamber evaporator 20 is interposed between the thermal insulator 12 and the space 19 where the temperature sensor 26 is disposed. For this reason, it is impossible to accurately control the compressor 4 based on a variation in the temperature of the thermal insulator 12.

[0012] This will be described in more detail with reference to Fig. 4. In Fig. 4, the solid line A represents a variation in the temperature sensed by the temperature sensor 26 when it is assumed that the variation in the temperature of the thermal insulator 13 has no influence on the refrigerating chamber evaporator 20, whereas the phantom line B represents a variation in the temperature sensed by the temperature sensor 26 when it is assumed that the variation in the temperature of the thermal insulator 12 has influence on the refrigerating chamber evaporator 20. Referring to Fig. 4, the compressor 4 is controlled to be turned on when the temperature sensed by the temperature sensor 26 corresponds to 5 °C, while being turn off when the sensed temperature corresponding to -30 °C. Under the influence of the temperature of the thermal insulator 13, the temperature of the refrigerating chamber evaporator where the temperature sensor 26 is installed may be increased at an accelerated rate because the temperature of the thermal insulator 13 is typically higher than the temperature of the evaporator 20. In this case, therefore, points of time, T_{11} , T_{13} , and T_{15} , at which the compressor 4 is switched to its ON state, are earlier than points of time, T_1 , T_3 , and T_5 , at which the compressor 4 is switched to its ON state in the case where the temperature of the thermal insulator 13 has no influence. On the other hand, points of time, T_{12} and T_{14} , at which the compressor is switched to its OFF state in the case where the temperature of the thermal insulator 13 has an influence, is later than points of time, T_2 and T_4 , at which the compressor 4 is switched to its ON state in the case where the temperature of the thermal insulator 13 has no influence. Accordingly, it is impossible to accurately control the compressor 4 in response to a variation in the temperature of the refrigerating chamber R unless the variation in the temperature of the thermal insulator 13 is rapidly transmitted to the temperature sensor 26. Furthermore, the ON time t_1 of the compressor 4 in the case where the temperature of the thermal insulator 13 has no influence is shorter than the ON time t_{11} of the compressor 4 in the case where the temperature of the thermal insulator 13 has an influence; whereas the OFF time t_2 of the compressor 4 in the case where the temperature of the thermal insulator 13 has no influence is longer than the OFF time t_{12} of the compressor 4 in the case where the temperature of the thermal insulator 13 has an influence. For this reason, there is a problem in that the temperature deviation between the freezing and refrigerating chambers F and R is larger than an allowable value.

SUMMARY OF THE INVENTION

[0013] Therefore, the present invention has been made in view of the above mentioned problems involved with the related art, and an object of the invention is to provide a direct cooling type refrigerator capable of allowing the temperature of a refrigerating chamber evaporator at a region where a temperature sensor is installed to be rapidly varied depending on a variation in the temperature of a thermal insulator disposed around the temperature sensor, thereby achieving an accurate refrigerator temperature control.

[0014] Another object of the invention is to provide a direct cooling type refrigerator capable of reducing the OFF time of a compressor, thereby preventing the temperature deviation between freezing and refrigerating chambers from increasing above an allowable value.

[0015] In accordance with the present invention, these objects are accomplished by providing a direct cooling type refrigerator comprising: a cabinet for constituting an outer structure of the refrigerator; an inner case arranged in the cabinet and adapted to define a refrigerating chamber; a thermal insulator interposed between the cabinet and the inner case; an evaporator arranged between the inner case and the thermal insulator and adapted to cool the inner case; a temperature sensor installed at the evaporator and adapted to sense a temperature of the evaporator; a control unit for controlling a compressor, based on the temperature sensed by the temperature sensor; and heat transfer promoting means for rapidly transmitting a temperature of the thermal insulator to a portion of the evaporator arranged at a region where the temperature sensor is installed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The above objects, and other features and advantages of the present invention will become more apparent after a reading of the following detailed description when taken in conjunction with the drawings, in which:

Fig. 1 is a sectional view illustrating a conventional direct cooling type refrigerator;

Fig. 2 is a circuit diagram illustrating a general refrigerant cycle used in direct cooling type refrigerators;

Fig. 3 is a sectional view illustrating an evaporator used in direct cooling type refrigerators;

Fig. 4 is a graph depicting ON/OFF intervals of a compressor in direct cooling type refrigerator;

Fig. 5 is a sectional view illustrating a direct cooling type refrigerator according to a first embodiment of the present invention;

Fig. 6 is an enlarged view illustrating a portion "A" in Fig. 5; and

Fig. 7 is a sectional view illustrating an essential portion of a direct cooling type refrigerator accord-

ing to a second embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] Now, embodiments of the present invention will be described in conjunction with the annexed drawings.

[0018] Fig. 5 is a sectional view illustrating a direct cooling type refrigerator according to an embodiment of the present invention.

[0019] As shown in Fig. 5, the direct cooling type refrigerator includes a cabinet 30 for constituting the outer structure of the refrigerator, inner cases 40 and 50 for defining freezing and refrigerating chambers F and R, and a thermal insulator 31 interposed between the cabinet 30 and the inner cases 40 and 50. The refrigerator also includes a compressor 54 for compressing a refrigerant, a condenser 56 for condensing a refrigerant gas emerging from the compressor 54, a capillary tube (not shown) for reducing the pressure of the refrigerant emerging from the condenser 56, a freezing chamber evaporator 60 for exchanging heat with the inner case 40 defining the freezing chamber F, thereby cooling the freezing chamber F, and a refrigerating chamber evaporator 70 for exchanging heat with the inner case 50 defining the refrigerating chamber R, thereby cooling the refrigerating chamber R. The refrigerator further includes heat transfer promoting means 90 for promoting transfer of heat from the thermal insulator 31 to the refrigerating chamber evaporator 70, and a control unit C for turning on/off the compressor 54 based on a temperature value sensed by a temperature sensor 80.

[0020] Each of the freezing and refrigerating chamber evaporators 60 and 70 includes inner and outer plate members 71 and 72 joined to each other while defining refrigerant passages 63 and 73 therebetween. The inner and outer plate members 71 and 72 are interposed between the inner case 40 or 50 of the associated freezing or refrigerating chamber F or R and the thermal insulator 31.

[0021] As shown in Fig. 6, the outer plate member 72 has a convex portion 72a protruded toward the thermal insulator 31 at a lower portion of the refrigerating chamber evaporator 70 in order to form a space 75 between the inner and outer plate members 71 and 72. The temperature sensor 80 is disposed in the space 75.

[0022] The temperature sensor 80 includes a closed tube 81 received in the space 75, a gas 82 contained in the tube 81 and adapted to increase/decrease in pressure in accordance with a variation in the temperature of the tube 81, and a thermistor (not shown) adapted to output, to the control unit C, a temperature signal corresponding to the increased/decreased pressure of the gas 82.

[0023] The heat transfer promoting means 90 comprises a heat transfer plate 91 having a heat diffusion

coefficient higher than that of the outer plate member 72 in order to promote the transfer of heat from the thermal insulator 31 to the convex portion 72a of the outer plate member 72. The heat transfer plate 91 is attached to the outer surface of the convex portion 72 of the outer plate member 72 in the refrigerating chamber evaporator 70.

[0024] The heat transfer plate 91 has a semicircular shape in order to completely surround the convex portion 72a.

[0025] The operation of the refrigerator having the above described configuration will be described in conjunction with Figs. 5 and 6.

[0026] Since the heat transfer plate 90 is arranged around the outer surface of the convex portion 72a of the outer plate member 72 defining the space 75 where the temperature sensor 80 adapted to sense the temperature of the refrigerating chamber evaporator 70 is installed, the temperature of the thermal insulator 31 increased under the influence of ambient temperature in an OFF state of the compressor 54 is rapidly transmitted to the inner and outer plate members 71 and 72 of the refrigerating chamber evaporator at the region where the temperature sensor 80 is disposed. Accordingly, the temperature of the thermal insulator 31 is rapidly transmitted to the temperature sensor 80. Thus, the refrigerator has an improved cooling efficiency because the compressor 54 is controlled based on the temperature of the thermal insulator 31 rapidly transmitted to the temperature sensor 80. In addition, the OFF time of the compressor 54 is reduced as compared to that of the conventional refrigerator. Accordingly, it is possible to prevent the temperature deviation between the freezing and refrigerating chambers from increasing above an allowable value.

[0027] Referring to Fig. 7, heat transfer promoting means 90 according to a second embodiment of the present invention is illustrated.

[0028] As shown in Fig. 7, the heat transfer promoting means 90 comprises a hollow enclosed member 92 attached to the outer surface of the convex portion 72a of the outer plate member 72 in the refrigerating chamber evaporator 70 at a region where the temperature sensor 80 is installed. The enclosed member 92 is filled with a gas 93 adapted to promote transfer of heat from the thermal insulator 31, such as air.

[0029] The enclosed member 92 has a rectangular cross section having, at one surface thereof, a concave surface conforming the convex portion 72a.

[0030] As apparent from the above description, the present invention provides a direct cooling type refrigerator in which heat transfer promoting means having a high heat diffusion coefficient is installed at a portion of an evaporator where a temperature sensor adapted to sense the temperature of the evaporator, in order to rapidly transfer a variation in the temperature of a thermal insulator filled in the refrigerator. Accordingly, the temperature sensor can rapidly sense an increase in the

temperature of the thermal insulator occurring in the OFF state of a compressor, thereby allowing the compressor to be accurately and rapidly controlled. Thus, it is possible to achieve an improvement in the cooling efficiency of the refrigerator.

[0031] 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 direct cooling type refrigerator comprising:

a cabinet for constituting an outer structure of the refrigerator;
 an inner case arranged in the cabinet and adapted to define a refrigerating chamber;
 a thermal insulator interposed between the cabinet and the inner case;
 an evaporator arranged between the inner case and the thermal insulator and adapted to cool the inner case;
 a temperature sensor installed at the evaporator and adapted to sense a temperature of the evaporator;
 a control unit for controlling a compressor, based on the temperature sensed by the temperature sensor; and
 heat transfer promoting means for rapidly transmitting a temperature of the thermal insulator to a portion of the evaporator arranged at a region where the temperature sensor is installed.

2. The direct cooling type refrigerator according to claim 1, wherein the evaporator comprises inner and outer plate members joined to each other, and the heat transfer promoting means is attached to the outer plate member of the evaporator at the region where the temperature sensor is installed.

3. The direct cooling type refrigerator according to claim 1, wherein the heat transfer promoting means is arranged between the evaporator and the thermal insulator.

4. The direct cooling type refrigerator according to claim 1, wherein the heat transfer promoting means comprises a heat transfer plate.

5. The direct cooling type refrigerator according to claim 4, wherein the evaporator has a convex portion providing a space for installing the temperature sensor, and the heat transfer plate has a semicircular shape so that it completely surrounds the convex portion of the outer plate member.

lar shape so that it completely surrounds the convex portion of the outer plate member.

6. The direct cooling type refrigerator according to claim 4, wherein the heat transfer plate is made of a metal having a thermal diffusivity higher than that of the evaporator.

7. The direct cooling type refrigerator according to claim 1, wherein the heat transfer promoting means comprises a hollow enclosed member filled with gas.

8. The direct cooling type refrigerator according to claim 7, wherein the enclosed member is interposed between the evaporator and the thermal insulator.

9. The direct cooling type refrigerator according to claim 7, wherein the enclosed member has, at one surface thereof, a concave surface adapted to completely surround a convex portion of the evaporator formed to provide a space for installing the temperature sensor.

10. The direct cooling type refrigerator according to claim 7, wherein the gas filled in the enclosed member is air.

FIG. 1 (Prior Art)

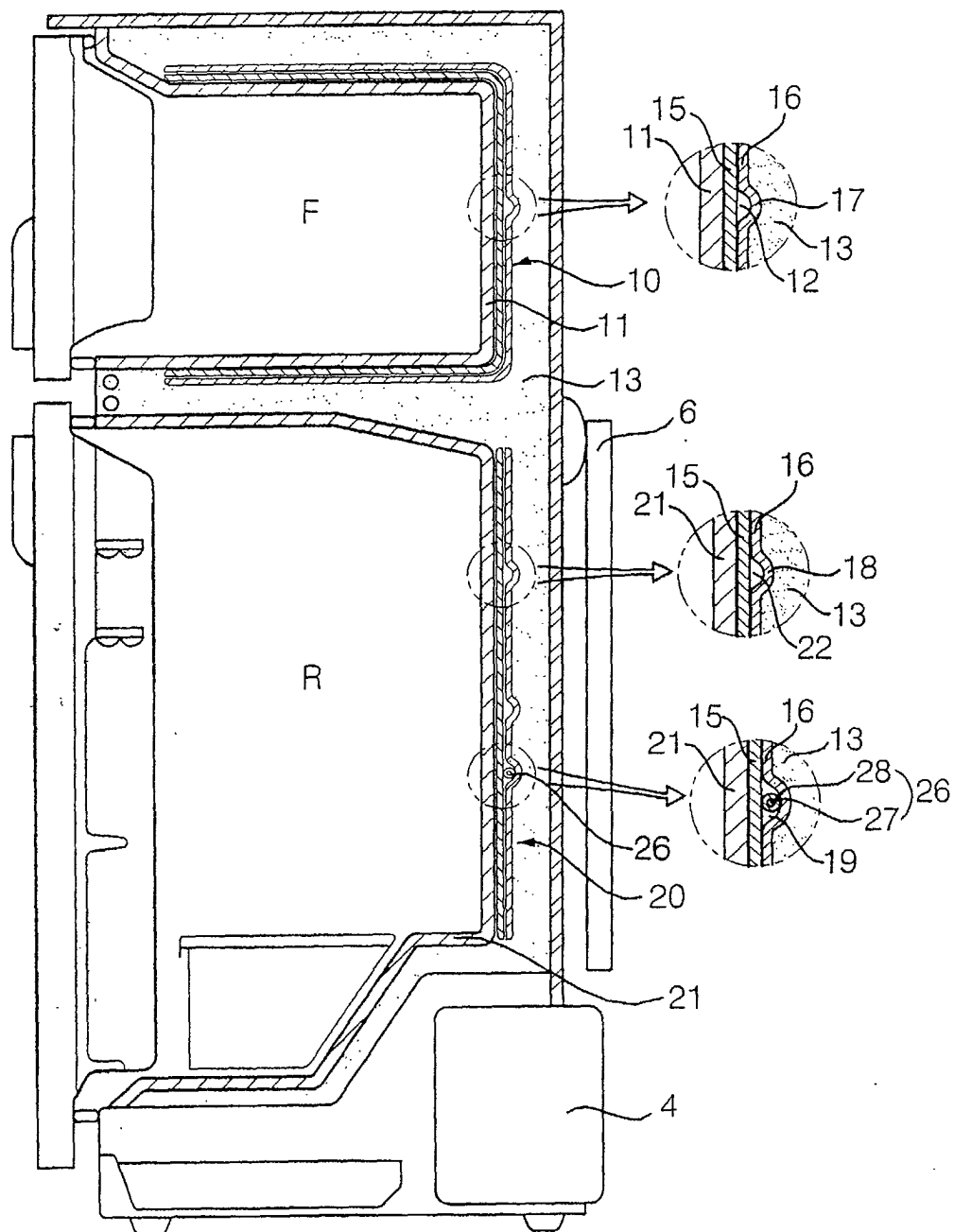


FIG. 2

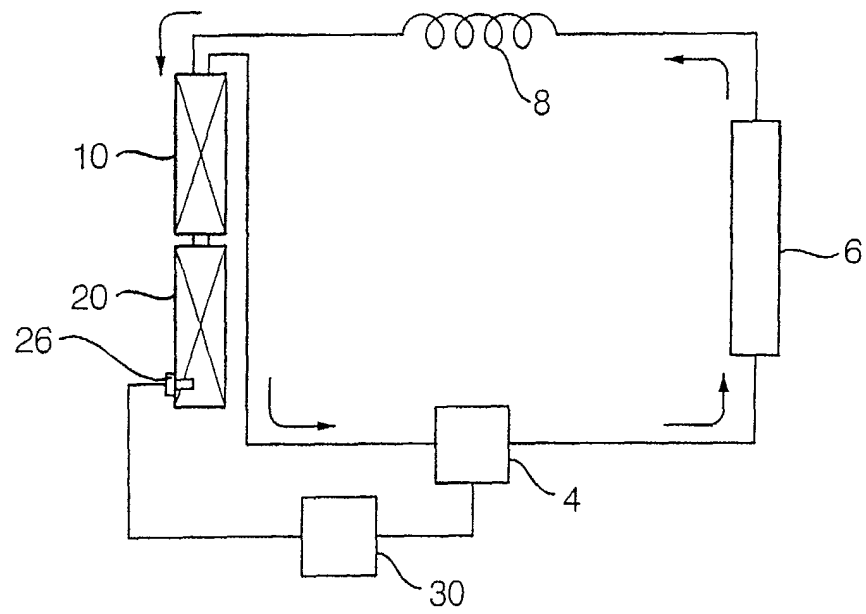


FIG. 3

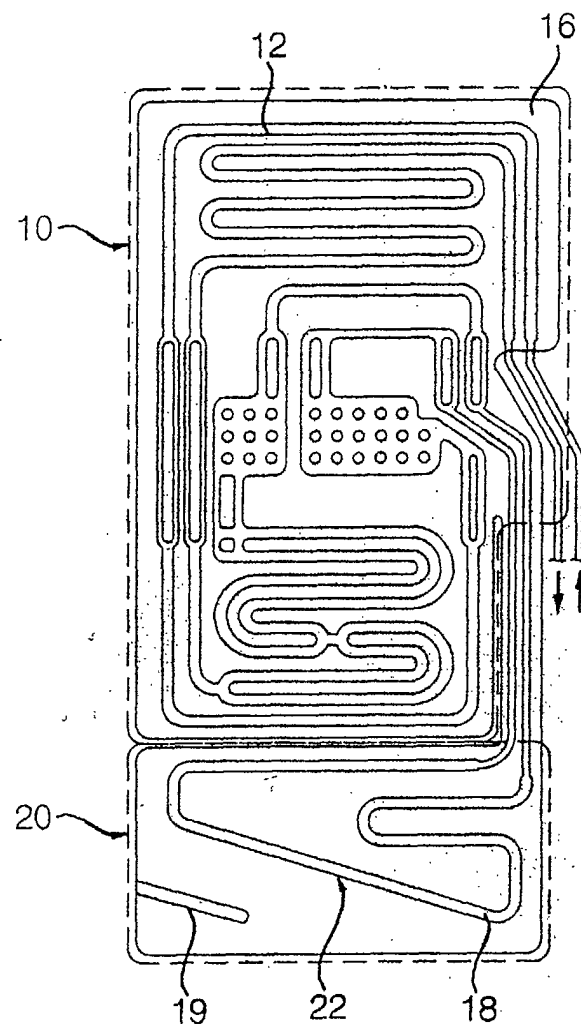


FIG. 4

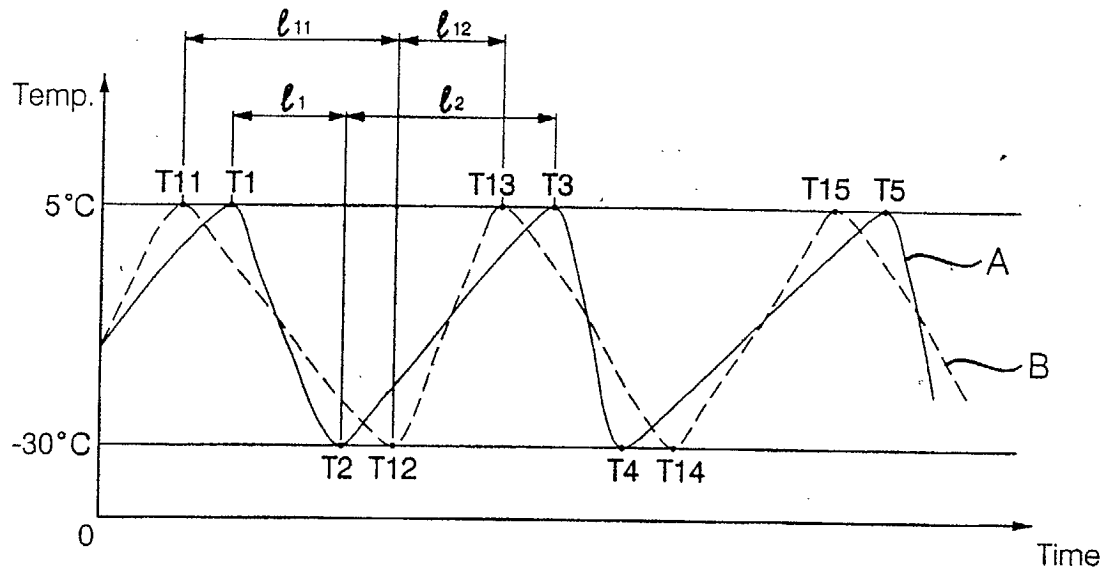


FIG. 5

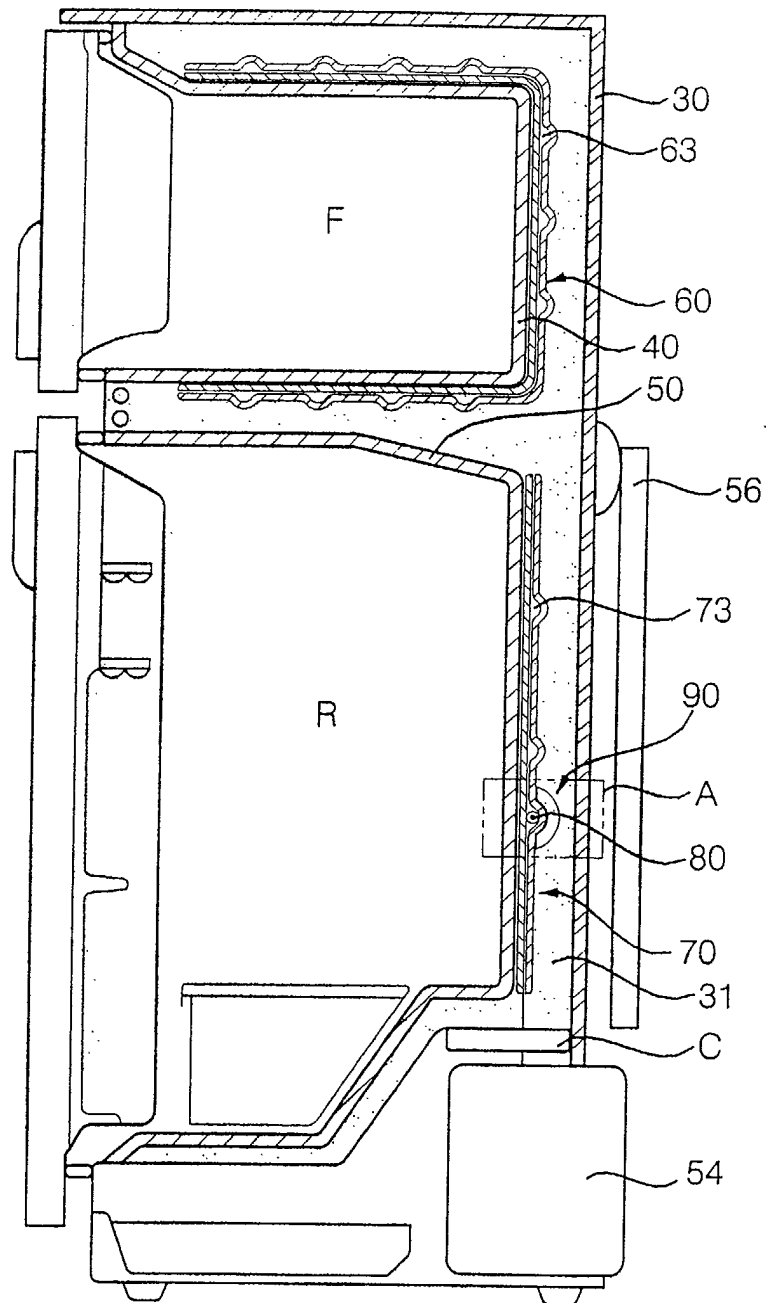


FIG. 6

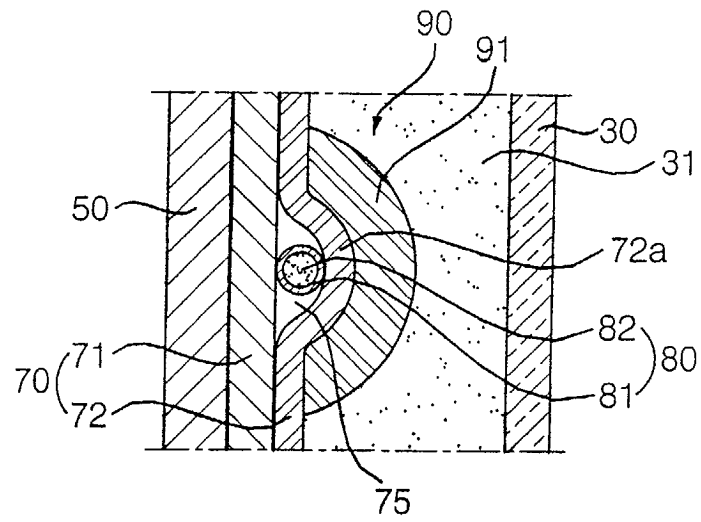


FIG. 7

