

DESCRIPTION

Title of Invention

REFRIGERATOR

Technical Field

5 [0001]

The present invention relates to a refrigerator that includes an anti-condensation pipe that prevents occurrence of condensation.

Background Art

[0002]

10 In the related art, there are refrigerators that include an anti-condensation pipe (also referred to as cabinet pipe, dew-proof pipe, or the like) that is used for preventing occurrence of condensation. Many such refrigerators each have a configuration in which an anti-condensation pipe is arranged around the circumferential edge of an opening of a main body of the refrigerator, and a high-
15 pressure refrigerant that is discharged from a compressor is condensed in the anti-condensation pipe, so that condensation is prevented from occurring at the circumferential edge of the opening of the main body of the refrigerator. However, since a refrigerant in the anti-condensation pipe is condensed at a refrigerant pressure equal to that in a condensation pipe, there has been a problem in that the
20 anti-condensation pipe is overheated, so that an extra compressor input is required, disadvantageously.

[0003]

Therefore, there have been proposed various refrigerators each having a configuration in which the flow rate of a refrigerant that flows into an anti-
25 condensation pipe is adjusted in order not to overheat the anti-condensation pipe. As an example of such refrigerators, a refrigerator that has a configuration in which a refrigerant-flow-distribution device (7) is interposed between a heat-dissipation capacitor (2a) and an anti-condensation capacitor (2b), and in which a refrigerant is distributed to the anti-condensation capacitor and a bypass pipe (6) in accordance
30 with a difference between the emperature of the surroundings and the temperature of

the anti-condensation capacitor in such a manner that a circumferential edge portion of an opening of a main body of the refrigerator will not be overheated has been disclosed (see, for example, Patent Literature 1).

Citation List

5 Patent Literature

[0004]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 8-285426 (see, for example, Fig. 1, Fig. 6, and the like)

Summary of Invention

10 Technical Problem

[0005]

However, with the configuration of the refrigerator described in Patent Literature 1, since the flow rate of a refrigerant that flows into the anti-condensation pipe varies depending on the flow rate of a refrigerant that flows into the bypass pipe, there has been a problem in that a pressure-sensing device with high precision is required in order to set the temperature of the refrigerant that is caused to flow into the anti-condensation pipe to a target temperature. This results in an increase in the manufacturing costs. In addition, an extra compressor input is required, and this results in an increase in power consumption.

2 [0006]

In the related art, various methods of adjusting the flow rate of a refrigerant in order not to overheat an anti-condensation pipe have been proposed, and in such methods, the flow rate of a refrigerant is adjusted by using a bypass flow path and a refrigerant-flow-distribution device, so that there has been a problem in that a flow-adjustment device with high precision is required in order to set the temperature of a refrigerant that is caused to flow into the anti-condensation pipe to a target temperature. This results a further increase in the manufacturing costs and power consumption.

25 [0007]

The present invention has been made to solve the above-described problems, and it is an object of the present invention to provide a refrigerator capable of setting the temperature of a refrigerant that flows into an anti-condensation pipe to a target temperature without a pressure-sensing device with high precision and a flow-adjustment device with high precision.

Solution to Problem

[0008]

A refrigerator according to the present invention includes a cabinet that has an interior that is partitioned into a plurality of storage chambers, a divider portion that divides an internal space of the cabinet into the plurality of storage chambers, and a refrigeration cycle that includes a compressor, a condensation pipe, a decompressor, an anti-condensation pipe, a capillary tube, and a cooler. The anti-condensation pipe is incorporated in at least a portion of an edge portion of the cabinet on a front surface side and at least a portion of an edge portion of the divider portion on the front surface side, the decompressor is connected between the condensation pipe and the anti-condensation pipe, and the condensation pipe, the decompressor, and the anti-condensation pipe are connected in series.

Advantageous Effects of Invention

[0009]

According to a refrigerator of the present invention, since the refrigerator includes a decompressor, the refrigerant pressure in an anti-condensation pipe can be reduced, and a compressor input and power consumption can be reduced without overheating the anti-condensation pipe.

Brief Description of Drawings

[0010]

[Fig. 1] Fig. 1 is a diagram illustrating the configuration of a refrigeration cycle of a refrigerator according to Embodiment of the present invention.

[Fig. 2] Fig. 2 is a diagram illustrating an example of the arrangement of an anti-condensation pipe of the refrigerator according to Embodiment of the present invention.

[Fig. 3] Fig. 3 is a Mollier diagram of isobutane that is a refrigerant that is generally used in refrigerators and a diagram illustrating a state transition of a refrigerant in a refrigeration cycle of a refrigerator of the related art.

[Fig. 4] Fig. 4 is a Mollier diagram of isobutane that is a refrigerant that is generally used in refrigerators and a diagram illustrating a state transition of a refrigerant in the refrigeration cycle of the refrigerator according to Embodiment of the present invention.

Description of Embodiments

[0011]

Embodiment of a refrigerator according to the present invention will be described below with reference to the drawings. Note that the present invention is not limited to Embodiment that will be described below. In addition, in the drawings including Fig. 1, the relationship between component members with respect to their sizes may sometimes be different from the actual relationship between the component members with respect to their sizes.

[0012]

Fig. 1 is a diagram illustrating the configuration of a refrigeration cycle of a refrigerator 100 according to Embodiment 1 of the present invention. The configuration of the refrigeration cycle of the refrigerator 100 will be described with reference to Fig. 1. This refrigerator 100 is configured to cool the inside of the refrigerator 100 to a target temperature by utilizing a vapor compression-type refrigeration cycle. In addition, in the refrigerator 100, a refrigerant pressure in an anti-condensation pipe that is embedded in a circumferential edge portion of an opening of a main body of the refrigerator is reduced, so that the anti-condensation pipe will not be overheated, and a compressor input is reduced, and as a result, the power consumption of the refrigerator can be reduced.

[0013]

As illustrated in Fig. 1, the refrigeration cycle of the refrigerator 100 is formed of a compressor 11, a condensation pipe 12, a decompressor 18, an anti-condensation pipe 13, a dryer 14, a capillary tube 15, and a cooler 16 that are connected by pipes.

In addition, the refrigeration cycle of the refrigerator 100 includes a heat exchange portion 17 that allows heat exchange between a refrigerant that flows through the capillary tube 15 and a refrigerant that flows through the pipe (a suction pipe) between the cooler 16 and the compressor 11.

5 [0014]

The compressor 11 is disposed in, for example, a machine chamber that is disposed in a lower portion on the rear surface side of the refrigerator 100. The compressor 11 is configured to compress a refrigerant into a high-temperature high-pressure refrigerant and is driven by an inverter, and operation of the compressor 11 is to be controlled in accordance with the state of the inside of the refrigerator 100.

10 [0015]

The condensation pipe 12 is connected to a discharge side of the compressor 11. This condensation pipe 12 represents a hot pipe that is used for drain evaporation, an air-cooled condenser that is disposed in the mounting space of the compressor 11, and a condensation pipe that is embedded in a side surface and the rear surface of the refrigerator with a heat-insulating material interposed therebetween.

15 [0016]

The decompressor 18 is connected between the condensation pipe 12 and the anti-condensation pipe 13. This decompressor 18 is configured to decompress and expand the refrigerant and may be formed of a valve whose opening degree is variably controllable that is, for example, an electronic expansion valve or the like.

2 [0017]

The anti-condensation pipe 13 is connected between the decompressor 18 and the dryer 14. This anti-condensation pipe 13 is disposed for preventing frosting in a front surface portion of the main body of the refrigerator and functions as a condenser.

25 [0018]

The dryer 14 is connected between the anti-condensation pipe 13 and the capillary tube 15. This dryer 14 includes a filter that is used for preventing dust,

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metal powder, and the like in the refrigeration cycle of the refrigerator 100 from flowing into the compressor 11 and an adsorbing member that adsorbs moisture in the refrigeration cycle.

[0019]

5 The capillary tube 15 is connected between the dryer 14 and the cooler 16. This capillary tube 15 functions as a decompressor that decompresses the refrigerant that has flowed through the dryer 14.

[0020]

10 The cooler 16 is connected between the capillary tube 15 and a portion of the heat exchange portion 17 on the suction pipe side. This cooler 16 is configured to cool, for example, the inside of a cooler chamber that is disposed on the rear surface side of the refrigerator 100. Note that a fan is disposed above the cooler 16, and this fan supplies air to the cooler 16 and sends cold air that has been cooled in the periphery of the cooler 16 to each storage chamber.

15 [0021]

 The heat exchange portion 17 allows heat exchange between the refrigerant that flows through the capillary tube 15 and the refrigerant that is drawn in the compressor 11.

[0022]

2 In addition, a controller 10 that includes a microcomputer and the like and controls the operation of the refrigerator 100 is disposed in, for example, an upper portion on the rear surface side of the refrigerator 100.

[0023]

25 Fig. 2 is a diagram illustrating an example of the arrangement of the anti-condensation pipe 13 of the refrigerator 100. The example of the arrangement of the anti-condensation pipe 13 will be described with reference to Fig. 2.

[0024]

30 As illustrated in Fig. 2, the refrigerator 100 includes a cabinet 21 that has the shape of a box that is open on its front surface side. This cabinet 21 includes an outer casing that forms an outline of the main body of the refrigerator and an inner

casing that forms an inner wall of the main body of the refrigerator, and the cabinet 21 has a configuration in which a heat-insulating material such as, for example, urethane is provided between the outer casing and the inner casing. In addition, a divider portion (partition wall) 22 that divides an internal space of the cabinet 21 into a plurality of the storage chambers is disposed within the cabinet 21. In the refrigerator 100, a refrigerator compartment 3, an ice-making compartment 4, a switching compartment 5, a freezer compartment 6, and a vegetable compartment 7 are formed as the storage chambers.

[0025]

The refrigerator compartment 3 is formed in an uppermost portion of the refrigerator 100, and the front of the refrigerator compartment 3 is covered with a double door that has a heat-insulation structure in such a manner as to be capable of being freely opened and closed. The ice-making compartment 4 and the switching compartment 5 are formed side by side below the refrigerator compartment 3, and the front of the ice-making compartment 4 and the front of the switching compartment 5 are each covered with a pull-out door that has a heat-insulation structure in such a manner as to be capable of being freely opened and closed. The freezer compartment 6 is formed below the ice-making compartment 4 and the switching compartment 5, and the front of the freezer compartment 6 is covered with a pull-out door that has a heat-insulation structure in such a manner as to be capable of being freely opened and closed. The vegetable compartment 7 is formed below the freezer compartment 6 and in a lowermost portion of the refrigerator 100, and the front of the vegetable compartment 7 is covered with a pull-out door that has a heat-insulation structure in such a manner as to be capable of being freely opened and closed.

[0026]

The door of each of the storage chambers is usually provided with a door open/close sensor (not illustrated) that detects the open/closed state of the door. The controller 10 detects the open/closed states of the doors as a result of receiving outputs from the door open/close sensors, and for example, in the case where one of

the doors has been open for long periods of time, the controller 10 can inform a user of the fact by using an operation panel (not illustrated) or an audio output device.

[0027]

The storage chambers are differentiated by temperature zones in which the temperatures within the storage chambers can be set (set temperature zones), and for example, the temperatures within the refrigerator compartment 3, the vegetable compartment 7, the ice-making compartment 4, and the freezer compartment 6 can be set within a range of about 0 degrees C to about 4 degrees C, within a range of about 3 degrees C to about 10 degrees C, to about -18 degrees C, and within a range of about -16 degrees C to about -22 degrees C, respectively. In addition, the temperature zone for the switching compartment 5 can be switched to a temperature zone for chilling (about 0 degrees C), soft freezing (about -7 degrees C) or the like. Note that the set temperatures of the storage chambers are not limited to these.

[0028]

For example, an operation panel that includes operation switches that are used for adjusting the temperatures within the storage chambers and a liquid crystal display that displays the temperatures within the storage chambers at that time is disposed on a surface of the door of the refrigerator compartment 3. It is preferable that this operation panel be provided with an outside-air-temperature sensor that detects the temperature of the outside air surrounding the refrigerator 100. The controller 10 controls the operation of the refrigeration cycle and the operation of each unit in such a manner that values that are detected by interior-temperature sensors that are provided in the storage chambers become set temperatures that are set by using the operation panel.

[0029]

As described above, the area inside the refrigerator 100 is partitioned into the plurality of storage chambers each of which is in a different temperature zone, and thus, there is a probability of condensation occurring in the cabinet 21 and the divider portion 22, around which the area inside the refrigerator 100 and the area outside the refrigerator 100 are close to each other, when the surface temperatures of the cabinet

21 and the divider portion 22 become the dew point temperature of the outside air or lower. Therefore, in the refrigerator 100, as illustrated in Fig. 2, the anti-condensation pipe 13 maintains the surface temperatures of the cabinet 21 and the divider portion 22 at the dew point temperature of the outside air or higher by condensation heat of a refrigerant.

[0030]

The anti-condensation pipe 13 is incorporated in a circumferential edge portion of a front opening of the cabinet 21 and an edge portion of the divider portions 22 on the front surface side by being bent. This anti-condensation pipe 13 is disposed in the cabinet 21 and the divider portion 22 with an elastic material such as butyl rubber that has a large heat capacity interposed therebetween. As illustrated in Fig. 2, the anti-condensation pipe 13 may be disposed in all the edge portions of the cabinet 21 and the divider portion 22 on the front surface side. Alternatively, the anti-condensation pipe 13 may be disposed only in portions of the edge portions of the cabinet 21 and the divider portion 22 on the front surface side that are adjacent to the ice-making compartment 4, the switching compartment 5, and the freezer compartment 6 (an area into which cold air in a refrigeration temperature zone may leak out). Note that the arrangement of the anti-condensation pipe 13 is not limited to that illustrated in Fig. 2, and the anti-condensation pipe 13 can be arranged at any place where the anti-condensation pipe 13 can suppress occurrence of frosting as a result of low-temperature cold air leaking out to the outside.

[0031]

An increase in the surface temperatures of the cabinet 21 and the divider portion 22 and a required input to the compressor 11 will now be described.

[0032]

For example, in the case where the surface temperatures of the cabinet 21 and the divider portion 22 are increased by not the anti-condensation pipe 13 but by a heater, the surface temperatures of the cabinet 21 and the divider portion 22 are increased by increasing a heater input. In the case of setting the surface temperatures of the cabinet 21 and the divider portion 22 to be the dew point

temperature of the outside air or higher in order to prevent occurrence of condensation in the cabinet 21 and the divider portion 22, if the surface temperatures become equal to the dew point temperature of the outside air by a certain heater input W_h , the surface temperatures become the dew point temperature of the outside air or higher when an input equal to or higher than the input W_h is applied, and the surface temperatures become the dew point temperature of the outside air or lower when an input equal to or lower than the input W_h is applied. In other words, the heater input and the surface temperatures of the cabinet 21 and the divider portion 22 are correlated, and when the heater input is increased, the temperature of the heater is increased resulting in an increase in the surface temperatures of the cabinet 21 and the divider portion 22.

[0033]

In contrast, in the refrigerator 100, the anti-condensation pipe 13 plays a role equivalent to that of such a heater, and the heater input is the compressor input. In other words, when a decrease in the surface temperatures of the cabinet 21 and the divider portion 22, that is, a decrease in the temperature of the anti-condensation pipe 13 can be realized, the compressor input is reduced.

[0034]

Fig. 3 is a Mollier diagram of isobutane that is a refrigerant that is generally used in refrigerators and a diagram illustrating a state transition of a refrigerant in a refrigeration cycle of a refrigerator of the related art. A refrigeration cycle of a refrigerator of the related art that does not include the decompressor 18 will be described with reference to Fig. 3. Note that the reference numerals in Fig. 3 denote the components denoted by the same reference numerals in Fig. 1. In addition, in Fig. 3, the horizontal axis represents enthalpy, and the vertical axis represents pressure. Furthermore, it is assumed that the temperature of air outside the refrigerator is 30 degrees C and that the temperature of air that flows into the cooler 16 is -15 degrees C.

[0035]

In the refrigerator, a refrigerant is compressed (from A to B in Fig. 3) into a high-temperature high-pressure refrigerant by the compressor 11, and the refrigerant transfers condensation heat to the outside air in the condensation pipe 12 as a result of a refrigerant saturation pressure becoming the outside air temperature or higher.

5 Since the refrigerator of the related art does not include the decompressor 18, the refrigerant flows into the anti-condensation pipe 13, which is positioned downstream of the condensation pipe 12, at a refrigerant pressure equal to that in the condensation pipe 12. Note that, although the refrigerant pressure is slightly reduced due to a refrigerant pressure loss within the condensation pipe 12, the pressure-reduction amount is significantly smaller than the pressure-reduction amount in the decompressor 18, which will be described later.

[0036]

The refrigerant that has transferred heat in the condensation pipe 12 further transfers the condensation heat to the outside air and the area inside the refrigerator in the anti-condensation pipe 13 (from B to C in Fig. 3). The refrigerant that has flowed out from the anti-condensation pipe 13 reaches the capillary tube 15 (see Fig. 1). In the capillary tube 15, the refrigerant is decompressed and at the same time exchanges heat with a refrigerant that flows through the suction pipe of the compressor 11 in the heat exchange portion 17 (see Fig. 1) (from C to D in Fig. 3). Then, the refrigerant that has flowed out from the capillary tube 15 flows into the cooler 16. In the cooler 16, the refrigerant is evaporated by air that flows into the cooler 16, removes heat from the air, which flows into the cooler 16, and returns to the compressor 11 (from D to A in Fig. 3).

[0037]

25 As described above, the temperature of the anti-condensation pipe 13 and the compressor input are correlated, and the compressor input can be reduced more than in the related art by setting the temperature of the anti-condensation pipe 13 to a temperature that is satisfactory. However, in a refrigerator of the related art, since a refrigerant pressure in the condensation pipe 12 and a refrigerant pressure in the anti-condensation pipe 13 are equal to each other, a refrigerant condensing temperature

in the anti-condensation pipe 13 is equal to a refrigerant condensing temperature in the condensation pipe 12. Since the refrigerant rejects heat in the condensation pipe 12, the refrigerant pressure in the condensation pipe 12 is always a refrigerant saturation pressure at the outside air temperature or higher, and inevitably, the refrigerant pressure in the anti-condensation pipe 13 is also a refrigerant saturation pressure at the outside air temperature or higher.

[0038]

Here, since the dew point temperature of the outside air is always the outside air temperature or lower, it is fundamentally sufficient that the temperature of the anti-condensation pipe 13 be the outside air temperature. However, in the refrigerator of the related art, the refrigerant pressure in the anti-condensation pipe 13 is equal to the refrigerant pressure in the condensation pipe 12, and thus, a refrigerant temperature in the anti-condensation pipe 13 is always maintained at the outside air temperature or higher.

[0039]

Fig. 4 is a Mollier diagram of isobutane that is a refrigerant that is generally used in refrigerators and a diagram illustrating a state transition of a refrigerant in the refrigeration cycle of the refrigerator 100. The refrigeration cycle of the refrigerator 100 that includes the decompressor 18 that is disposed between the condensation pipe 12 and the anti-condensation pipe 13 and connected in series to the condensation pipe 12 and the anti-condensation pipe 13 will be described with reference to Fig. 4. Note that the reference numerals in Fig. 4 denote the components denoted by the same reference numerals in Fig. 1. In addition, in Fig. 3, the horizontal axis represents enthalpy, and the vertical axis represents pressure. Furthermore, it is assumed that the temperature of air outside the refrigerator is 30 degrees C and that the temperature of air that flows into the cooler 16 is -15 degrees C.

[0040]

In the refrigerator 100, a refrigerant is compressed (from A to B in Fig. 4) into a high-temperature high-pressure refrigerant by the compressor 11, and the refrigerant

transfers condensation heat to the outside air in the condensation pipe 12 as a result of a refrigerant saturation pressure becoming the outside air temperature or higher. Since the refrigerator 100 includes the decompressor 18, the refrigerant pressure in the anti-condensation pipe 13 can be reduced by decompressing the pressure of a refrigerant that has flowed out from the condensation pipe 12 by the decompressor 18 (from E to F in Fig. 4). As a result, the refrigerant temperature in the anti-condensation pipe 13 is reduced. The refrigerant pressure can be reduced by the decompressor 18 to a saturation pressure at a refrigerant saturation temperature in the anti-condensation pipe 13 that is lower than the outside air temperature by 3 degrees C to 5 degrees C.

[0041]

Although, normally, in the case where the refrigerant saturation pressure in the anti-condensation pipe 13 falls below the outside air temperature, the refrigerant cannot be condensed, the anti-condensation pipe 13 is disposed at a position close to the inside of the refrigerator 100 as illustrated in Fig. 2, and accordingly, is in contact with air having a temperature not higher than the outside air temperature. However, since it is necessary to consider the dew point temperature of the outside air, the refrigerant saturation temperature in the anti-condensation pipe 13 can be the outside air temperature, and in the case where the compressor input is further reduced, the refrigerant saturation temperature in the anti-condensation pipe 13 can be a temperature that is lower than the outside air temperature by 3 degrees C to 5 degrees C.

[0042]

As described above, when the temperature of the anti-condensation pipe 13 is reduced, the input to the compressor 11 can be reduced, and since the temperature of the anti-condensation pipe 13 can be reduced in the refrigeration cycle of the refrigerator 100, which includes the decompressor 18, the compressor input can be reduced more than in the case of the refrigerator of the related art.

[0043]

As described above, in the refrigerator 100, the condensation pipe 12, the decompressor 18, and the anti-condensation pipe 13 are connected in series, and the decompressor 18 is disposed between the condensation pipe 12 and the anti-condensation pipe 13, so that the refrigerant pressure in the anti-condensation pipe 13 can be reduced lower than that in the condensation pipe 12. Therefore, the temperature of the anti-condensation pipe 13 can be reduced by the decompressor 18, and thus, the compressor input can be reduced more than in the case of the refrigerator of the related art. As a result, according to the refrigerator 100, the compressor input can be reduced, and the power consumption can be reduced without a pressure-sensing-device with high precision and a flow-adjustment device with high precision and without overheating the anti-condensation pipe 13.

[0044]

Note that, in order to reduce the refrigerant pressure in the anti-condensation pipe 13 lower than that in the condensation pipe 12, a refrigerant circuit configuration in which the condensation pipe is present downstream of the flow of a refrigerant in the anti-condensation pipe 13 is undesirable. In addition, although a fixed pressure reducing valve such as a capillary tube may be used as the decompressor 18, in order to correspond to operational state of the refrigerator and the outside air temperature, it is desirable to use an electronic expansion valve (a valve that can adjust the cross-sectional area of a flow path in a multi-step manner or a continuous manner) that can arbitrarily adjust a pressure-reduction amount.

Industrial Applicability

[0045]

A compressor input can be reduced, and power consumption of a refrigerator can be reduced by utilizing the present invention.

Reference Signs List

[0046]

3 refrigerator compartment 4 ice-making compartment 5 switching compartment 6 freezer compartment 7 vegetable compartment 10 controller 11 compressor 12 condensation pipe 13 anti-condensation pipe 14 dryer

15 capillary tube 16 cooler 17 heat exchange portion 18 decompressor
21 cabinet 22 divider portion 100 refrigerator

CLAIMS

[Claim 1]

A refrigerator comprising:

a cabinet that has an interior that is partitioned into a plurality of storage
5 chambers;

a divider portion that divides an internal space of the cabinet into the plurality of
storage chambers; and

a refrigeration cycle that includes a compressor, a condensation pipe, a
decompressor, an anti-condensation pipe, a capillary tube, and a cooler,

10 wherein the anti-condensation pipe is incorporated in at least a portion of an
edge portion of the cabinet on a front surface side and at least a portion of an edge
portion of the divider portion on the front surface side,

wherein the decompressor is connected between the condensation pipe and
the anti-condensation pipe, and

15 wherein the condensation pipe, the decompressor, and the anti-condensation
pipe are connected in series.

[Claim 2]

The refrigerator of claim 1,

2 wherein the decompressor adjusts a refrigerant pressure in the anti-
condensation pipe in such a manner that a refrigerant saturation temperature in the
anti-condensation pipe is substantially equal to an outside air temperature.

[Claim 3]

The refrigerator of claim 1 or 2,

25 wherein the decompressor adjusts the refrigerant pressure in the anti-
condensation pipe in such a manner that the refrigerant saturation temperature in the
anti-condensation pipe is lower than the outside air temperature by 3 degrees C to 5
degrees C.

[Claim 4]

The refrigerator of any one of claims 1 to 3,

wherein the decompressor is an electronic expansion valve capable of variably controlling a pressure-reduction amount.

[Claim 5]

5 The refrigerator of any one of claims 1 to 3,
 wherein the decompressor is a capillary tube.