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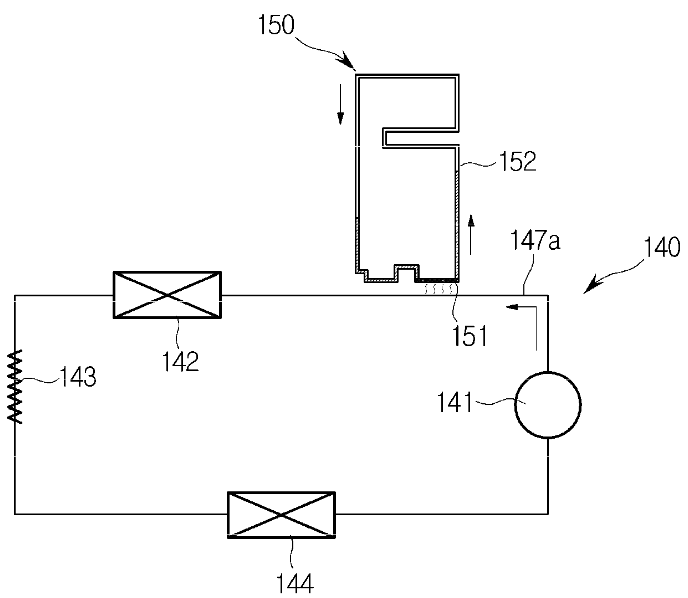
(54) REFRIGERATOR AND METHOD OF CONTROLLING THE SAME

(57) A refrigerator includes a main body (110) having a storage compartment (120), a door provided at the main body, a refrigerating portion (140) which refrigerates the storage compartment using a compressor (141) , a condenser (142), a depressurizer and an evaporator which are connected with a refrigerant pipe (147) , and a heat transfer portion having a first flow passage portion (151) which is disposed adjacent to the refrigerant pipe (147) of the refrigerating portion and receives heat from the refrigerant pipe, and a second flow passage portion (152) which is disposed at a front surface (a1) of the main body with which the door comes in contact and to which heat of the first flow passage portion is transferred.

FIG. 6A



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Description

[0001] The present invention relates to a refrigerator capable of preventing dew formation and a method of controlling the same.

[0002] In general, a refrigerator refers to an appliance that creates a low temperature environment in a storage compartment such as a refrigerating compartment and a freezing compartment, etc. through a refrigerating cycle which is operated when a power supply is applied, so that foods may be stored in a refrigerated state or a frozen state for an extended period of time.

[0003] As the storage compartment of the refrigerator is sealed from the outside by a door and a temperature in the sealed storage compartment becomes lower than a temperature of the external atmosphere, heat transfer between the low temperature in the storage compartment and a high temperature in the external atmosphere occurs along an edge of the door. At this time, a dew-point temperature is formed between contact surfaces of a main body and the door of the refrigerator, and a substantial amount of dew may form between the contact surfaces of the main body and the door of the refrigerator when air in the external atmosphere has a high temperature and high humidity.

[0004] Accordingly, when the temperature in the storage compartment of the refrigerator becomes lower than the temperature of external atmosphere, dew may form due to the temperature difference at a boundary portion between the storage compartment and the external atmosphere, particularly at an edge at which the main body and the door of the refrigerator come in contact with each other.

[0005] This may not only degrade an image (physical appearance) of a product, but also may be unsanitary, and dirty the floor nearby with dew that flows down to the floor.

[0006] Accordingly, dew should be prevented from forming at the boundary portion of the refrigerator, particularly at the edge portion at which the main body and the door of the refrigerator come in contact with each other.

[0007] To solve this problem, in the related art, a condensing pipe of a condenser is inserted into an inner portion of a contact surface of the main body with which the door of the refrigerator comes in contact, and a temperature at the contact surface of the main body is increased by heat emitted from the condensing pipe so that dew does not form at the main body.

[0008] Since the condensing pipe is a part of the freezing cycle, and emits heat by using a change in state of a refrigerant that circulates in the freezing cycle, a heat-generating temperature varies depending on a heat radiating capability of the condenser.

[0009] That is, when the capability of the condenser in the freezing cycle is low, the temperature of the condensing pipe increases excessively and thus the temperature of the contact surface of the main body increases excessively, causing heat from the increased temperature to re-penetrate into the inner portion of the storage compartment.

[0010] At this time, in the refrigerator, an operating period of the freezing cycle is shortened so as to maintain the storage compartment at a desired temperature. Thus, there is a problem in that power consumption of the refrigerator is increased.

[0011] In addition, when the capability of the condenser is increased in order to lower the power consumption of the refrigerator, excess heat is emitted from the condenser. In this case, the temperature of the condensing pipe is lowered and thus the temperature of the contact surface of the main body is also lowered.

[0012] That is, as the temperature at the contact surface of the main body of the refrigerator is not increased above the dew-point temperature, there is a problem in that dew is not prevented from forming.

[0013] Additional aspects and/or advantages will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the disclosure.

[0014] Therefore, it is an aspect of the disclosure to provide a refrigerator including a heat transfer portion that is disposed adjacent to a refrigerating portion which receives heat emitted from the refrigerating portion, and transfers the received heat to prevent dew from forming between surfaces of a main body and a surface of a door which come in contact with each other, and a method of controlling the same.

[0015] An aspect of the disclosure provides a refrigerator in which, in order to prevent dew from forming between surfaces of a main body and a door which come in contact with each other, an operation of at least one of a compressor and a heat radiating fan is controlled based on indoor humidity so that a temperature of heat transferred from a refrigerating portion to a heat transfer portion is controlled, and a method of controlling the same.

[0016] An aspect of the disclosure provides a refrigerator including a valve configured to adjust heat transfer of a heat transfer portion used to prevent dew from forming between surfaces of a main body and a door which come in contact with each other, wherein a duty cycle of the valve is controlled based on indoor humidity, and a method of controlling the same.

[0017] An aspect of the disclosure provides a refrigerator including a valve configured to adjust heat transfer of a heat transfer portion used to prevent dew from forming between surfaces of a main body and a door which come in contact with each other, wherein an ON operation of the valve is controlled based on indoor humidity and a temperature of a front surface of the main body, and a method of controlling the same.

[0018] According to an aspect of the disclosure, there is provided a refrigerator which may include a main body having a storage compartment, a door provided at the main body and configured to close and open the storage compartment, a refrigerating portion configured to refrigerate the storage compartment, the refrigerating portion including a compressor, a condenser, a depressurizer and an evaporator which are connected with a refrigerant pipe, and a heat transfer portion having a first flow passage portion which is disposed adjacent to the refrigerant pipe of the refrigerating portion and receives heat from the refrigerant pipe, and a second flow passage portion which is disposed at a front surface of the main body with which the door comes in contact and to which heat of the first flow passage portion is transferred.

[0019] In the refrigerator, a first refrigerant may circulate in the refrigerant pipe of the refrigerating portion, a second refrigerant may circulate in the first flow passage portion and the second flow passage portion of the heat transfer portion, and the first refrigerant and the second refrigerant may be spatially separated from one another.

[0020] The first flow passage portion may be disposed at a lower portion of the main body and may be asymmetrically disposed to the second flow passage portion which may be disposed at the lower portion of the main body.

[0021] The refrigerator may further include a joining member configured to join the first flow passage portion of the heat transfer portion and the refrigerant pipe.

[0022] The first flow passage portion of the heat transfer portion and the refrigerant pipe may be formed in a double pipe structure.

[0023] The first flow passage portion of the heat transfer portion may be disposed in an inner portion of the refrigerant pipe.

[0024] The first flow passage portion may have a circular shape or a groove shape in cross-section.

[0025] The first flow passage portion may include a body and a groove portion formed at an outer portion of the body.

[0026] A length of the double pipe may be determined based on a temperature of a front surface of the main body.

[0027] The refrigerant pipe adjacent to the first flow passage portion may be disposed between the compressor and the condenser.

[0028] The refrigerant pipe adjacent to the first flow passage portion may be disposed between the condenser and the depressurizer.

[0029] The refrigerator may further include a humidity detector configured to detect indoor humidity, and a controller configured to control a number of revolutions of the compressor based on the detected humidity.

[0030] The refrigerator may further include a humidity detector configured to detect indoor humidity, a fan configured to radiate heat of the condenser, and a controller configured to control an electric voltage of the fan based on the detected humidity.

[0031] The refrigerator may further include a humidity detector configured to detect indoor humidity, a valve configured to adjust a heat transfer of the heat transfer portion, and a controller configured to control a duty cycle of the valve based on the detected humidity.

[0032] The refrigerator may further include a humidity detector configured to detect indoor humidity, a temperature detector configured to detect a temperature of a front surface of the main body, a valve configured to adjust a heat transfer of the heat transfer portion, and a controller configured to control an opening of the valve based on the detected humidity and temperature.

[0033] According to an aspect of the disclosure, there is provided a method of controlling a refrigerator including a main body having a storage compartment, a door configured to close and open the storage compartment, and a refrigerating portion configured to refrigerate the storage compartment using a compressor, a condenser, a depressurizer and an evaporator which are connected by a refrigerant pipe. The method may include detecting indoor humidity and adjusting a temperature of a refrigerant pipe based on the detected humidity, wherein the adjusting of the temperature of the refrigerant pipe may include adjusting a temperature of a first flow passage portion of a heat transfer portion disposed adjacent to the refrigerant pipe and adjusting a temperature of a second flow passage portion of the heat transfer portion disposed at a front surface of the main body by adjusting the temperature of a first flow passage portion.

[0034] The adjusting of the temperature of the refrigerant pipe based on the detected humidity may include increasing a temperature of the refrigerant discharged from the compressor by increasing the number of revolutions of the compressor when the detected humidity is greater than a reference humidity.

[0035] The adjusting of the temperature of the refrigerant pipe based on the detected humidity may include decreasing an electric voltage supplied to a fan configured to radiate heat of the condenser when the detected humidity is greater than a reference humidity.

[0036] According to an aspect of the disclosure, there is provided a method of controlling a refrigerator including a main body having a storage compartment, a door configured to close and open the storage compartment, and a refrigerating portion configured to refrigerate the storage compartment using a compressor, a condenser, a depressurizer and an evaporator which are connected by a refrigerant pipe. The method may include detecting indoor humidity and adjusting a temperature of a front surface of the main body based on the detected humidity, wherein the adjusting of the temperature of the front surface of the main body may include adjusting a valve which blocks heat from being supplied from a first flow passage portion of a heat transfer portion disposed adjacent to the refrigerant pipe to a second flow passage portion of a heat transfer portion disposed at a front surface of the main body.

[0037] The adjusting of the valve may include controlling a duty cycle of the valve based on the detected humidity.

[0038] The adjusting of the valve may include detecting the temperature of a the main body, identifying dew-point temperature corresponding to the detected humidity, determining whether the detected temperature is less than the identified dew-point temperature, and opening the valve when the detected temperature is less than the identified dew-point temperature.

[0039] According to an aspect of the disclosure, there is provided a refrigerator which may include a main body having a storage compartment, a door provided at the main body and configured to close and open the storage compartment, a refrigerating portion configured to refrigerate the storage compartment using a compressor, a condenser, a depressurizer and an evaporator which are connected by a refrigerant pipe, and a heat transfer portion which is disposed adjacent to the refrigerant pipe connected to the condenser, receives heat from the refrigerant pipe, and transfers the received heat to the front surface of the main body.

[0040] According to an aspect of the disclosure, the refrigerator may further include a humidity detector configured to detect humidity of an outside of the main body, and a controller configured to increase a number of revolutions of the compressor when the detected humidity is greater than a reference humidity.

[0041] According to an aspect of the disclosure, the refrigerator may further include a humidity detector configured to detect humidity of an outside of the main body, a fan disposed adjacent to the condenser, and a controller configured to decrease an electric voltage supplied to the fan when the detected humidity is greater than a reference humidity.

[0042] The heat transfer portion may further include a valve configured to block heat from being transferred to the front surface of the main body.

[0043] According to an aspect of the disclosure, the refrigerator may further include a humidity detector configured to detect humidity of an outside of the main body, and a controller configured to adjust a duty cycle of the valve based on the detected humidity.

[0044] According to an aspect of the disclosure, the refrigerator may further include a humidity detector configured to detect humidity of an outside of the main body, a temperature detector configured to detect a temperature of a front surface of the main body, and a controller configured to identify a dew-point temperature at the detected humidity and to control an opening of the valve based on the identified dew-point temperature and the detected temperature.

[0045] According to an aspect of the disclosure, a refrigerator may include a main body having a storage compartment, a compressor to compress refrigerant which moves through a refrigerant pipe, a condenser to condense the refrigerant which has been compressed by the compressor, a fan to cool the condenser and to radiate heat of the condenser, a heat transfer portion disposed in an inner portion of a front surface of the main body to receive heat from the refrigerant pipe and to transfer heat to a contact portion of the front surface of the main body, and a controller configured to control an operation of at least one of the compressor and the fan to control a temperature of the refrigerant moving through the refrigerant pipe so as to maintain a desired temperature of the front surface of the main body.

[0046] The heat transfer portion may include a flow passage which may include a first flow passage portion which receives heat from the adjacent refrigerant pipe and is disposed between the condenser and a depressurizer or between the condenser and compressor, and a second flow passage portion disposed adjacent to the front surface of the main body and to receive heat from the first flow passage portion.

[0047] The desired temperature of the front surface of the main body may be determined using a look-up table stored in a storage based on a detected humidity of an indoor space where the refrigerator is disposed.

[0048] The refrigerator may include a humidity detector configured to detect humidity of an outside of the main body, and the controller may control at least one of a number of revolutions of the compressor and an electric voltage of the fan when the detected humidity is greater than a reference humidity.

[0049] According to an aspect of the disclosure, as a first cycle configured to refrigerate a storage compartment and a second cycle configured to provide heat to the front surface of the main body are provided separately from each other and the second cycle is configured to receive heat from the first cycle, both a decrease in freezing capability and an increase in power consumption due to an increase in pressure loss in a pipe of the first cycle are prevented.

[0050] In addition, the temperature of the refrigerant pipe configured to transfer heat to the heat transfer portion may be easily adjusted by controlling an operation of the compressor or the first fan based on the detected humidity of the indoor space.

[0051] In addition, since heat transfer of the heat transfer portion is controlled based on at least one of the detected humidity of the indoor space and the detected temperature of the front surface of the main body, an excessive increase in a temperature of the front surface of the main body in which the heat transfer portion is disposed may be prevented. Accordingly, re-penetration of heat into the storage compartment may be prevented, thus reducing power consumption of the refrigerator.

[0052] A capability of the condenser may be greater than that of an existing condenser because the heat transfer portion receives heat of the refrigerant discharged from the compressor before the condenser.

[0053] Accordingly, a lower limit on improvement of the heat radiating capability of the condenser may be eliminated.

[0054] These and/or other aspects and advantages will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings in which:

FIG. 1 is a front exemplary view of a refrigerator according to an embodiment of the disclosure.

FIG. 2 is a detailed exemplary view illustrating a main body of a refrigerator according to an embodiment of the disclosure.

FIG. 3 is an exemplary view illustrating an inner portion of a refrigerator according to an embodiment of the disclosure.

FIG. 4A is a rear exemplary view illustrating a refrigerator, and FIG. 4B is a detailed exemplary view illustrating a machinery compartment of a refrigerator according to an embodiment of the disclosure.

FIG. 5 is an exemplary view illustrating a layout of a heat transfer portion provided in a refrigerator according to an embodiment of the disclosure.

FIGS. 6A and 6B are structural diagrams illustrating layouts of a first flow passage portion 151 of a heat transfer portion provided in a refrigerator according to an embodiment of the disclosure.

FIGS. 7 to 12 are exemplary views illustrating a heat transferring structure of a heat transfer portion configured to receive heat from a refrigerating portion provided in a refrigerator according to an embodiment of the disclosure.

FIGS. 13A to 13D are cross-sectional views illustrating a double pipe shown in FIG. 12.

FIG. 14 is a graph showing a relation between a length of a double pipe and a temperature of a front surface of a main body.

FIG. 15 is a control configuration diagram of a refrigerator according to an embodiment of the disclosure.

FIG. 16 is a flow chart illustrating a control sequence of a refrigerator according to an embodiment of the disclosure.

FIG. 17 is a table showing control values of a refrigerator according to an embodiment of the disclosure, including operating values of a compressor and a first fan in accordance with detected values of humidity.

FIG. 18 is an exemplary view illustrating a heat transfer portion provided in a refrigerator according to an embodiment of the disclosure.

FIG. 19 is a control configuration diagram of a refrigerator according to an embodiment of the disclosure.

FIG. 20 is a flow chart illustrating a control sequence of a refrigerator according to an embodiment of the disclosure.

FIG. 21 is a control configuration diagram of a refrigerator according to an embodiment of the disclosure.

FIG. 22 is a flow chart illustrating a control sequence of a refrigerator according to an embodiment of the disclosure.

FIG. 23 is a graph illustrating results obtained by comparing power consumption and a temperature of a front surface of a side-by-side refrigerator including a refrigerating compartment and a freezing compartment partitioned side by side.

[0055] Reference will now be made in detail to example embodiments which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. The embodiments are described below to explain the disclosure by referring to the figures.

[0056] Hereinafter, the disclosure will be described in detail with reference to the accompanying drawings.

[0057] As shown in FIG. 1, a refrigerator 100 may include a main body 110, storage compartments 120 (121 and 122) and doors 130 (131 and 132).

[0058] The main body 110 forms an exterior of the refrigerator 100.

[0059] As shown in FIG. 2, the main body 110 may include an upper surface 110a, a lower surface 110b, a left surface 110c, a right surface 110d and a rear surface 110e, and the upper and lower surfaces 110a and 110b, the left and right surfaces 110c and 110d, and the rear surface 110e are disposed next to each other and form a box shape having a receiving space.

[0060] Edges at the upper and lower surfaces 110a and 110b and the left and right surfaces 110c and 110d of the main body form a front surface a1. The front surface a1 of the main body 110 is opened.

[0061] An intermediate partitioning wall 111 may be provided in the receiving space, and the receiving space of the main body 110 may be partitioned into an upper receiving space and a lower receiving space by the intermediate partitioning walk 111.

[0062] In this way, the receiving space partitioned into the upper receiving space and the lower receiving space in the main body 110 may form a plurality of storage compartments 120 (121 and 122) for storing foods.

[0063] Herein, the storage compartments 120 may include a first storage compartment configured to store foods in a frozen state, i.e., a freezing compartment 121, and a second storage compartment configured to store foods in a refrigerated state, i.e., a refrigerating compartment 122.

[0064] In this example embodiment, the receiving space of the main body may be partitioned into the upper receiving space and the lower receiving space by the partitioning wall. At this time, the upper storage compartment may be used as the freezing compartment and the lower storage compartment may be used as the refrigerating compartment, or in contrast, the upper storage compartment may be used as the refrigerating compartment and the lower storage compartment may be used as the freezing compartment.

[0065] In addition, the receiving space of the main body may be partitioned into a left receiving space and a right receiving space using a partitioning wall. At this time the left storage compartment may be used as the freezing compartment and the right storage compartment may be used as the refrigerating compartment, or in contrast, the left storage compartment may be used as the refrigerating compartment and the right storage compartment may be used as the freezing compartment. The disclosure is not limited to the above described example embodiments, and one of ordinary skill in the art would understand that the receiving space of the main body may be partitioned in various manners.

[0066] Additionally, the refrigerator 100 may further include an ice-manufacturing compartment (not shown) configured to make ice.

[0067] The refrigerator 100 may further include at least one first hole 112 which is formed at an inner wall surface of the main body 110 forming the freezing compartment 121 and causes cold air which has exchanged heat in an evaporator to be introduced into the freezing compartment 121.

[0068] In addition, the refrigerator 100 may further include a plurality of second holes 113 that are formed at the inner wall surface of the main body 110 forming the refrigerating compartment 122 and cause cold air which has exchanged heat in an evaporator to be introduced into the refrigerating compartment 122.

[0069] Shelves and storage boxes configured to store foods may be mounted in the inner portions of the freezing compartment 121 and the refrigerating compartment 122.

[0070] In addition, positions in the refrigerating compartment 121 and the refrigerating compartment 122 at which the first hole and the second holes are formed may be determined based on the mounting positions of the shelves and the storage boxes.

[0071] The refrigerator may include the doors 130 which are configured to open and close openings of the main body 110.

[0072] More specifically, the freezing compartment 121 and the refrigerating compartment 122 each have an opening, and the doors 130 (131 and 132) may be hingedly mounted to the opening portion of the freezing compartment 121 and the opening portion the refrigerating compartment 122, respectively.

[0073] The freezing compartment 121 and the refrigerating compartment 122 may be opened closed by the doors 130 (131 and 132), respectively. That is, the doors 130 (131 and 132) may shield inner portions of the freezing compartment 121 and the refrigerating compartment 122 from the outside.

[0074] Also, a plurality of shelves for storing foods may be mounted on inner surfaces of the doors 131 and 132.

[0075] The doors 130 (131 and 132) come in contact with the front surface a1 of the main body 110 and the front surface a2 of the partitioning wall when their respective storage compartments are closed.

[0076] That is, the main body 110 may include contacting surfaces a1 and a2 with which the doors 130 (131 and 132) come in contact.

[0077] The refrigerator may further include a refrigerating portion 140 and a heat transfer portion 150, as shown in FIGS. 3, 4A and 4B.

[0078] The main body 110 of the refrigerator may include a duct 114 which is provided adjacent to the rear surface 110e and forms a flow passage through which cold air moves, and a machinery compartment 115 which is disposed at a lower portion in which the lower surface 110b and the rear surface 110e come in contact with each other, and in which the refrigerating portion 140 is disposed.

[0079] The duct 114 may be connected to the freezing compartment 121 and the refrigerating compartment 122 so that cold air which has exchanged heat in the evaporator 144 is supplied to the freezing compartment 121 and the refrigerating compartment 122 and cold air is received from the freezing compartment 121 and the refrigerating compartment 122.

[0080] That is, the duct 114 may be shielded from the outside and is a space in which the cold air exchanges heat and is circulated.

[0081] The refrigerator 100 may further include a damper which is disposed in the duct 114 and adjusts movement of the cold air.

[0082] The refrigerator 100 may further include the machinery compartment 115 formed at a lower portion of the rear surface of the main body 110.

[0083] The machinery compartment 115 may include an opening and a cover 116 configured to open and close the opening. That is, the machinery compartment 115 may be opened or closed by the cover 116.

[0084] A portion of the refrigerating portion 140 may be disposed in the inner portion of the machinery compartment 115.

[0085] As shown in FIG. 4A, the refrigerating portion 140 may perform a first cycle in which changes in state of a first refrigerant including compression, condensation, expansion and evaporation are repeated sequentially. The refrigerating portion 140 may include a compressor 141 configured to compress the first refrigerant and discharge the first refrigerant at a high temperature and a high pressure, a condenser 142 configured to condense the high-temperature high-pressure first refrigerant that has been compressed in the compressor 141 via heat radiation, a capillary tube 143 serving as a depressurizer configured to depressurize the first refrigerant that has been condensed in the condenser 142, and an evaporator 144 which receives the depressurized first refrigerant from the capillary tube 143, refrigerates ambient air through a refrigerating action of absorbing nearby latent heat, and returns the first refrigerant in a gas state to the compressor 141.

[0086] Herein, the compressor 141 may be an inverter type compressor in which a number of revolutions per minute (RPM) may be controlled.

[0087] The refrigerating portion 140 may further include a heat radiating fan 145 serving as a first fan configured to cool the condenser 143, and a blowing fan 146 serving as a second fan. The second fan, i.e., the blowing fan 146, may be installed to correspond to the evaporator 144 so that air may be sucked from the freezing compartment 121 and the refrigerating compartment 122, and applies a blowing power to the air so that the air which has passed by the evaporator 144 may be discharged to each of the freezing compartment 121 and the refrigerating compartment 122.

In addition, an expanding valve may be used as the depressurizer.

[0088] That is, the blowing fan 146 may be disposed in the duct 114 and may blow cold air that has exchanged heat in the evaporator 144 configured to produce cold air through heat exchange to supply the cold air to the freezing compartment 121 and the refrigerating compartment 122. The compressor 141, the heat radiating fan 145 and the condenser 142 may be disposed in the machinery compartment 115. The capillary tube 143 may further be disposed in the machinery compartment 115.

[0089] Herein, the compressor 141, the condenser 142, the capillary tube 143 and the evaporator 144 may be connected to each other via refrigerant pipes 147 (147a, 147b, 147c and 147d) through which the first refrigerant moves.

[0090] More specifically, the first refrigerant pipe 147a may be connected between the compressor 141 and the condenser 142, the second refrigerant pipe 147b may be connected between the condenser 142 and the capillary tube 143, the third refrigerant pipe 147c may be connected between the capillary tube 143 and the evaporator 144, and the fourth refrigerant pipe 147d may be connected between the evaporator 144 and the compressor 141.

[0091] That is, although the machinery compartment 115 and the duct 114 may be spatially separated from each other, the machinery compartment 115 and the duct 114 may share at least a portion of the refrigerating portion 140 which is connected to each other via the refrigerant pipes 147 (147a, 147b, 147c and 147d).

[0092] The heat transfer portion 150 may be disposed adjacent to the refrigerant pipe 147a of the refrigerating portion 140, as shown in FIG. 4B.

[0093] The heat transfer portion 150 may be disposed in the main body 110 along the front surface a1 and a2 of the main body 110 and may be used to prevent dew from forming between the main body 110 and the doors 130 (131 and 132), as shown in FIG. 5.

[0094] The heat transfer portion 150 may perform the second cycle in which changes in state of the second refrigerant including evaporation and condensation are sequentially repeated, and the heat transfer portion 150 may be disposed adjacent to the refrigerant pipe 147a of the refrigerating portion 140 to receive heat from the refrigerant pipe 147a and transfer the heat to the front surface of the main body, a temperature of which is relatively low.

[0095] That is, the heat transfer portion 150 may be disposed in an inner portion of the front surface, which is a contact surface with which the door comes in contact among the plurality of surfaces of the main body 110 and transfers heat to the contact surface with which the doors 130 (131 and 132) come in contact, so that a temperature of the front surface of the main body 110 may be increased.

[0096] The heat transfer portion 150 may be constituted with one flow passage through which heat is circulated. The one flow passage may be divided into a first flow passage portion 151 and a second flow passage portion 152. The first flow passage portion 151 may be disposed adjacent to the refrigerant pipe 147 of the refrigerating portion in the machinery compartment 115, and may receive heat from the adjacent refrigerant pipe 147. The second flow passage portion 152 may protrude from the machinery compartment 115 to the front surfaces a1 and a2 of the main body, and the heat absorbed in the first flow passage portion may circulate in the second flow passage portion 152.

[0097] As the heat transfer portion is disposed along the front surface of the main body, the heat transfer portion forms an upright structure.

[0098] That is, the first flow passage portion may be disposed at a lower portion of the flow passage, and the second flow passage portion may be formed to extend from the first flow passage portion along the front surface of the main body and may include an extended flow passage portion which is disposed at a lower portion of the flow passage and adjacent to the first flow passage portion, and a front surface flow passage portion may be disposed at the front surface of the main body and have an upright structure.

[0099] The flow passage of the heat transfer portion disposed at the lower portion of the main body of the refrigerator may be divided into two portions (the first flow passage portion and the extended flow passage portion of the second flow passage portion) and the two flow passage portions may be formed asymmetrically to each other so that a flow occurs in any one of the portions (i.e. the first flow passage portion) (see, FIG. 7).

[0100] In addition, a plurality of the heat transfer portions may be formed and disposed in parallel.

[0101] Herein, referring to FIGS. 6A and 6B, a layout of the first flow passage portion 151 of the heat transfer portion will be described.

[0102] As one example, the first flow passage portion 151 of the heat transfer portion may be disposed adjacent to the first refrigerant pipe 147a which connects the compressor 141 and the condenser 142, and may receive heat from a high-temperature high-pressure gaseous refrigerant moving from the compressor 141 to the condenser 142, as shown in FIG. 6A.

[0103] As another example, the first flow passage portion 151 of the heat transfer portion may be disposed adjacent to the second refrigerant pipe 147b which connects the condenser 142 and the capillary tube 143, and may receive heat from a mid-temperature high-pressure liquid refrigerant moving from the condenser 142 to the capillary tube 143, as shown in FIG. 6B.

[0104] The position at which the first flow passage portion 151 of the heat transfer portion is disposed may be determined based on the performance of the condenser.

[0105] That is, when the performance of the condenser of the refrigerating portion is higher than a reference performance, if the first flow passage portion 151 of the heat transfer portion is disposed at the refrigerant pipe 147b between the condenser and the capillary tube, an amount of heat is too small to increase the temperature of the front surface of the refrigerator above the dew-point temperature.

[0106] Accordingly, when the performance of the condenser is higher than the reference performance, the first flow passage portion 151 of the heat transfer portion may be disposed at the refrigerant pipe 147a between the compressor and the condenser, and when the performance of the condenser is lower than the reference performance, the first flow passage portion 151 of the heat transfer portion may be disposed at the refrigerant pipe 147b between the condenser and the capillary tube.

[0107] The heat transfer portion 150 transfers heat using a heat source supplied from the refrigerant pipe 147 of the refrigerating portion 140 and an elevated pressure increased by the heat source. The flow passage may contain a transferring material (for example, the second refrigerant 153) for transferring the heat.

[0108] That is, the heat transfer portion 150 may further include the transferring material 153 contained in the flow passage.

[0109] The transferring material may be the second refrigerant, and may be the same type as or a different type from the first refrigerant circulating in the refrigerating portion 140.

[0110] In addition, although the second refrigerant of the heat transfer portion 150 may be spatially separated from the first refrigerant circulating in the refrigerating portion 140, heat may be transferred from the first refrigerant to the second refrigerant because the first flow passage portion is disposed adjacent to the refrigerant pipe.

[0111] A thermosiphon action occurs in the flow passage portions 151 and 152 of the heat transfer portion 150. This will be described with reference to FIG. 7.

[0112] In the refrigerant pipe in the refrigerating portion, when the heat source is transferred thereto, the transferring material (i.e. refrigerant) contained in the inner portion of the first flow passage portion may be converted into a gas, and the gas may be raised due to a density difference ΔP. The raised gas in the flow passage may be converted into a liquid at the front surface at a relatively low temperature, and the heat source in the flow passage may be transferred to the front surface of the refrigerator.

[0113] The refrigerant converted into the liquid while circulating in the flow passage moves down due to the force of gravity, and returns to the lower portion of the flow passage.

[0114] Herein, even if a portion of the gas is converted into a liquid in a middle portion of the flow passage, the liquid is circulated together with the gas in the entire inner portion of the flow passage due a pressure difference formed in the first flow passage portion.

[0115] The refrigerant moves stably because a temperature equal to or greater than about 50 °C (based on a room temperature of about 25 °C) is the maintained temperature between the compressor and the condenser.

[0116] That is, the heat transfer portion 150 receives heat from the refrigerant pipe 147 of the refrigerating portion, and transfers heat using the thermosiphon of the received heat.

[0117] That is, the first cycle (i.e. the freezing cycle) for refrigerating the storage compartment operates in the refrigerating portion of the refrigerator, and the second cycle (i.e. thermosiphon) for transferring heat to the front surface of the main body operates in the heat transfer portion 150.

[0118] Accordingly, in the refrigerator, as the first cycle for refrigerating the storage compartments and the second cycle for providing heat to the front surface of the main body are provided separately from each other and the second cycle receives heat from the first cycle, both a decrease in freezing capability and an increase in power consumption due to an increase in pressure loss of the pipe of the first cycle are prevented.

[0119] In other words, the temperature of the front surface on the main body of the refrigerator may be stably adjusted regardless of the performance of the condenser because the heat of the refrigerant discharged from the compressor is transferred to the heat transfer portion before the condenser.

[0120] As a result, the capability of the condenser may be greater than that of a conventional condenser, and thus a lower limit on improvement of the heat radiating performance of the condenser is eliminated.

[0121] A heat transferring structure of the heat transfer portion 150 configured to receive heat from the refrigerating portion 140 will be described below with reference to FIGS. 8 to 12.

[0122] As shown in FIG. 8, the heat transfer portion 150 may further include one or more joining members 154a for joining the first flow passage portion 151 to the refrigerant pipe 147a.

[0123] Herein, the joining member 154a may be formed by welding or soldering of metals that are able to conduct heat.

[0124] As shown in FIG. 9, the heat transfer portion 150 comes in contact with the first flow passage portion 151 to the refrigerant pipe 147a, and may further include one or more fastening members 154b to maintain the contact state.

[0125] Herein, the fastening member 154b may include a cable or a clamp, for example.

[0126] As shown in FIG. 10, the heat transfer portion 150 comes in contact with the first flow passage portion 151 to the refrigerant pipe 147a, and further may include one or more adhesion members 154c to maintain the contact state.

[0127] Herein, the adhesion member 154c may include a tape with an adhesive material applied thereto, for example a metal tape such as an aluminum tape.

[0128] As shown in FIG. 11, the first flow passage portion 151 of the heat transfer portion 150 and the refrigerant pipe 147a may be formed in a twisted structure so that the first flow passage portion 151 and the refrigerant pipe 147a come in contact with each other.

[0129] Thus, heat may be transferred from the refrigerant pipe 147a to the first flow passage portion 151 of the heat transfer portion.

[0130] As shown in FIG. 12, the first flow passage portion 151 of the heat transfer portion and the refrigerant pipe 147a may be formed in a double pipe structure.

[0131] The refrigerant pipe 147a may include two holes formed at a predetermined distance from each other, through which the first flow passage portion 151 enters and exits the refrigerant pipe 147a.

[0132] The first flow passage portion 151 may be inserted into one hole formed at the refrigerant pipe 147a and then may be withdrawn from the other hole, so that a portion of the first flow passage portion is disposed in an inner portion of the refrigerant pipe 147a.

[0133] The two holes may be sealed from an outside with the first flow passage portion 151 inserted into the refrigerant pipe 147a.

[0134] The first flow passage portion 151 may receive heat directly from the refrigerant in the refrigerant pipe 147a.

[0135] In the example embodiment, although the structure in which the first flow passage portion 151 is inserted into the inner portion of the refrigerant pipe 147a is described, the refrigerant pipe 147a may also be inserted into the first flow passage portion 151.

[0136] The double pipe structure will be described with reference to FIGS. 13A to 13D. FIGS. 13A to 13D are cross-sectional views illustrating the double pipe shown in FIG. 12.

[0137] As shown in FIG. 13A, the first flow passage portion 151 of the heat transfer portion and the refrigerant pipe 147a may be formed in cylindrical shapes. As shown in FIG. 13A, the first flow passage portion 151 of the heat transfer portion is surrounded by or enclosed by the refrigerant pipe 147a. A reverse arrangement may be provided where the first flow passage portion 151 of the heat transfer portion surrounds or encloses the refrigerant pipe 147a.

[0138] As shown in FIG. 13B, the refrigerant pipe 147a may be formed in a cylindrical pipe shape, and the first flow passage portion 151 of the heat transfer portion may be formed in a groove shape in order to enhance heat transfer performance. As shown in FIG. 13B, the first flow passage portion 151 may include groove portions which may come in contact with an inner portion of the refrigerant pipe 147a. For example, as shown in FIG. 13B, six groove portions protrude outward from a center of the first flow passage portion 151 of the heat transfer portion to contact the inner portion of the refrigerant pipe 147a. However, more than or less than six groove portions may be provided. A reverse arrangement may be provided in which the first flow passage portion 151 of the heat transfer portion is formed in a cylindrical pipe shape and the refrigerant pipe 147a is formed in a groove shape.

[0139] As shown in FIG. 13C, the refrigerant pipe 147a and the first flow passage portion 151 of the heat transfer portion may be formed in cylindrical pipe shapes. A plurality of groove portions 155 may be formed at an outer portion of the first flow passage portion in order to enhance heat transfer performance.

[0140] That is, the first flow passage portion 151 may include a body in a cylindrical shape and a plurality of the groove portions 155 formed at an outer portion of the body. As shown in FIG. 13C, the first flow passage portion 151 may include groove portions 155 which protrude outward from an outer portion of the first flow passage portion 151 of the heat transfer portion, but do not come in contact with an inner portion of the refrigerant pipe 147a. For example, as shown in FIG. 13C, eight groove portions 155 protrude outward from an outer portion of the first flow passage portion 151 of the heat transfer portion. However, more than or less than eight groove portions 155 may be provided. A reverse arrangement may be provided with respect to the first flow passage portion 151 of the heat transfer portion and the refrigerant pipe 147a.

[0141] As shown in FIG. 13D, the refrigerant pipe 147a and the first flow passage portion 151 of the heat transfer portion may be formed in cylindrical shapes. A plurality of groove portions 148 may be formed in an inner portion of the refrigerant pipe 147a to enhance heat transfer performance of the first flow passage portion 151, and the groove portions 148 may come in contact with an outer portion of the first flow passage portion 151.

[0142] That is, the refrigerant pipe may include a body in a cylindrical shape and the plurality of groove portions 148 formed in the inner portion of the body. As shown in FIG. 13D, an empty space may be formed between each of the groove portions 148 and between the refrigerant pipe 147a and the first flow passage portion 151 of the heat transfer portion. For example, as shown in FIG. 13D, ten groove portions 148 protrude inward from an inner portion of the refrigerant pipe 147a toward the first flow passage portion 151 of the heat transfer portion, to come in contact with an outer circumferential portion thereof. However, more than or less than ten groove portions 148 may be provided. A reverse arrangement may be provided with respect to the first flow passage portion 151 of the heat transfer portion and the refrigerant pipe 147a.

[0143] As the first flow passage portion 151 of the heat transfer portion and the refrigerant pipe 147a may be formed in a double pipe structure, heat of the refrigerant pipe 147a may be transferred to the first flow passage portion 151 of the heat transfer portion, the heat transfer performance may be enhanced by forming groove portions, and thus a length of the first flow passage portion (i.e. a length of flow passage which receives heat) may be shortened.

[0144] That is, a length L of the double pipe which is formed by the heat transfer portion and the refrigerant pipe varies the temperature of the front surface of the main body. Herein, the length of the double pipe corresponds to or is equal to a length of the first flow passage portion inserted into the inner portion of the refrigerant pipe. This will be described with reference to FIG. 14.

[0145] FIG. 14 is a graph showing the temperature of the front surface of the main body depending on the length of the double pipe provided in a French-door refrigerator (FDR) and a top-mount freezer (TMF) refrigerator, and shows that when the length of the double pipe of either of the FDR and the TMF refrigerator is longer, the heat transfer performance is higher, leading to a higher temperature in the front surface of the main body.

[0146] In other words, in manufacturing the refrigerator, when the temperature of the front surface of the main body of the refrigerator at which dew is prevented from forming between the front surface and the door is determined, the length of the double pipe may be determined based on the determined temperature of the front surface.

[0147] As the first flow passage portion of the heat transfer portion and the refrigerant pipe are formed in a double pipe structure, heat may be transferred to the front surface of the main body without being separately controlled so that dew is prevented from forming between the main body and the door.

[0148] In addition, the temperature of the front surface of the main body may be adjusted in order to efficiently prevent dew from forming between the main body and the door.

[0149] Herein, because the temperature of the front surface of the main body is adjusted by controlling the temperature of the inner portion of the heat transfer portion which transfers heat to the front surface of the main body, the temperature of the refrigerant pipe disposed adjacent to the heat transfer portion should be adjusted in order to adjust the temperature of the heat transfer portion.

[0150] That is, the refrigerator may further include a drive module 160 configured to adjust the temperature of the refrigerant pipe which affects the temperature of the heat transfer portion. This will be described with reference to FIG. 15.

FIG. 15 is a control configuration diagram of a refrigerator according to an embodiment of the disclosure including the drive module 160 which drives the compressor 141 or the first fan 145 in order to adjust the temperature of the refrigerant pipe.

[0151] The drive module 160 of the refrigerator may include a humidity detector 161, a controller 162, a storage 163, a first driving portion 164 and a second driving portion 165. Portions or some of the components of the drive module 160 may be disposed in the machinery compartment 115, for example. Portions or some of the components of the drive module 160 may alternatively be disposed elsewhere in the main body of the refrigerator (e.g. near a rear portion or lower portion of the refrigerator).

[0152] The humidity detector 161 may detect humidity in an indoor space in which the refrigerator is disposed. Herein, the humidity may refer to a relative humidity (%) in the indoor space.

[0153] The humidity detector 161 may be provided at an outside of the main body 110 (e.g., on an exterior surface of the main body 110).

[0154] The controller 162 may control the operations of the compressor 141, the first fan 145 and the second fan 146 of the refrigerating portion based on the detected temperatures of the inner portions of the plurality of storage compartments so that the temperatures in the inner portions of the plurality of storage compartments are maintained at desired temperatures. For example, the controller 162 may include one or more of a processor, an arithmetic logic unit, a central processing unit (CPU), a graphics processing unit (GPU), a digital signal processor (DSP), an image processor, a microcomputer, a field programmable array, a programmable logic unit, an application-specific integrated circuit (ASIC), a microprocessor or any other device capable of responding to and executing instructions in a defined manner.

[0155] The controller 162 periodically identifies the detected humidity received and controls the operation of at least one of the compressor 141 and the first fan 145 based on the detected humidity in order to prevent dew from forming between the main body and the door.

[0156] The controller 162 adjusts the temperature of the refrigerant pipe 147 disposed adjacent to the first flow passage portion 151 of the heat transfer portion by controlling of at least one of the operations of the compressor 141 and the first fan 145.

[0157] In addition, when the controller 162 compares the detected humidity received and a reference humidity and the received humidity is determined to be greater than the reference humidity, the operation of at least one of the compressor 141 and the first fan 145 may be controlled based on the detected humidity received.

[0158] The reference humidity may be stored in the storage 163. For example, the storage 163 may include a storage medium, such as a nonvolatile memory device, such as a Read Only Memory (ROM), Programmable Read Only Memory (PROM), Erasable Programmable Read Only Memory (EPROM), and flash memory, a USB drive, a volatile memory device such as a Random Access Memory (RAM), a hard disk, floppy disks, a blueray disk, or optical media such as CD ROM discs and DVDs, or combinations thereof. However, examples of the storage are not limited to the above description, and the storage may be realized by other various devices and structures as would be understood by those skilled in the art.

[0159] At least one of the voltages of the compressor 141 and the first fan 145 corresponding to the detected humidity may be stored in the storage 163.

[0160] Herein, a rotational speed of the compressor may be given in RPM, and a change in the voltage of the first fan varies the rotational speed of the first fan.

[0161] The first driving portion 164 may drive the compressor 141 at a rotational speed corresponding to a command from the controller 162.

[0162] The second driving portion 165 may apply a voltage corresponding to a command from the controller 162 to the first fan 145.

[0163] FIG. 16 is a flow chart illustrating a control sequence of a refrigerator according to an embodiment of the disclosure. This will be further described with reference to FIGS. 15 and 17.

[0164] The refrigerator (e.g., using the humidity detector) detects humidity in the indoor space (201) while maintaining the inner portions of the plurality of storage compartments at desired temperatures. Herein, the humidity may refer to a relative humidity (%) in the indoor space.

[0165] Then, the refrigerator (e.g., using the controller) decides (determines) whether the detected humidity is greater than the preset reference humidity (202), and maintains the temperature of the refrigerant pipe at a predetermined temperature when a decision that the detected humidity is the reference humidity or less is made (203).

[0166] Herein, the refrigerant pipe may correspond to a refrigerant pipe adjacent to which the first flow passage portion 151 of the heat transfer portion is disposed, and may be the refrigerant pipe 147a between the compressor and the condenser or the refrigerant pipe 147b between the condenser and the capillary tube.

[0167] Maintaining the temperature of the refrigerant pipe at a predetermined temperature may include rotating the compressor 141 at a preset rotational speed in RPM, and applying a preset reference voltage to the first fan 145 so that the rotational speed of the first fan is maintained at a reference rotational speed.

[0168] In contrast, the refrigerator increases the temperature of the refrigerant pipe when a decision or determination that the detected humidity is greater than the reference humidity is made (204).

[0169] Herein, increasing the temperature of the refrigerant pipe corresponds to increasing a condensing temperature of the refrigerant in the refrigerant pipe, and increasing the temperature of the refrigerant pipe may include increasing the temperature of the refrigerant discharged from the compressor by increasing the RPM of the compressor.

[0170] In addition, increasing the temperature of the refrigerant pipe may include decreasing the blowing power of the fan so as to decrease an amount of the heat radiated from the refrigerant pipe.

[0171] In addition, increasing the temperature of the refrigerant pipe may include increasing the temperature of the refrigerant discharged from the compressor by increasing the RPM of the compressor and, at the same time, decreasing the amount of heat radiated from the refrigerant pipe by decreasing the blowing power of the first fan (e.g., by decreasing a rotational speed of the first fan).

[0172] In addition, the temperature of the refrigerant pipe becomes higher when the detected humidity is higher.

[0173] This will be described more specifically below.

[0174] As an example, the refrigerator identifies the RPM of the compressor corresponding to the detected humidity, and operates the compressor based on the identified RPM such that the compressor rotates at a higher RPM when the detected humidity is higher.

[0175] Herein, the RPM of the compressor at which the temperature of the refrigerant pipe increases is higher than the reference RPM.

[0176] As another example, the refrigerator identifies the voltage of the first fan corresponding to the detected humidity and applies the identified voltage to the first fan, wherein a lower voltage is applied to the first fan when the detected humidity is higher.

[0177] Herein, the voltage of the first fan at which the temperature of the refrigerant pipe increases is lower than the reference voltage.

[0178] As yet another example, the refrigerator identifies the RPM of the compressor corresponding to the detected humidity and the voltage of the first fan, then operates the compressor at the identified RPM, and at the same time, applies the identified voltage to the first fan.

[0179] In addition, adjusting values of the compressor and the first fan when the temperature of the refrigerant pipe is increased by operating the compressor and the first fan simultaneously are smaller than adjusting values of the compressor and the first fan when the temperature of the refrigerant pipe is increased by separately operating the compressor or the first fan.

[0180] The refrigerator increases the temperature of the refrigerant pipe by operating at least one of the compressor and the first fan based on the detected humidity such that the temperature of the refrigerant pipe increases when the detected humidity is higher.

[0181] Then, the refrigerator restores the controlled operations of the compressor and the first fan when the detected humidity is lower than the reference humidity.

[0182] This will be further described with reference to FIG. 17.

[0183] When the temperature of the front surface of the main body is maintained at the reference temperature (about 21 °C) with respect to room temperature of about 25 °C, dew does not form between the front surface of the main body and the door below the reference relative humidity (about 75%).

[0184] However, when the detected relative humidity is greater than the reference relative humidity, dew forms at the front surface of the main body.

[0185] That is, when air of the indoor space contains a great amount of moisture, the temperature is lowered at the front surface of the main body having a relatively low temperature, an amount of saturated water vapor is lowered, and thus dew forms at the front surface of the main body.

[0186] In order to prevent dew from forming, the temperature of the front surface of the main body should be increased when the detected relative humidity is greater than the reference relative humidity. Here, the temperature of the front surface of the main body should be higher as the detected relative humidity is higher. For example, as shown in FIG. 17, when the relative humidity corresponds to 90%, the temperature of the front surface of the main body should be about 24.5 °C, whereas when the relative humidity corresponds to 70%, the temperature of the front surface of the main body should be about 21 °C.

[0187] That is, the temperature of the refrigerant discharged from the compressor increases as the rotational speed of the compressor 141 increases, and the temperature of the refrigerant pipe may increase as the temperature of the refrigerant increases.

[0188] At this time, heat of a higher temperature is transferred to the heat transfer portion disposed adjacent to the refrigerant pipe, and thus the temperature of the front surface of the main body increases.

[0189] In addition, as a lower voltage is applied to the first fan 145, the rotational speed of the first fan decreases and the blowing power decreases accordingly, and an amount of the heat discharged from the refrigerant pipe decreases with the decrease of the blowing power.

[0190] At this time, as the heat of a higher temperature is transferred to the heat transfer portion disposed adjacent to the refrigerant pipe, the temperature of the front surface portion of the main body increases.

[0191] FIG. 18 is an exemplary view illustrating a heat transfer portion provided in a refrigerator according to an embodiment of the disclosure.

[0192] The refrigerator according to an embodiment of the disclosure may further include a valve 156 configured to adjust movement of the heat in a heat transfer portion, unlike the refrigerator according to an embodiment of the disclosure. Note that a description of substantially the same constitutions already disclosed herein will be omitted for the sake of brevity.

[0193] The heat transfer portion 150 may be disposed in the inner portion of a main body 110 along the front surfaces a1 and a2 of the main body 110 and may be used to prevent dew from forming between the main body 110 and the doors 130 (131 and 132).

[0194] That is, the heat transfer portion 150 may be disposed in the inner portion of the front surface, which is a contact surface with which the door comes in contact among the plurality of surfaces of the main body 110, so that a temperature of the front surface of the main body 110 may be increased by heat transferred from the heat transfer portion 150 to the contact surface.

[0195] The heat transfer portion 150 may be constituted with one flow passage through which heat is circulated. The one flow passage may be divided into a first flow passage portion 151 and a second flow passage portion 152. The first flow passage portion 151 may be disposed adjacent to the refrigerant pipe 147 of the refrigerating portion in the machinery compartment 115, and may receive heat from the adjacent refrigerant pipe 147. The second flow passage portion 152 may protrude from the machinery compartment 115 to the front surfaces a1 and a2 of the main body, and the heat absorbed at the first flow passage portion 151 may be circulated in the second flow passage portion 152.

[0196] The heat transfer portion 150 may further include a valve 156 configured to prevent heat from being transferred in the flow passage.

[0197] The valve 156 may be disposed adjacent to the first flow passage portion 151.

[0198] That is, the refrigerator adjusts the temperature of the front surface of the main body by adjusting an opening of the valve 156.

[0199] FIG. 19 is a control configuration diagram of a refrigerator according to an embodiment of the disclosure, wherein the refrigerator may further include a drive module 170 configured to drive an adjuster which adjusts the temperature of the front surface of the main body.

[0200] Herein, the adjuster may include the valve 156 which supplies or blocks heat by opening or closing the flow passage of the heat transfer portion.

[0201] The drive module 170 of the refrigerator may include a humidity detector 171, a controller 172, a storage 173, and a driving portion 174. Portions or some of the components of the drive module 170 may be disposed in the machinery compartment 115, for example. Portions or some of the components of the drive module 170 may alternatively be disposed elsewhere in the main body of the refrigerator (e.g. near a rear portion or lower portion of the refrigerator).

[0202] The humidity detector 171 may detect humidity in an indoor space in which the refrigerator is disposed. Herein, the humidity may refer to a relative humidity (%) in the indoor space.

[0203] The humidity detector 171 may be provided at an outside of the main body 110 (e.g., on an exterior surface of the main body 110).

[0204] The controller 172 may control the operations of the compressor 141, the first fan 145 and the second fan 146 of the refrigerating portion based on the detected temperatures of the inner portions of the plurality of storage compartments so that the temperatures in the inner portions of the plurality of storage compartments are maintained at a desired temperatures. For example, the controller 172 may include one or more of a processor, an arithmetic logic unit, a central processing unit (CPU), a graphics processing unit (GPU), a digital signal processor (DSP), an image processor, a microcomputer, a field programmable array, a programmable logic unit, an application-specific integrated circuit (ASIC), a microprocessor or any other device capable of responding to and executing instructions in a defined manner.

[0205] The controller 172 periodically identifies the detected humidity received, identifies a duty cycle which corresponds to the detected humidity, and sends an ON/OFF signal to the valve 156 based on the identified duty cycle.

[0206] That is, the controller 172 controls an ON time and an OFF time of the valve 156 based on the duty cycle.

[0207] The duty cycles corresponding to each humidity detected may be stored in the storage 173. For example, the storage 173 may include a storage medium, such as a nonvolatile memory device, such as a Read Only Memory (ROM), Programmable Read Only Memory (PROM), Erasable Programmable Read Only Memory (EPROM), and flash memory, a USB drive, a volatile memory device such as a Random Access Memory (RAM), a hard disk, floppy disks, a blue-ray disk, or optical media such as CD ROM discs and DVDs, or combinations thereof. However, examples of the storage are not limited to the above description, and the storage may be realized by other various devices and structures as would be understood by those skilled in the art

[0208] The driving portion 174 may open or close the valve 156 depending on the ON/OFF signal sent from the controller 172.

[0209] FIG. 20 is a flow chart illustrating a control sequence of a refrigerator according to an embodiment of the disclosure.

[0210] The refrigerator (e.g., using a humidity detector) detects humidity in the indoor space while maintaining the temperatures in the inner portions of the plurality of storage compartments at desired temperatures (211) in order to prevent dew from forming. Herein, the detected humidity may refer to a relative humidity (%) in the indoor space.

[0211] Then, the refrigerator (e.g., using the controller) identifies the duty cycle of the valve 156 which corresponds to the detected humidity (212).

[0212] In addition, the refrigerator may identify the dew-point temperature corresponding to the detected humidity, and then identify the duty cycle of the valve 156 corresponding to the identified dew-point temperature. At this time, the duty cycles of the valve which correspond to the dew-point temperatures may be stored in advance, e.g. in the storage.

[0213] Then, the refrigerator (e.g., using the controller) controls the opening and closing of the valve 156 based on the identified duty cycle (213) so that the heat transferred to the front surface of the main body is adjusted such that a greater amount of heat is transferred to the front surface of the main body when the detected humidity is higher.

[0214] More specifically, when the valve 156 is closed, the flow passage is also closed so that a heat flow through the first flow passage portion is blocked, and when the valve 156 is opened, the flow passage which constitutes the heat transfer portion is also opened so that the heat of the first flow passage portion circulates in the flow passage, the heat emitted from the flow passage of the heat transfer portion during the circulation is transferred to the main body, and thus the temperature of the front surface of the main body is increased.

[0215] That is, the heat of the heat transfer portion is transferred to the front surface of the main body while the valve is open.

[0216] Accordingly, the amount of heat transferred to the front surface of the main body may be adjusted by adjusting the ON time of the valve provided at the heat transfer portion. In other words, the temperature of the front surface of the main body may be adjusted by adjusting the ON/OFF time of the valve provided at the heat transfer portion.

[0217] In addition, the refrigerator (e.g., using the controller) controls the ON time of the valve 156 so that the ON time is longer as the detected humidity is higher, and thus further increases the temperature of the front surface of the main body and accordingly prevents dew from forming between the main body and the door.

[0218] This is because the dew-point temperature is higher as the relative humidity is higher.

[0219] A refrigerator according to an embodiment of the disclosure may further include a temperature detector configured to detect the temperature of the front surface of the main body.

[0220] Herein, the temperature of the front surface of the main body may be a temperature of the front surface adjacent to a freezing compartment. Other constitutions which are substantially the same as those of other embodiments disclosed herein will not be described again for the sake of brevity.

[0221] FIG. 21 is a control diagram of a refrigerator according to an embodiment of the disclosure further including a drive module 180 configured to drive the valve 156 in order to control the temperature of the front surface of the main body.

[0222] The drive module 180 of the refrigerator may include a humidity detector 181, a temperature detector 182, a controller 183, a storage 184 and a driving portion 185. Portions or some of the components of the drive module 180 may be disposed in the machinery compartment 115, for example. Portions or some of the components of the drive module 180 may alternatively be disposed elsewhere in the main body of the refrigerator (e.g. near a rear portion or lower portion of the refrigerator).

[0223] The humidity detector 181 may detect humidity in the indoor space in which the refrigerator is disposed, and sends the detected humidity to the controller 183. Herein, the humidity may refer to a relative humidity (%) of the indoor space.

[0224] The humidity detector 181 may be provided at an outside of the main body 110 (e.g., on an exterior surface of the main body 110).

[0225] The temperature detector 182 may detect the temperature of the front surface of the main body, and may send the detected temperature to the controller 183.

[0226] The controller 183 may control operations of the compressor 141, the first fan 145 and the second fan 146 of the refrigerating portion based on the detected temperatures of the inner portions of the plurality of storage compartments so as to maintain the temperatures of the inner portions of the plurality of storage compartments at the target temperatures. For example, the controller 183 may include one or more of a processor, an arithmetic logic unit, a central processing unit (CPU), a graphics processing unit (GPU), a digital signal processor

(DSP), an image processor, a microcomputer, a field programmable array, a programmable logic unit, an application-specific integrated circuit (ASIC), a microprocessor or any other device capable of responding to and executing instructions in a defined manner.

[0227] The controller 183 periodically identifies the detected humidity and the detected temperature received and controls the ON/OFF of the valve based on the detected humidity and the detected temperature in order to prevent dew from forming between the main body and the door.

[0228] The dew-point temperatures which correspond to each reference humidity may be stored in the storage 184. For example, the storage 184 may include a storage medium, such as a nonvolatile memory device, such as a Read Only Memory (ROM), Programmable Read Only Memory (PROM), Erasable Programmable Read Only Memory (EPROM), and flash memory, a USB drive, a volatile memory device such as a Random Access Memory (RAM), a hard disk, floppy disks, a blue-ray disk, or optical media such as CD ROM discs and DVDs, or combinations thereof. However, examples of the storage are not limited to the above description, and the storage may be realized by other various devices and structures as would be understood by those skilled in the art.

[0229] The driving portion 185 may open or close the valve 156 according to the ON/OFF signal sent form the controller 183.

[0230] FIG. 22 is a flow chart illustrating a control sequence of a refrigerator according to an embodiment of the disclosure.

[0231] The refrigerator detects humidity in the indoor space (e.g., using the humidity detector) and detects a temperature of the front surface of the main body (e.g., using the temperature detector) while maintaining the temperatures in the inner portions of the plurality of storage compartments at target temperatures (221) in order to prevent dew from forming. Herein, the detected humidity may refer to a relative humidity (%) in the indoor space.

[0232] Then, the refrigerator identifies the dew-point temperature which corresponds to the detected humidity (222), and compares the identified dew-point temperature with the detected temperature.

[0233] That is, the refrigerator (e.g., using the controller) decides or determines whether the detected temperature is lower than the dew-point temperature (223), and opens the valve (224) in order to transfer heat to the front surface of the main body when a decision or determination that the detected temperature is lower than the dew-point temperature is made.

[0234] More specifically, when the valve 156 is closed, the flow passage is also closed so that a heat flow through the first flow passage portion is blocked, and when the valve 156 of the heat transfer portion is opened, the flow passage which constitutes the heat transfer portion is also opened so that the heat of the first flow passage portion circulates in the flow passage, the heat emitted from the flow passage of the heat transfer portion during the heat circulation is transferred to the main body, and thus the temperature of the front surface of the main body increases.

[0235] That is, the heat of the heat transfer portion is transferred to the front surface of the main body so that the temperature of the front surface of the main body increases above the dew-point temperature when the valve is opened.

[0236] Then, the refrigerator closes the valve when the temperature of the front surface of the main body is greater than the dew-point temperature so that the heat transferred to the front surface of the main body is blocked.

[0237] In this way, an excessive increase in the temperature of the front surface of the main body may be prevented based on the detected humidity of the indoor space, and re-penetrating of heat into the storage compartment is prevented, so that the power consumption of the refrigerator may be improved. This will be described with reference to FIG. 23.

[0238] FIG. 23 is a graph illustrating results obtained by comparing power consumption and the temperature of the front surface of a side-by-side refrigerator having a refrigerating compartment and a freezing compartment partitioned side by side.

[0239] As shown in FIG. 23, as a heat source which re-penetrates into the front surface of the refrigerator is zero, it may be seen that power consumption may be reduced by about 4.7% compared to basic power consumption.

[0240] In addition, it may be seen that an effect of a reduction of the power consumption of about 2% or more may be achieved when the temperature of the front surface of the refrigerator is increased just enough to cover relative humidity of about 75%.

[0241] As a result, when the humidity in winter is less than about 40%, the power consumption may be reduced by about 3% or more.

[0242] Aspects of the above-described example embodiments may be recorded in non-transitory computer-readable media including program instructions to implement various operations embodied by a computer. The media may also include, alone or in combination with the program instructions, data files, data structures, and the like. Examples of non-transitory computer-readable media include magnetic media such as hard disks, floppy disks, and magnetic tape; optical media such as CD ROM disks, Blue-Ray disks, and DVDs; magneto-optical media such as optical discs; and other hardware devices that are specially configured to store and perform program instructions, such as semiconductor memory, read-only memory (ROM), random access memory (RAM), flash memory, USB memory, and the like. Examples of program instructions include both machine code, such as produced by a compiler, and files containing higher level code that may be executed by the computer using an interpreter. The program instructions may be executed by one or more processors. The described hardware devices may be configured to act as one or more software modules in order to perform the operations of the above-described embodiments, or vice versa. In addition, a non-transitory computer-readable storage medium may be distributed among computer systems connected through a network and computer-readable codes or program instructions may be stored and executed in a decentralized manner. In addition, the non-transitory computer-readable storage media may also be embodied in at least one application specific integrated circuit (ASIC) or Field Programmable Gate Array (FPGA).

[0243] Although example embodiments of the disclosure have been shown and described, it would be appreciated by those skilled in the art that changes may be made to these embodiments without departing from the principles of the invention, the scope of which is defined in the claims.

Claims

1. A refrigerator comprising:

a main body having a storage compartment;
a door provided at the main body and configured to close and open the storage compartment;
a refrigerating portion configured to refrigerate the storage compartment, the refrigerating portion comprising a compressor and a condenser which are connected with a refrigerant pipe; and
a heat transfer portion having a first flow passage portion which is disposed adjacent to the refrigerant pipe of the refrigerating portion and receives heat from the refrigerant pipe, and a second flow passage portion which is disposed at a front surface of the main body and to which heat of the first flow passage portion is transferred.

2. The refrigerator of claim 1, wherein
a first refrigerant circulates in the refrigerant pipe of the refrigerating portion,
a second refrigerant circulates in the first flow passage portion and the second flow passage portion of the heat transfer portion, and
the first refrigerant and the second refrigerant are spatially separated.

3. The refrigerator of claim 1 or 2, wherein the first flow passage portion is disposed at a lower portion of the main body and is disposed asymmetrically to the second flow passage portion which is disposed at the lower portion of the main body.

4. The refrigerator of claim 1, 2 or 3, further comprising a joining member configured to join the first flow passage portion of the heat transfer portion and the refrigerant pipe.

5. The refrigerator of any one of the preceding claims, wherein the first flow passage portion of the heat transfer portion and the refrigerant pipe are formed in a double pipe structure, and a length of the double pipe is determined based on a temperature of the front surface of the main body.

6. The refrigerator of any one of the preceding claims, wherein the refrigerant pipe adjacent to the first flow passage portion is disposed between the compressor and the condenser.

7. The refrigerator of any one of the preceding claims, wherein the refrigerating portion further comprises a depressurizer which is connected with the refrigerant pipe, and the refrigerant pipe adjacent to the first flow passage portion is disposed between the condenser and the depressurizer.

8. The refrigerator of any one of the preceding claims, further comprising:

a humidity detector configured to detect indoor humidity; and
a controller configured to control a number of revolutions of the compressor based on the detected humidity.

9. The refrigerator of any one of claims 1 to 7, further comprising:

a humidity detector configured to detect indoor humidity;
a fan configured to radiate heat of the condenser; and
a controller configured to control an electric voltage of the fan based on the detected humidity.

10. The refrigerator of any one of claims 1 to 7, further comprising:

a humidity detector configured to detect indoor humidity;
a valve configured to adjust heat transfer of the heat transfer portion; and
a controller configured to control a duty cycle of the valve based on the detected humidity.

11. The refrigerator of any one of claims 1 to 7, further comprising:

a humidity detector configured to detect indoor humidity;
a temperature detector configured to detect a temperature of the front surface of the main body;
a valve configured to adjust heat transfer of the heat transfer portion; and

a controller configured to control an opening of the valve based on the detected humidity and temperature.

12. A method of controlling a refrigerator including a main body having a storage compartment, the method comprising:

detecting indoor humidity; and
adjusting a temperature of a refrigerant pipe based on the detected humidity, wherein the adjusting of the temperature of the refrigerant pipe comprises adjusting a temperature of a first flow passage portion of a heat transfer portion disposed adjacent to the refrigerant pipe and adjusting a temperature of a second flow passage portion of the heat transfer portion disposed at a front surface of the main body by adjusting the temperature of the first flow passage portion.

13. The method of claim 12, wherein the adjusting of the temperature of the refrigerant pipe based on the detected humidity comprises increasing the number of revolutions of a compressor disposed in the main body when the detected humidity is greater than a reference humidity, decreasing an electric voltage of a fan disposed in the main body which is configured to radiate heat of a condenser disposed in the main body when the detected humidity is greater than a reference humidity, and/or adjusting a valve disposed in the main body which blocks heat from being supplied from the first flow passage portion of the heat transfer portion disposed adjacent to the refrigerant pipe to the second flow passage portion of the heat transfer portion disposed at the front surface of the main body.

14. The method of claim 13, wherein the adjusting of the valve comprises controlling a duty cycle of the valve based on the detected humidity.

15. The method of claim 13, wherein the controlling of the valve comprises:

detecting a temperature of the front surface of the main body;
identifying a dew-point temperature which corresponds to the detected humidity;
determining whether the detected temperature is less than the identified dew-point temperature; and
opening the valve when the detected temperature is less than the identified dew-point temperature.

FIG. 1

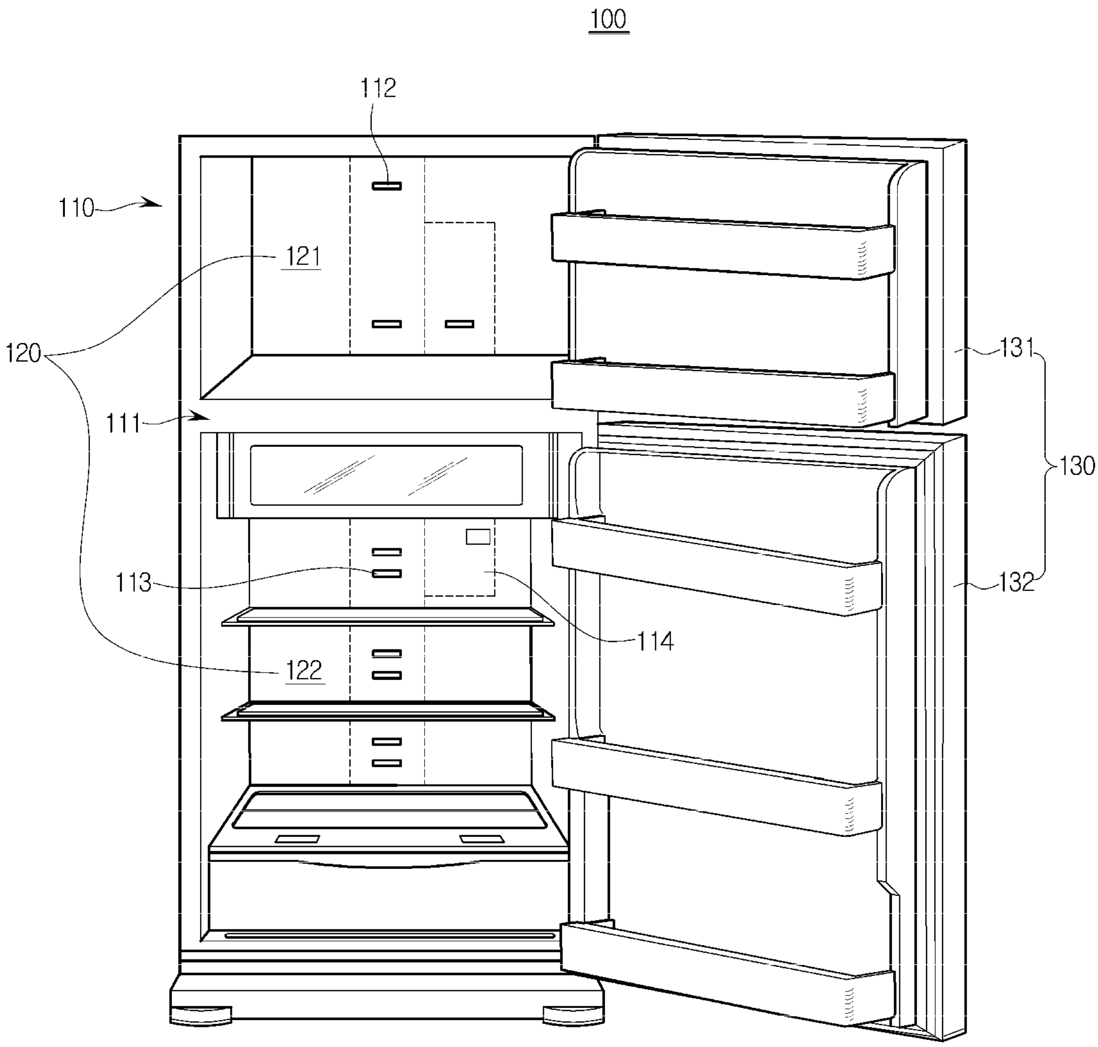


FIG. 2

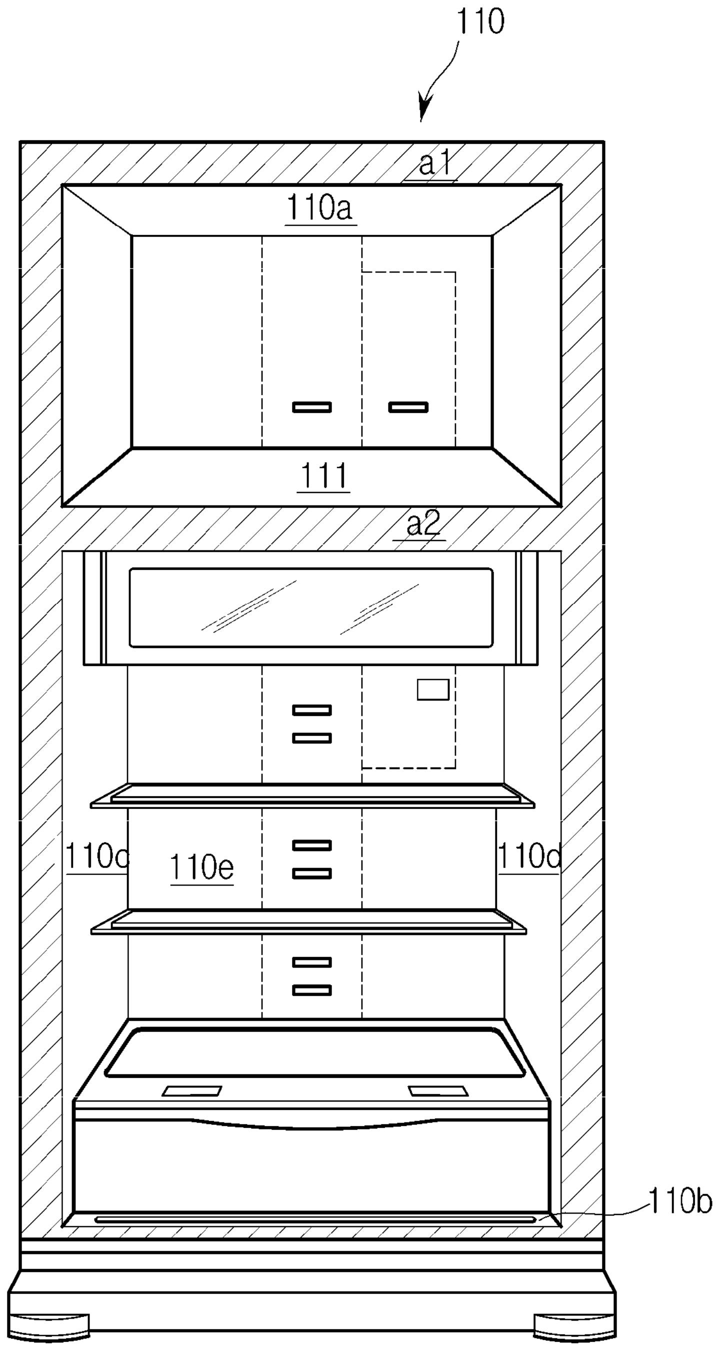


FIG. 3

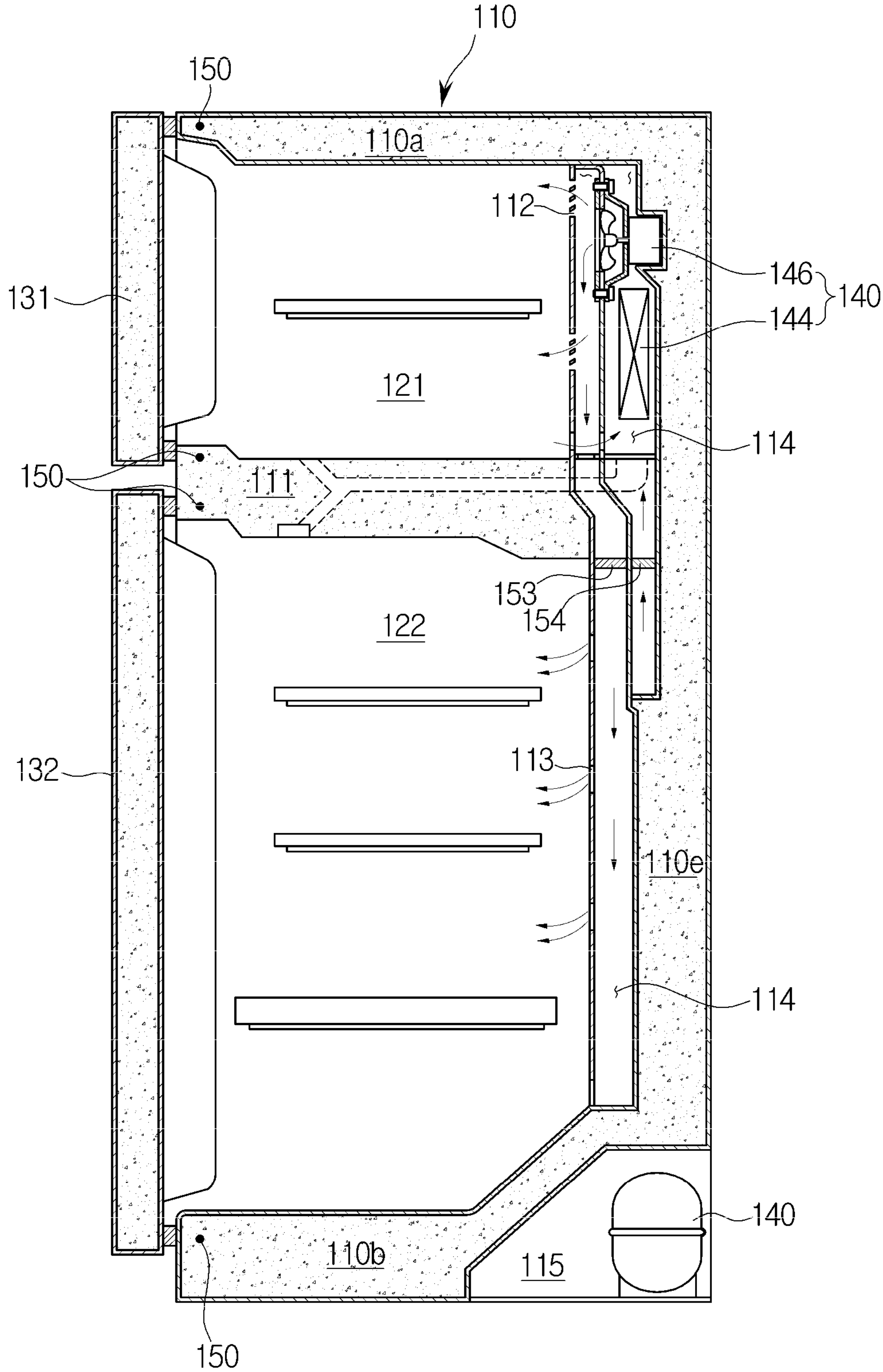

110
150
110a
112
131
146
140
144
121
114
150
111
153
154
122
132
113
110e
114
140
110b
115
150

FIG. 4A

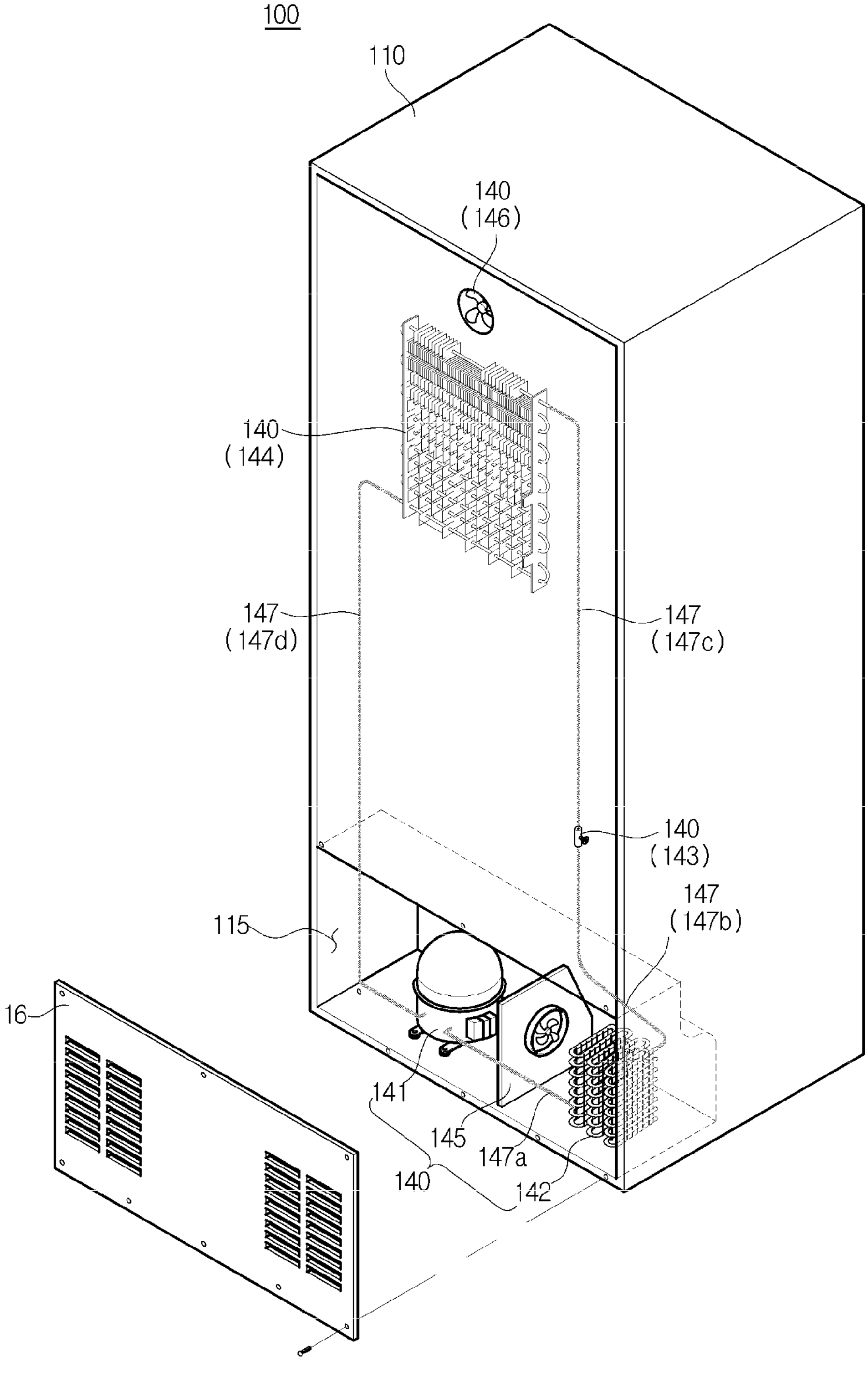

100
110
140
(146)
140
(144)
147
(147d)
147
(147c)
140
(143)
147
(147b)
115
116
141
145
147a
140
142

FIG. 4B

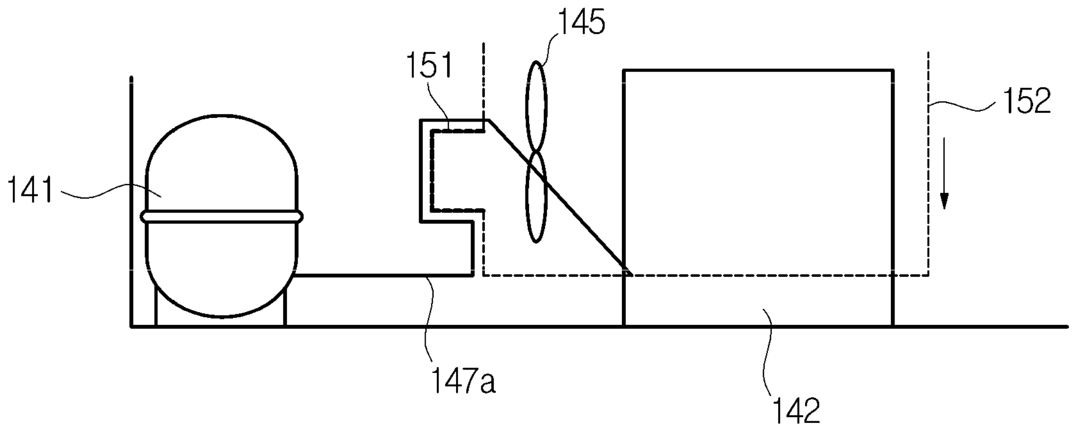


FIG. 5

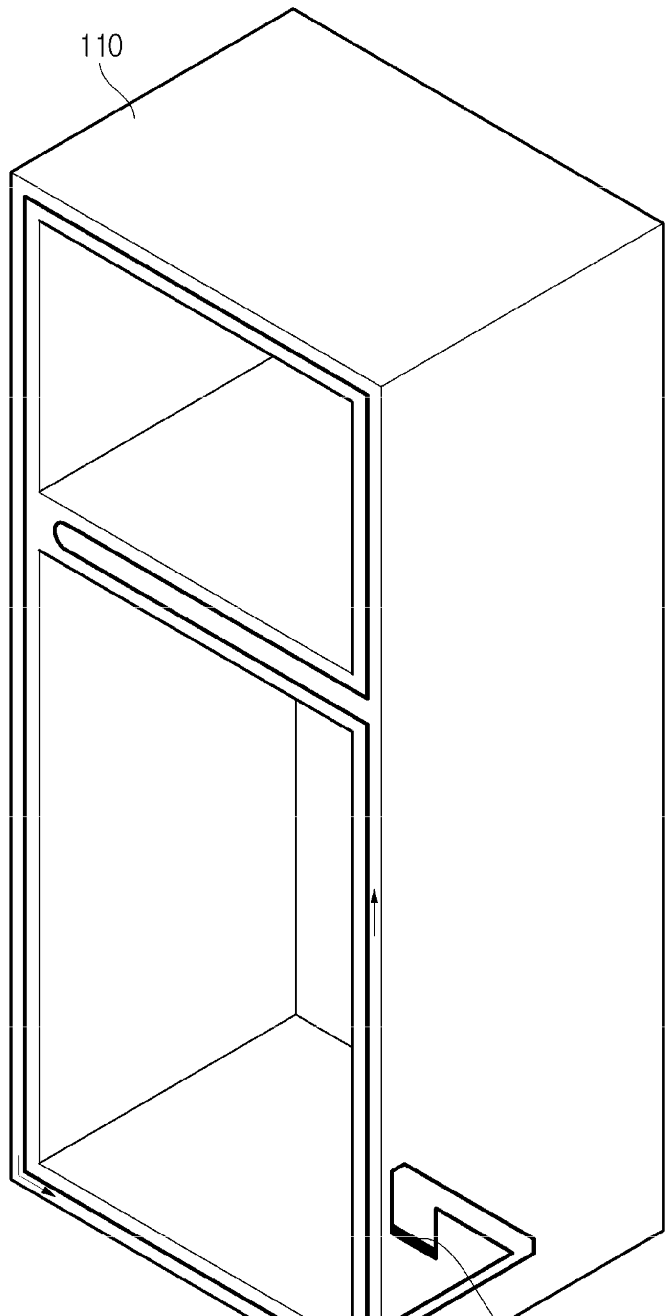


FIG. 6A

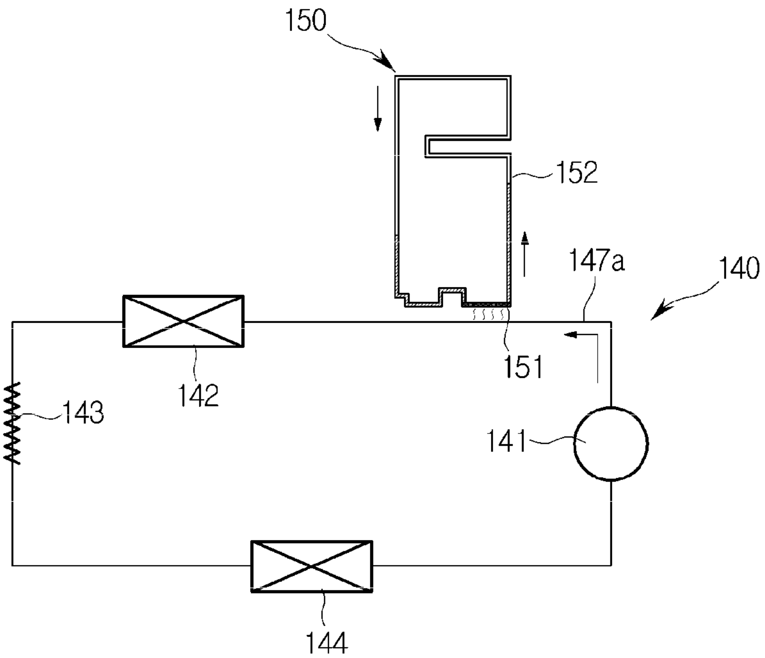

150
152
147a
140
151
142
143
141
144

FIG. 6B

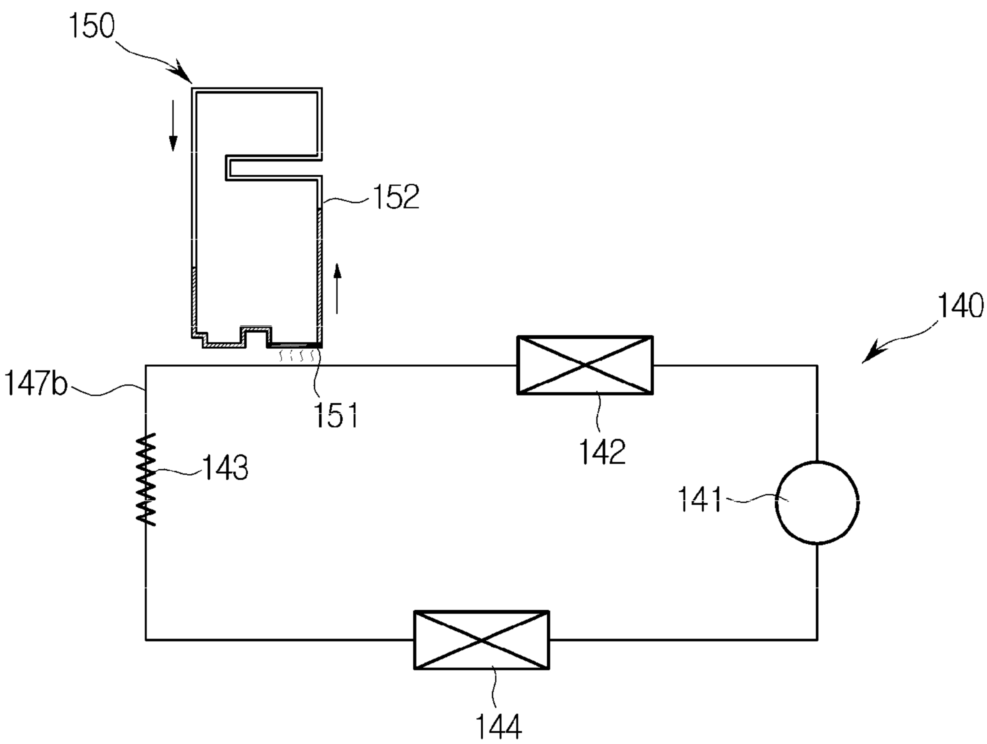

150
152
140
147b
151
142
143
141
144

FIG. 7

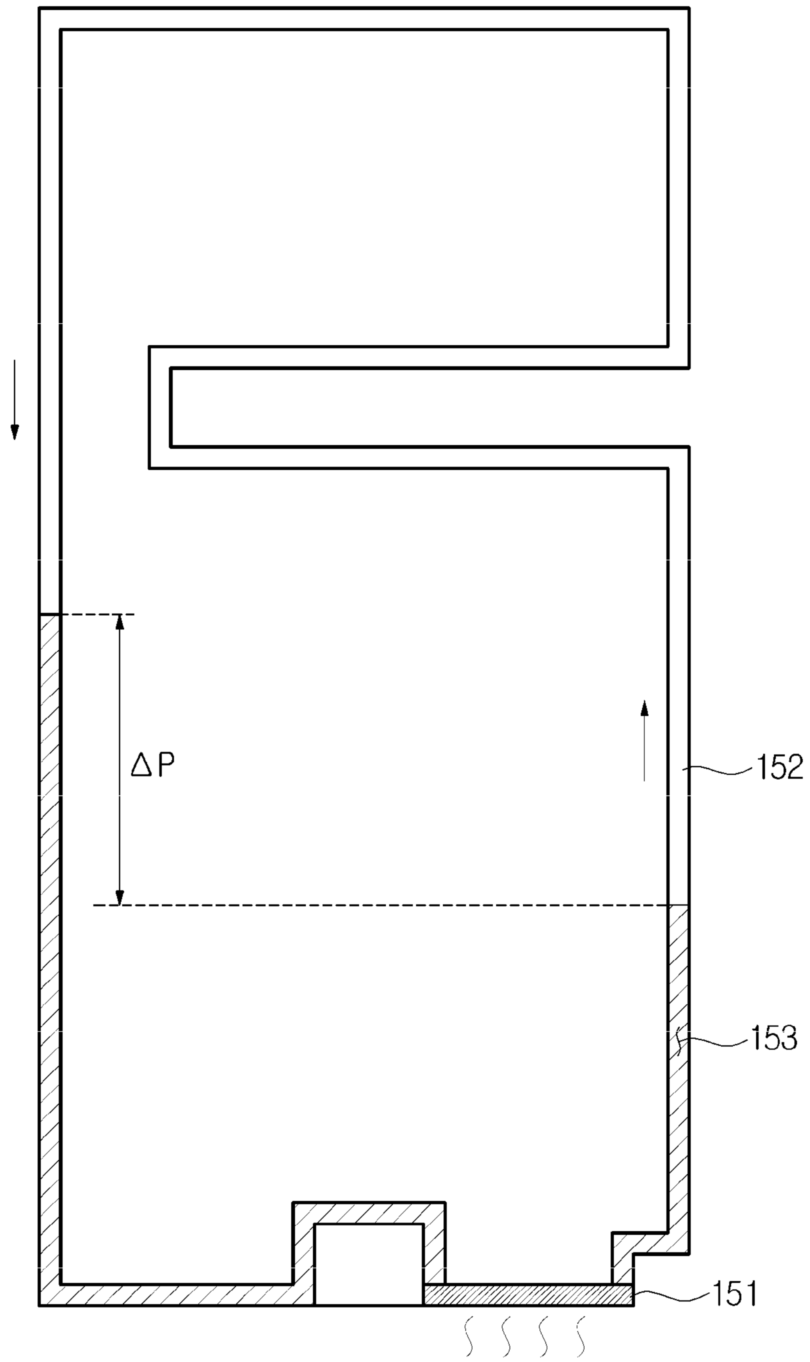


FIG. 8

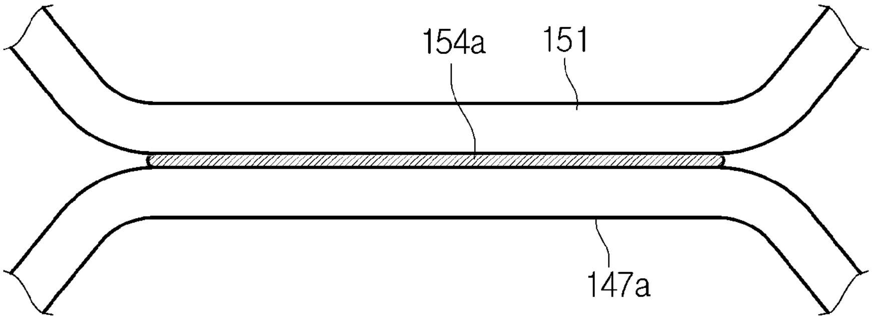


FIG. 9

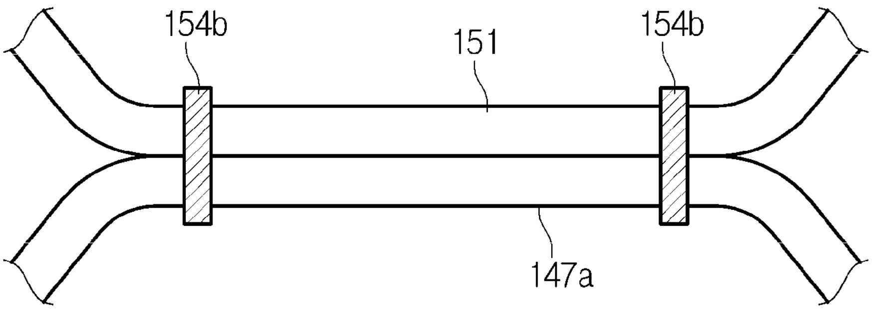


FIG. 10

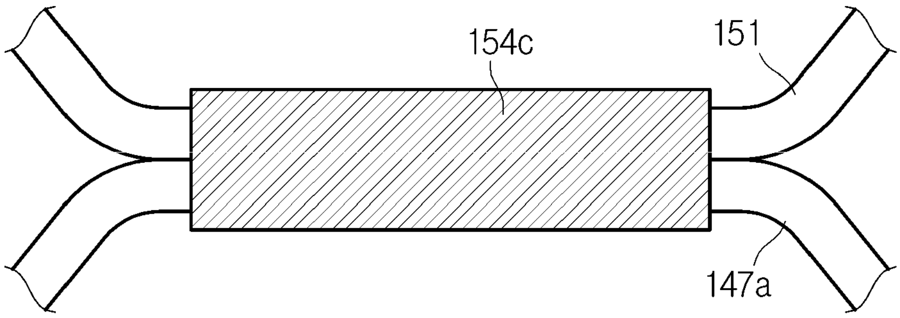


FIG. 11

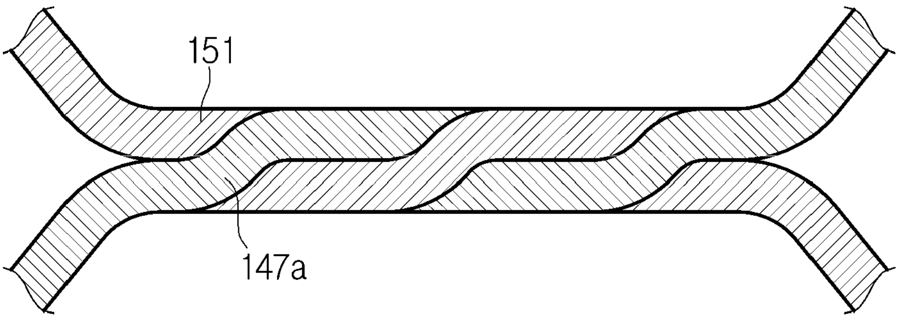


FIG. 12

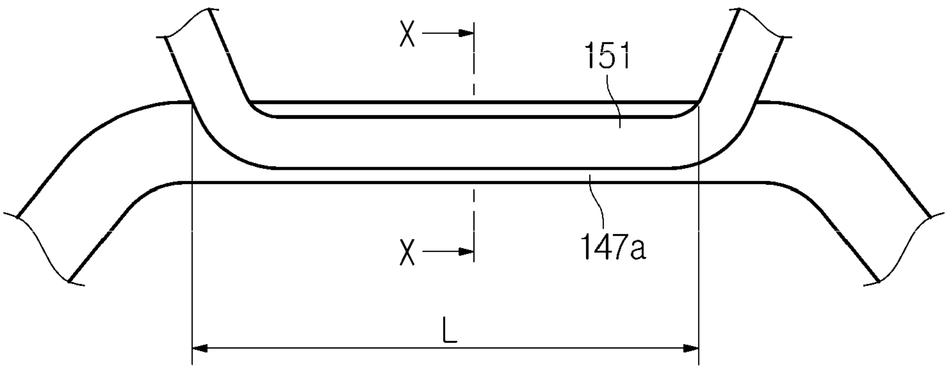


FIG. 13A

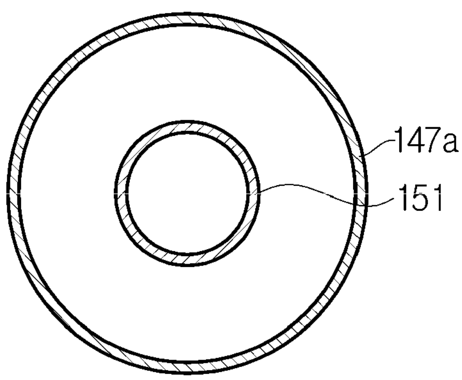


FIG. 13B

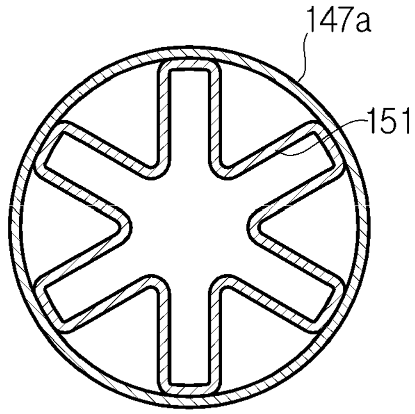


FIG. 13C

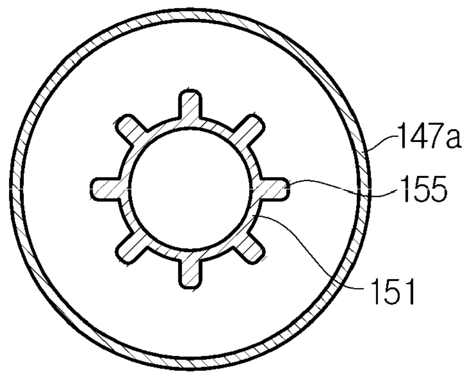


FIG. 13D

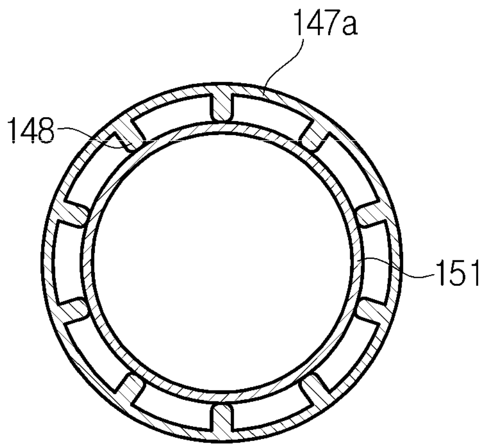


FIG. 14

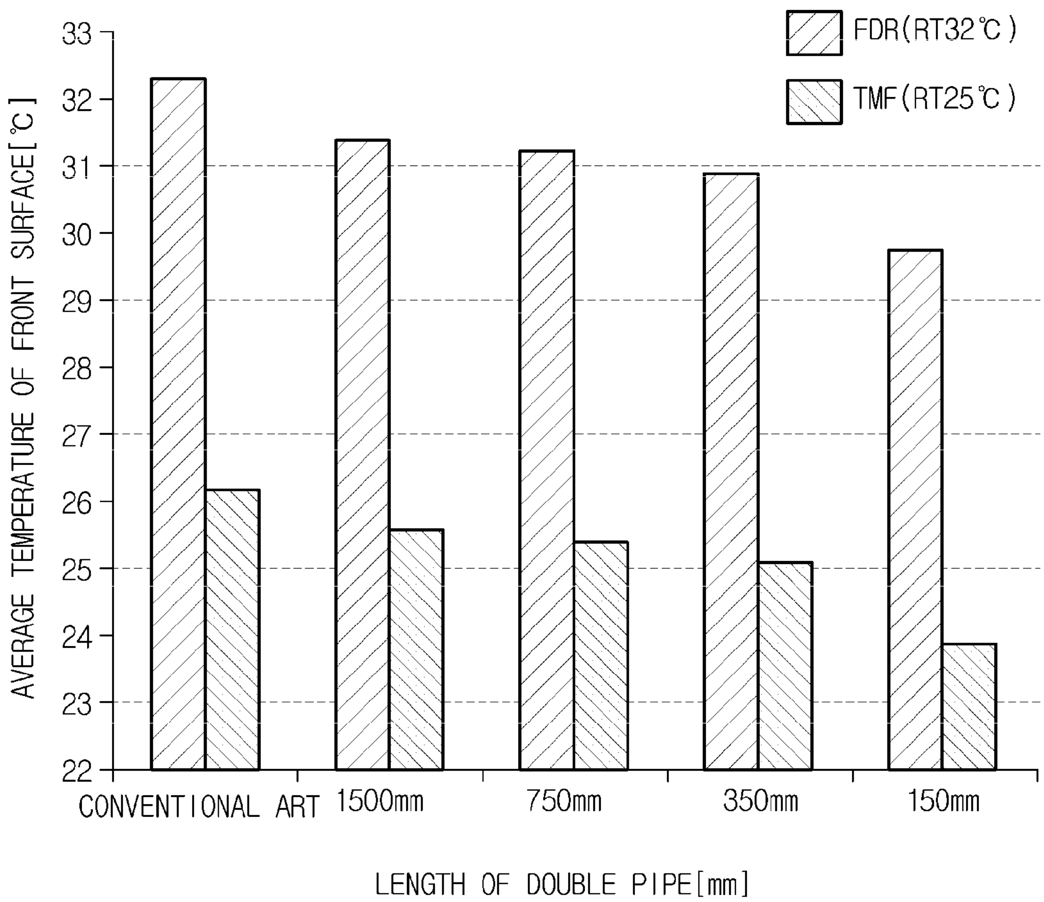

FDR(RT32℃)
TMF(RT25℃)
AVERAGE TEMPERATURE OF FRONT SURFACE[℃]
33
32
31
30
29
28
27
26
25
24
23
22
CONVENTIONAL ART
1500mm
750mm
350mm
150mm
LENGTH OF DOUBLE PIPE[mm]

FIG. 15

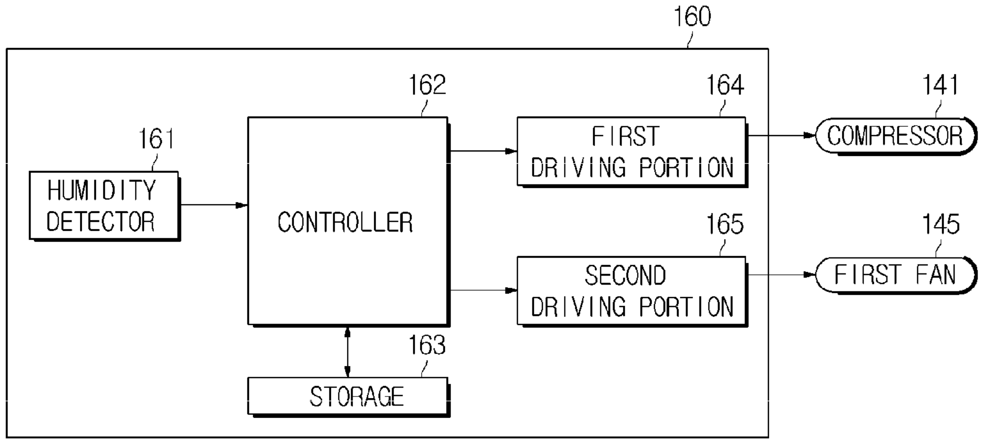

160
162
164
141
161
HUMIDITY DETECTOR
CONTROLLER
FIRST DRIVING PORTION
COMPRESSOR
165
145
SECOND DRIVING PORTION
FIRST FAN
163
STORAGE

FIG. 16

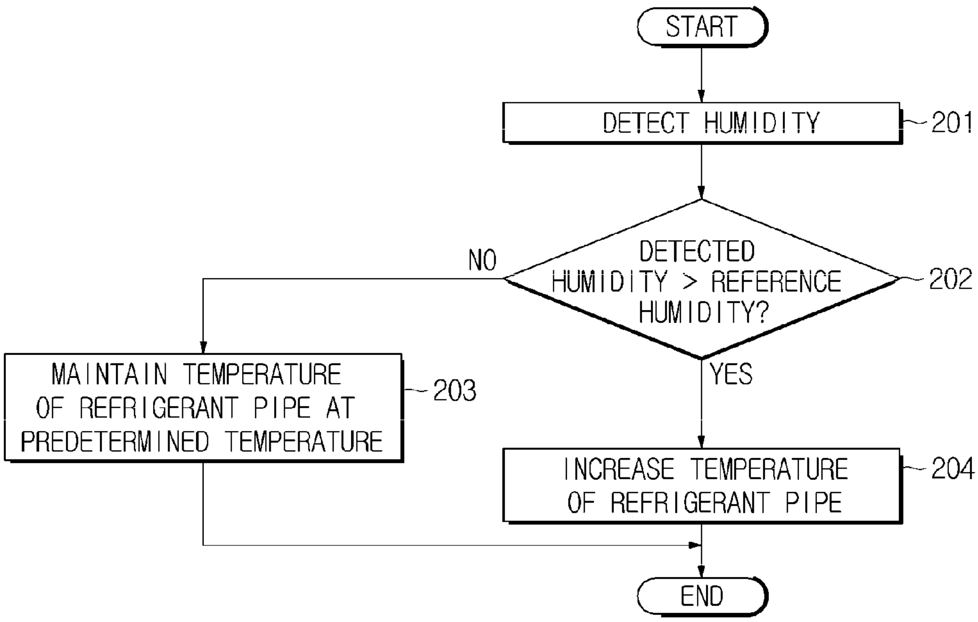

START
DETECT HUMIDITY
201
NO
DETECTED HUMIDITY > REFERENCE HUMIDITY?
202
MAINTAIN TEMPERATURE OF REFRIGERANT PIPE AT PREDETERMINED TEMPERATURE
203
YES
INCREASE TEMPERATURE OF REFRIGERANT PIPE
204
END

FIG. 17

RT25℃	PRESENT EMBODIMENT		
RELATIVE HUMIDITY	TEMPERATURE OF FRONT SURFACE	C-Fan	Comp RPM
95%	24.5℃	8.5V	1400RPM
90%	23.5℃	9V	1350RPM
85%	22.5℃	9.5V	1300RPM
80%	21.5℃	10V	1250RPM
75%	21℃	10.5V	1200RPM
70%	21℃	10.5V	1200RPM
65%	21℃	10.5V	1200RPM
60%	21℃	10.5V	1200RPM
55%	21℃	10.5V	1200RPM
50%	21℃	10.5V	1200RPM
45%	21℃	10.5V	1200RPM
30%	21℃	10.5V	1200RPM
35%	21℃	10.5V	1200RPM
30%	21℃	10.5V	1200RPM

FIG. 18

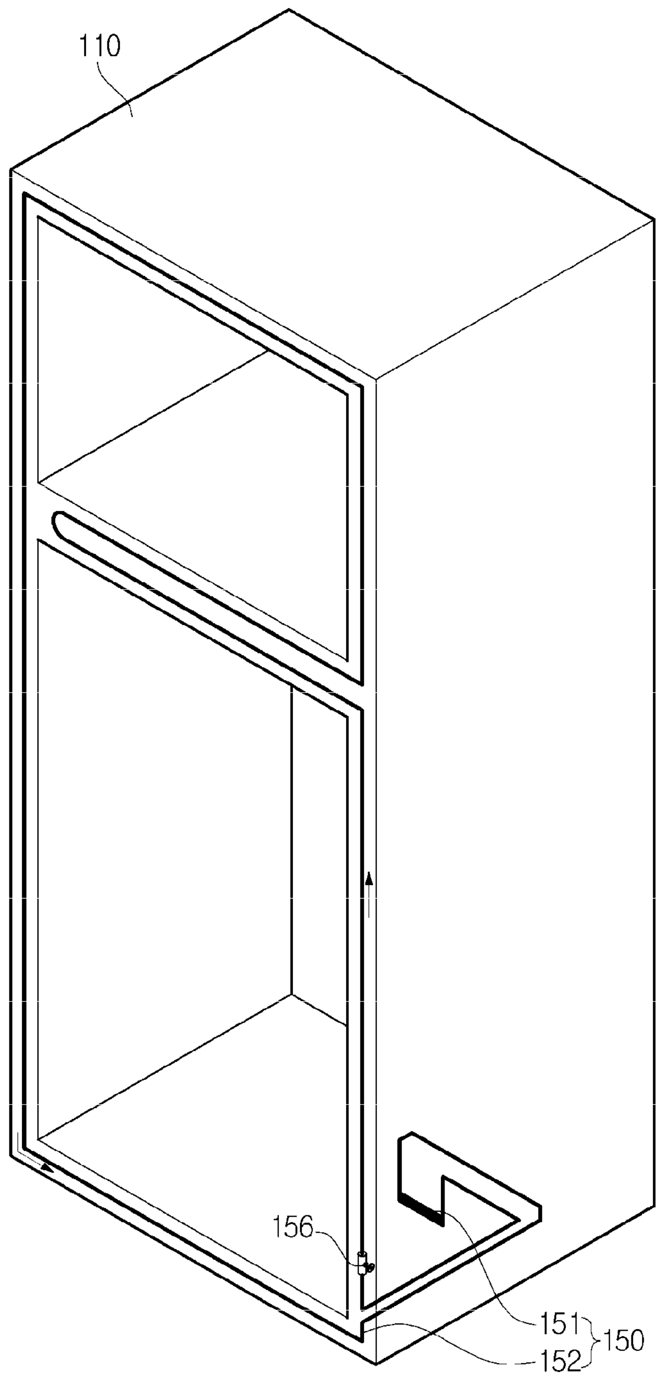


FIG. 19

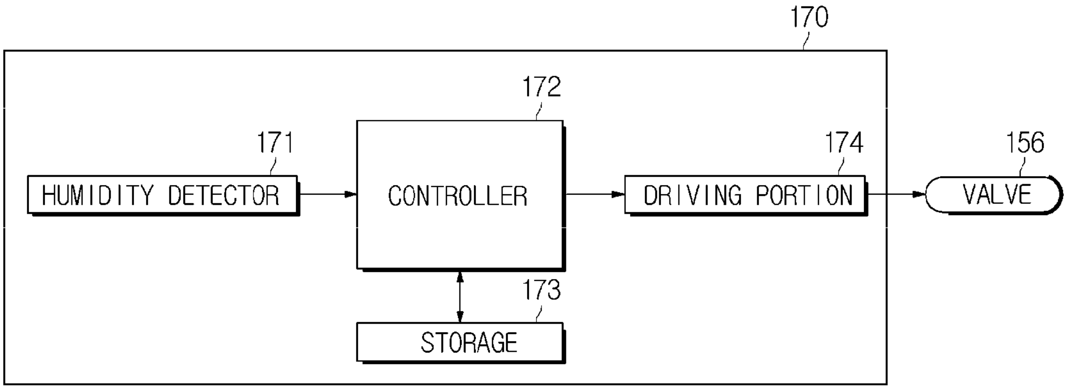

170
172
171
174
156
HUMIDITY DETECTOR
CONTROLLER
DRIVING PORTION
VALVE
173
STORAGE

FIG. 20

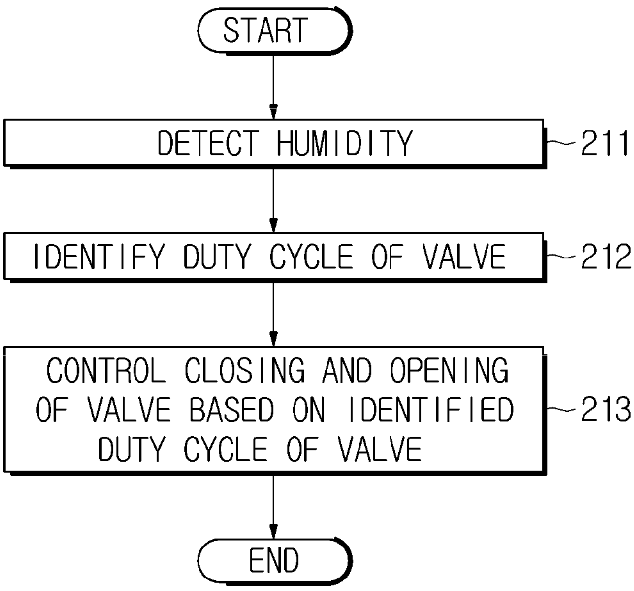

START
DETECT HUMIDITY
211
IDENTIFY DUTY CYCLE OF VALVE
212
CONTROL CLOSING AND OPENING OF VALVE BASED ON IDENTIFIED DUTY CYCLE OF VALVE
213
END

FIG. 21

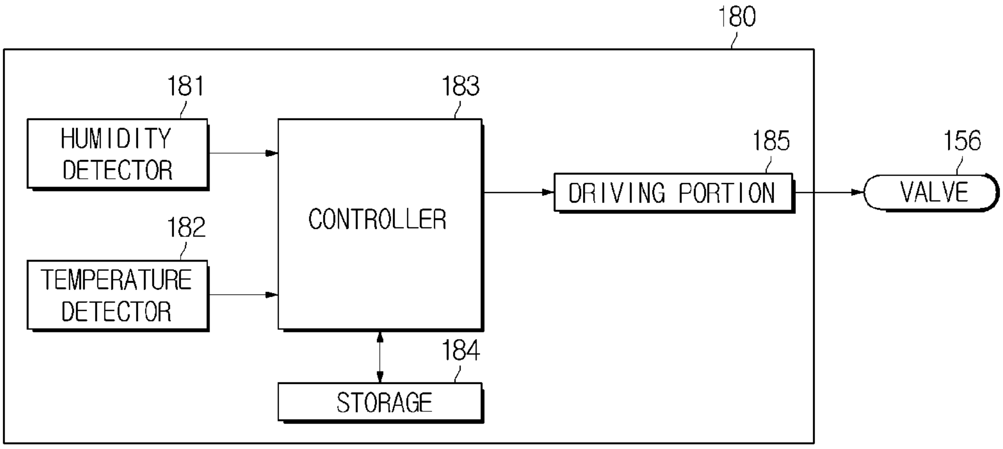

180
181
HUMIDITY DETECTOR
182
TEMPERATURE DETECTOR
183
CONTROLLER
184
STORAGE
185
DRIVING PORTION
156
VALVE

FIG. 22

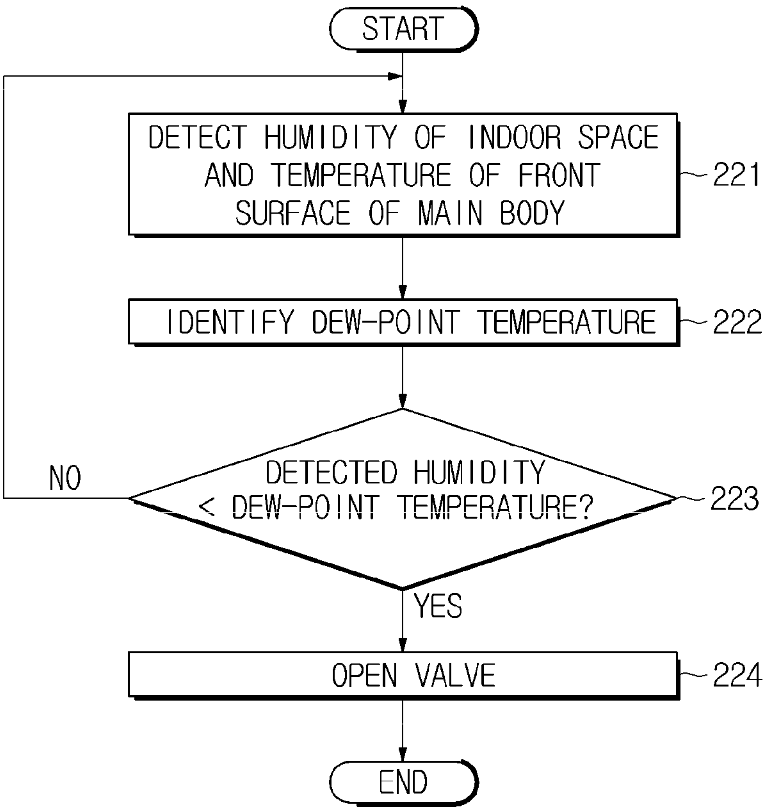
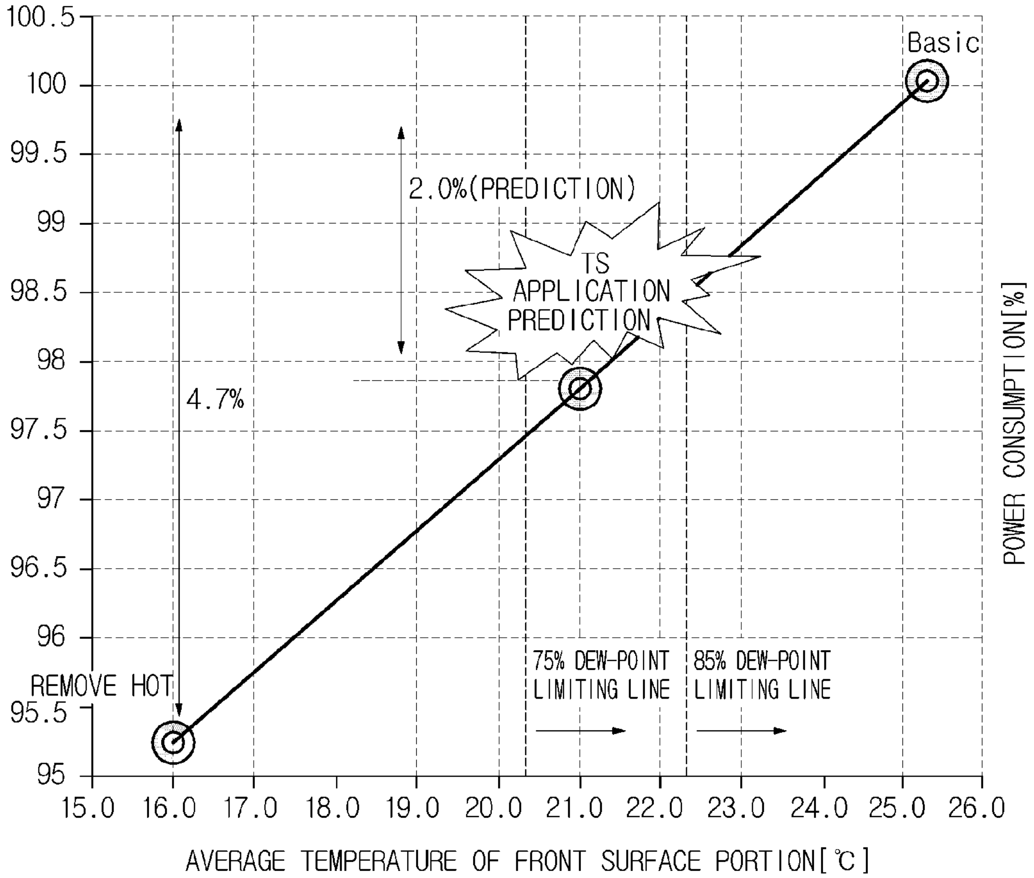

START
DETECT HUMIDITY OF INDOOR SPACE AND TEMPERATURE OF FRONT SURFACE OF MAIN BODY
221
IDENTIFY DEW-POINT TEMPERATURE
222
DETECTED HUMIDITY < DEW-POINT TEMPERATURE?
223
NO
YES
OPEN VALVE
224
END

FIG. 23


Basic
2.0%(PREDICTION)
TS
APPLICATION
PREDICTION
4.7%
REMOVE HOT
75% DEW-POINT
LIMITING LINE
85% DEW-POINT
LIMITING LINE
100.5
100
99.5
99
98.5
98
97.5
97
96.5
96
95.5
95
15.0
16.0
17.0
18.0
19.0
20.0
21.0
22.0
23.0
24.0
25.0
26.0
AVERAGE TEMPERATURE OF FRONT SURFACE PORTION[℃]
POWER CONSUMPTION[%]

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 15 16 6074

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2011/060500 A1 (ELECTROLUX HOME PRODUCTS PTY LTD [AU]; SANDERS PHILIP [AU]; SUSSMILCH) 26 May 2011 (2011-05-26)	1-7	INV. F25D21/04
Y	* paragraphs [0050] - [0061]; figures 3-5 *	8-11	
X	US 2012/017612 A1 (JUNGE BRENT ALDEN [US] ET AL) 26 January 2012 (2012-01-26)	12,13	
Y	* paragraphs [0006], [0017] - [0027]; figures *	9,14,15	
X	US 4 158 294 A (KEELING JR K BAILEY) 19 June 1979 (1979-06-19) * abstract * * column 4, lines 5-28; figures *	1-6	
Y	US 2013/192285 A1 (BAE JUNGWOOK [KR] ET AL) 1 August 2013 (2013-08-01) * paragraphs [0058] - [0075]; figures *	8,10,11, 14,15	
A	GB 2 344 413 A (SAMSUNG ELECTRONICS CO LTD [KR]) 7 June 2000 (2000-06-07) * the whole document *	1-15	TECHNICAL FIELDS SEARCHED (IPC) F25D F25B

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	23 October 2015	Vigilante, Marco

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 15 16 6074

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
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23-10-2015

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		US 6289691 B1	18-09-2001

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82