

DESCRIPTION

Title of Invention

REFRIGERATOR

5 Technical Field

[0001]

The present invention relates to a refrigerator that is improved in cooling performance.

10 Background Art

[0002]

In recent years, in terms of protection of the global environment, various measures have been taken for energy saving in electrical products.

Also in refrigerators configured to store and stock food and other goods, there has been a high interest in energy saving performance, and there has been a growing need for refrigerators that can more efficiently store food and other goods. Further, in recent years, the number of two-earner families has been increasing. Thus, there has also been a growing need for refrigerators with large capacity that are adaptable to a case of purchasing a large amount of food and other goods at the same time.

20 [0003]

To meet such needs, refrigerators that are large in capacity and high in energy saving performance have been proposed and put into practical use.

[0004]

In related-art refrigerators, a cooling compartment is provided on a back surface side of storage compartments such as a freezer compartment and a refrigerator compartment, and chilled air generated in a cooling device in the cooling compartment is sent by an air-sending fan to each of the storage compartments, to thereby cool food and other goods stored in the storage compartments.

25 [0005]

30 An isolation wall for partitioning the respective storage compartments and the

cooling compartment is provided between the respective storage compartments and the cooling compartment, and a clearance is secured between the isolation wall and the cooling device in the cooling compartment. A chilled air return port is formed in the isolation wall. The chilled air return port is configured to allow communication
5 between each of the storage compartments and the cooling compartment, to thereby cause return air from each of the storage compartments that is raised in temperature by cooling the storage compartments to flow into the cooling compartment. Further, a plurality of airflow direction plates are formed at the chilled air return port. The plurality of airflow direction plates are each configured to cause the return air from
10 each of the storage compartments to efficiently flow into the cooling compartment.
[0006]

In such refrigerators, the cooling device provided in the cooling compartment is decreased in surface temperature to about -25 degrees Celsius when generating the chilled air. Consequently, when heat is exchanged with the return air that contains
15 moisture and flows into the cooling compartment from each of the storage compartments, frost is formed on a surface of the cooling device.
[0007]

When the frost is formed on the surface of the cooling device as described above, performance of the cooling device is adversely affected, specifically, air
20 passage resistance of the cooling device is increased, and heat exchange capacity is reduced, with the result that the energy saving performance is lowered. Consequently, in the related-art refrigerators, a heater configured to melt the frost adhering to the cooling device is provided, and when heat from the heater is transferred to the cooling device, the frost adhering to the surface of the cooling
25 device is melted. Then, the melted frost drips as defrost water, thereby the frost adhering to the surface of the cooling device can be removed.
[0008]

In this case, the defrost water generated by melting the frost drips to the lower side as it is. However, at this time, the defrost water may drip onto the airflow
30 direction plates at the chilled air return port in some cases. When the defrost water

having dripped onto the airflow direction plates remains on the airflow direction plates as it is as described above, there is a fear in that the defrost water turns into frost again to clog the chilled air return port. When the chilled air return port is clogged, circulation of the air in the refrigerator is inhibited, with the result that there arises a difficulty in performing cooling of the inside of each of the storage compartments normally.

[0009]

In view of the above, to prevent clogging of the chilled air return port with the frost as described above, there has been proposed a structure in which a space is secured between the airflow direction plates and the cooling device to prevent the defrost water generated by melting the frost from dripping onto the airflow direction plates (for example, Patent Literature 1 and Patent Literature 2).

With this disclosure, the defrost water can be prevented from dripping onto the airflow direction plates, and in addition, frost adhesion, dew adhesion, and other phenomena in the storage compartments that are caused due to entry of the defrost water into the storage compartments can be prevented.

Citation List

Patent Literature

[0010]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2012-237520

Patent Literature 2: Japanese Unexamined Patent Application Publication No. 2013-139982

Summary of Invention

Technical Problem

[0011]

However, in the structures described in Patent Literature 1 and Patent Literature 2, in terms of the capacity of the storage compartments, an unnecessary

space is provided in the refrigerator. Thus, there is a problem in that the capacity of the storage compartments is sacrificed.

[0012]

The present invention has been made in view of the above-mentioned
5 problems in the related art, and has an object to provide a refrigerator that is capable of achieving larger capacity while securing cooling quality.

Solution to Problem

[0013]

10 According to one embodiment of the present invention, there is provided a refrigerator including a storage compartment configured to perform at least one of freezing and refrigerating of food, a cooling compartment including a cooling device provided on a back surface side of the storage compartment, and configured to generate chilled air for cooling the storage compartment, and a heater provided below
15 the cooling device, and configured to melt frost adhering to the cooling device, and an isolation wall partitioning the storage compartment and the cooling compartment from each other, the isolation wall including a chilled air return port having a first opening plane opened to a cooling compartment side, and a second opening plane opened to a storage compartment side, and configured to allow communication between the
20 storage compartment and the cooling compartment, to cause return air from the storage compartment to flow into the cooling compartment, and an airflow direction plate provided at the chilled air return port, and inclined downward from the storage compartment side toward a cooling device side. A minimum interval in a gap defined between the first opening plane of the chilled air return port and a surface of the
25 cooling device on the storage compartment side is equal to or smaller than a minimum interval in a gap defined between a surface of the isolation wall on the cooling compartment side and the surface of the cooling device on the storage compartment side.

30 Advantageous Effects of Invention

[0014]

As described above, according to one embodiment of the present invention, the airflow direction plate is inclined, and a distance of the gap secured between the chilled air return port and the cooling device is equal to or smaller than a distance of a gap secured between the isolation wall and the cooling device. Thus, the refrigerator having larger capacity while securing the cooling quality can be achieved.

Brief Description of Drawings

[0015]

[Fig. 1] Fig. 1 is a front view for illustrating a refrigerator according to Embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is an internal structural view for illustrating the internal structure of the refrigerator taken along the line segment A-A illustrated in Fig. 1 and viewed in the arrow direction.

[Fig. 3] Fig. 3 is an enlarged view for illustrating a main part of the structure of a cooling compartment surrounded by the dotted line B illustrated in Fig. 2.

[Figs. 4] Figs. 4 are structural views for illustrating a periphery of a freezer compartment return port taken along the line segment C-C illustrated in Fig. 3 and viewed in the arrow direction.

[Fig. 5] Fig. 5 is a structural view for illustrating the periphery of the freezer compartment return port taken along the line segment D-D illustrated in Fig. 3 and viewed in the arrow direction.

[Fig. 6] Fig. 6 is a front view for illustrating an example of configurations of a cooling device, an air-sending fan, and a pre-cooling device of Fig. 2.

[Fig. 7] Fig. 7 is an explanatory schematic view for illustrating an example of a flow of defrost water when frost is removed in the refrigerator of Fig. 1.

[Fig. 8] Fig. 8 is an explanatory schematic view for illustrating another example of the flow of the defrost water when the frost is removed in the refrigerator of Fig. 1.

[Fig. 9] Fig. 9 is a schematic view for illustrating temperature measurement positions in the cooling device of Fig. 6.

[Fig. 10] Fig. 10 is a graph for showing temperature measurement results at the measurement positions in Fig. 9 in a case in which a heat-conductive wall is provided and a case in which the heat-conductive wall is not provided.

5 Description of Embodiments

[0016]

A refrigerator according to the present invention is described below. In the drawings referred to in the description below, the size relationship among components may be different from the actual size relationship in some cases.

10 Further, forms of the components described herein are merely examples, and the components are not limited to those described herein.

[0017]

Embodiment 1

Fig. 1 is a front view for illustrating a refrigerator 1 according to Embodiment 1 of the present invention. Fig. 2 is an internal structural view for illustrating the internal structure of the refrigerator 1 taken along the line segment A-A illustrated in Fig. 1 and viewed in the arrow direction. Fig. 3 is an enlarged view for illustrating a main part of the structure of a cooling compartment 10 surrounded by the dotted line B illustrated in Fig. 2.

20 [0018]

[Configuration of Refrigerator]

As illustrated in Fig. 1, the refrigerator 1 includes a housing 1A constructing an outer shell. The housing 1A is formed into, for example, a cuboid shape. In the inside of the housing 1A, there are provided storage compartments such as a refrigerator compartment 2, an ice-making compartment 3, a versatile compartment 4, a freezer compartment 5, and a vegetable compartment 6, and doors are provided for each one of the storage compartments. In this example, double-hinged doors including two doors are adopted to the refrigerator compartment 2. However, the doors of the refrigerator compartment 2 are not limited to the example. For example, a single-hinged door including one door may be adopted.

[0019]

Further, on a surface of one of the doors provided to the refrigerator compartment 2, there is provided an operation panel 7 for setting a temperature or other conditions of each of the storage compartments and displaying a state of each of the storage compartments. The operation panel 7 is not limited to be provided on the surface of the door, and may be provided, for example, in the inside of the refrigerator 1, specifically, on a side surface of the refrigerator compartment 2.

[0020]

The refrigerator compartment 2 is a space including opening-closing doors as the doors, and is arranged at an uppermost portion. The ice-making compartment 3 is a space including a pullout door as a door, and is arranged below the refrigerator compartment 2. The versatile compartment 4 is a space including a pullout door as a door, and is arranged in parallel to the ice-making compartment 3. In the versatile compartment 4, a cold retention temperature range can be switched into various temperature ranges such as a freezing temperature range (for example, about -18 degrees Celsius), a refrigerating temperature range (for example, about 3 degrees Celsius), a chilled temperature range (for example, about 0 degrees Celsius), and a soft freezing temperature range (for example, about -7 degrees Celsius). The freezer compartment 5 is a space including a pullout door as a door, and is arranged below the ice-making compartment 3 and the versatile compartment 4. The vegetable compartment 6 is a space including a pullout door as a door, and is arranged at a lowermost portion.

The refrigerator 1 is not limited to the above-mentioned configuration. For example, the refrigerator 1 may be constructed without providing the ice-making compartment 3 and the versatile compartment 4. Further, for example, the positions of the freezer compartment 5 and the vegetable compartment 6 may be reversed.

[0021]

In the refrigerator compartment 2, there are provided one or a plurality of refrigerator compartment storage cases 2A and one or a plurality of refrigerator compartment storage racks 2B for storing food. Further, in the refrigerator

compartment 2, a chilled compartment 2C is provided, and one or a plurality of chilled compartment storage cases 2D for storing food are provided.

In the ice-making compartment 3, one or a plurality of ice-making compartment storage cases 3A for storing food are provided. In the freezer compartment 5, one or a plurality of freezer compartment storage cases 5A for storing food are provided. In the vegetable compartment 6, one or a plurality of vegetable compartment storage cases 6A for storing food are provided. Although not illustrated, also in the versatile compartment 4, a versatile compartment storage case for storing food is provided.

[0022]

The storage compartments such as the refrigerator compartment 2, the ice-making compartment 3, the versatile compartment 4, the freezer compartment 5, and the vegetable compartment 6 are partitioned from the adjacent storage compartments by heat-insulating partition walls 8 for blocking heat transfer.

[0023]

A machine chamber 9 is provided at a lower portion of the housing 1A on a back surface side. A compressor (not shown) is accommodated in the machine chamber 9. The compressor is configured to compress sucked refrigerant into a high-temperature and high-pressure state, and to discharge the refrigerant.

[0024]

Further, in the inside of the housing 1A, thermistors and a controller (not shown) are provided.

The thermistor is provided in each one of the storage compartments, and is configured to measure the temperature in a corresponding one of the storage compartments.

The controller is configured to control the entire refrigerator 1. For example, the controller is configured to control, for example, capacity of the compressor and an air-sending amount of an air-sending fan 12 described later on the basis of the temperatures measured by the thermistors so that the temperature in each of the storage compartments becomes a preset temperature. The control unit is

constructed by, for example, hardware for implementing this function, such as a

circuit device, or software to be executed by a processor such as a microcomputer and a central processing unit (CPU).

[0025]

In the inside of the housing 1A on the back surface side, there is provided the cooling compartment 10 configured to generate chilled air for cooling the inside of each of the storage compartments and to send the chilled air.

[0026]

[Structure of Cooling Compartment]

Next, the structure of the cooling compartment 10 is described.

As illustrated in Fig. 3, in the cooling compartment 10, there are provided a cooling device 11, the air-sending fan 12 (see Fig. 2), a pre-cooling device 13, and a heater 14. Further, between the cooling compartment 10 and the storage compartments (in particular, the freezer compartment 5), that is, on a front surface side of the cooling compartment 10, an isolation wall 20 for partitioning the cooling compartment 10 and the storage compartments is provided entirely along the side-surfaces direction that is the width direction of the housing 1A.

[0027]

The cooling device 11 is a heat exchanger configured to cool air in the inside of the refrigerator 1. The cooling device 11, of which detailed description is given later, is configured to exchange heat between refrigerant flowing through a refrigerant pipe and air to cool the air. In this example, the air in the inside of the refrigerator 1 flows from the lower side toward the upper side of the cooling device 11.

The air-sending fan 12 is provided above the cooling device 11, and is configured to send the air cooled by the cooling device 11 (hereinafter appropriately referred to as "chilled air") to each of the storage compartments.

[0028]

The pre-cooling device 13 is provided below the cooling device 11, and, similarly to the cooling device 11, is configured to exchange heat between refrigerant flowing through a refrigerant pipe and air. Detailed description of the pre-cooling device 13 is given later.

The heater 14 is provided below the cooling device 11. The heater 14 is, for example, a radiant heater, and is provided to melt frost adhering to the cooling device 11 and a surface of the isolation wall 20 on the cooling device 11 side.

A heater roof 14A is provided on an upper surface of the heater 14. The heater roof 14A is configured to protect the heater 14 from defrost water that may drip when the frost is removed.

[0029]

A gap serving as a clearance X is secured between a surface of the cooling device 11 on the freezer compartment 5 side and a surface of the isolation wall 20 on the cooling compartment 10 side. With this configuration, a bypass air passage 30 is formed. In the bypass air passage 30, the air is caused to flow to bypass the cooling device 11, but above the cooling device 11, the air having bypassed the cooling device 11 flows to be converged on the cooling device 11 side.

With the bypass air passage 30 secured as described above, even when frost formation is progressed from the lower side of the cooling device 11 as the air is cooled, and the lower side of the cooling device 11 is clogged due to the frost formation, the air flows through the bypass air passage 30, thereby a coolable time period of the cooling device 11 can be prolonged.

[0030]

A drip tray 21 and a drain 22 are provided below the cooling compartment 10.

The drip tray 21 is provided at a position at which the defrost water generated by melting the frost by heat of the heater 14 during frost removal drips. The drain 22 is configured to discharge the defrost water having dripped onto the drip tray 21 to the outside.

[0031]

On the lower side of the isolation wall 20 on the front surface side of the cooling compartment 10, there are formed a freezer compartment return port 23 and a vegetable compartment return port 24 as chilled air return ports.

The freezer compartment return port 23 has a first opening plane 23a opened to the cooling compartment 10, and a second opening plane 23b opened to the

freezer compartment 5. The freezer compartment return port 23 is configured to allow communication between the cooling compartment 10 and the freezer compartment 5, to thereby cause return air from the freezer compartment 5 to flow into the cooling compartment 10.

5 The "first opening plane 23a" herein refers to a plane formed by connecting a boundary line between the upper end of the opening of the freezer compartment return port 23 and the surface of the isolation wall 20 on the cooling compartment 10 side and a boundary line between the lower end of the opening and the surface of the isolation wall 20 on the cooling compartment 10 side into a flat plane. Further, the
10 "second opening plane 23b" herein refers to a plane formed by connecting a boundary line between the upper end of the opening of the freezer compartment return port 23 and the surface of the isolation wall 20 on the freezer compartment 5 side and a boundary line between the lower end of the opening and the surface of the isolation wall 20 on the freezer compartment 5 side into a flat plane.

15 The opening of the freezer compartment return port 23 is formed so that the lower end of the opening is located at approximately the same height as the lower end of the cooling device 11, or located above the lower end of the cooling device 11. With this configuration, heat exchange in the cooling device 11 can efficiently be performed.

20 [0032]

 Further, the freezer compartment return port 23 is formed on an extension of the lower side of the isolation wall 20. Thus, a gap serving as a clearance Y between the first opening plane 23a of the freezer compartment return port 23 and the surface of the cooling device 11 on the freezer compartment 5 side has a size
25 substantially equal to or smaller than the clearance X in the above-mentioned bypass air passage 30. In this case, when a minimum interval in the clearance Y is set to be equal to or smaller than a minimum interval in the clearance X in the bypass air passage 30, the space in the inside of the refrigerator 1 can more efficiently be utilized, thereby the capacity of the refrigerator 1 can be increased.

30 [0033]

The vegetable compartment return port 24 is formed below the freezer compartment return port 23, and has an opening plane opened to each of the cooling compartment 10 and the vegetable compartment 6. The vegetable compartment return port 24 is configured to allow communication between the cooling compartment 10 and the vegetable compartment 6, to thereby cause return air from the vegetable compartment 6 to flow into the cooling compartment 10.

As described above, arrangement positions of the freezer compartment return port 23 and the vegetable compartment return port 24 are set to be different from each other. Thus, the return air from the freezer compartment 5 and the return air from the vegetable compartment 6 can be prevented from merging when flowing into the cooling compartment 10.

Further, the vegetable compartment return port 24 is formed below the freezer compartment return port 23 so that the return air from the vegetable compartment 6, which contains a large amount of moisture, flows into the vicinity of the pre-cooling device 13. Consequently, dehumidification of the return air can sufficiently be performed by the pre-cooling device 13 so that frost formation on the cooling device 11 can be prevented, thereby being capable of preventing reduction in cooling capacity. With this configuration, a fin pitch of the cooling device 11 can be reduced, thereby the cooling performance in the cooling device 11 can be enhanced.

[0034]

In the freezer compartment return port 23 formed in the isolation wall 20, there are formed a plurality of airflow direction plates 25 for causing the return air from the freezer compartment 5 to efficiently flow into the cooling compartment 10. The airflow direction plates 25 are each formed into a flat plate-like shape, and formed to be inclined downward from a horizontal direction from the freezer compartment 5 side to the cooling device 11 side.

[0035]

The plurality of airflow direction plates 25 are provided in the freezer compartment return port 23 so that the cooling device 11, the heater 14, and other components in the cooling compartment 10 are shielded from light, thereby visibility

from the outside can be improved.

Further, the plurality of airflow direction plates 25 are provided in the freezer compartment return port 23. Thus, radiant heat from the heater 14 and a pipe heater 17 described later that is generated when the frost is removed can be blocked, and entry of heat into the freezer compartment 5 can be prevented, thereby energy saving performance of the refrigerator 1 can be further enhanced.

[0036]

Figs. 4 are structural views for illustrating a periphery of the freezer compartment return port 23 taken along the line segment C-C illustrated in Fig. 3 and viewed in the arrow direction.

As illustrated in Fig. 4(a), a width of the freezer compartment return port 23 that extends in the side-surfaces direction as viewed from the back surface side is set to be within a range within which heat generated in the heater 14 can be transferred, that is, to be within an effective heat generating range of the heater 14. The width is set as described above so that, when the frost is formed in the freezer compartment return port 23, the frost can reliably be removed by frost removing.

[0037]

Further, as illustrated in Fig. 4(b), in the freezer compartment return port 23, a heat-conductive wall 26 is provided between the airflow direction plates 25 in the freezer compartment return port 23 and the cooling device 11. The heat-conductive wall 26 is provided, for example, at the vicinity of the center portion in the freezer compartment return port 23 in the side-surfaces direction. The heat-conductive wall 26 is a part formed by bonding a heat conductive part such as an aluminum tape to a surface of the heat-conductive wall 26 on the cooling device 11 side.

[0038]

As described above, through the bonding of the aluminum tape or other parts to the surface of the heat-conductive wall 26 on the cooling device 11 side, the heat from the heater 14 when the frost is removed can be transferred to the entire freezer compartment return port 23 and the entire cooling device 11. Consequently, the frost in the freezer compartment return port 23 and the cooling device 11 can be removed

without being left.

[0039]

It is preferred that a width of the heat-conductive wall 26 in the side-surfaces direction be set to, for example, from about 30 mm to about 100 mm. This is because, for example, to bond the aluminum tape or other parts to the entire surface of the heat-conductive wall 26 on the cooling device 11 side, when the width of the heat-conductive wall 26 is set to be approximately equal to a width of an aluminum tape that is commercially and easily available, manufacturing cost such as material cost and bonding processing cost can be reduced.

[0040]

The position of the heat-conductive wall 26 is not limited to the position illustrated in Fig. 4(b). For example, as illustrated in Fig. 4(c), a plurality of heat-conductive walls 26 may be arranged in the freezer compartment return port 23 in the side-surfaces direction at regular intervals.

[0041]

Fig. 5 is a structural view for illustrating the periphery of the freezer compartment return port 23 taken along the line segment D-D illustrated in Fig. 3 and viewed in the arrow direction.

As illustrated in Fig. 5, a rib-like inclined portion 27 protruding to the freezer compartment 5 side is formed on a wall provided below the freezer compartment return port 23 at a portion between the freezer compartment 5 and the cooling compartment 10.

The inclined portion 27 is formed by one flat plate formed into a valley shape protruding downward or by connecting a plurality of flat plates formed as the same.

[0042]

Further, a drain hole 28 for guiding the defrost water to the drip tray 21 is opened at the bottom of the valley shape in the inclined portion 27. With the inclined portion 27 formed and the drain hole 28 opened to have the above-mentioned shapes, the defrost water that enters the freezer compartment 5 and drips onto the inclined portion 27 when the frost is removed flows toward the drain hole 28 to be guided to

the drip tray 21.

[0043]

[Structure of Cooling Device, Air-sending fan, and Pre-cooling Device]

Fig. 6 is a front view for illustrating an example of configurations of the cooling
5 device 11, the air-sending fan 12, and the pre-cooling device 13 of Fig. 2.

As illustrated in Fig. 6, the cooling device 11 includes a refrigerant pipe 15 and
fins 16.

The cooling device 11 is configured to exchange heat between air passing
through the plurality of fins 16 and refrigerant flowing through the refrigerant pipe 15.

10 The fins 16 are stacked at preset regular intervals (hereinafter appropriately
referred to as "fin pitch"), and the air flows through the fins 16. The fins 16 have
openings into which the refrigerant pipe 15 is inserted, and the refrigerant pipe 15 is
inserted into these openings so that the fins 16 and the refrigerant pipe 15 are joined
to each other.

15 [0044]

The fin pitch of the fins 16 is determined in consideration of prevention of
increase in air passage resistance, which may be caused when the fins 16 are
clogged due to frost formation on the cooling device 11. To prevent such clogging,
the fin pitch is set in a range of, for example, from about 5 mm to about 10 mm.

20 Further, in the cooling device 11, a larger amount of frost is formed on an
upstream side than on a downstream side in an airflow direction. This is because,
as the air moves toward the downstream side, the air is subjected to heat exchange
with the cooling device 11, and an amount of moisture in the air is reduced.

Consequently, in the cooling device 11, the fin pitch is set larger on the
25 upstream side than on the downstream side in the airflow direction. Specifically, it is
preferred that, for example, the fin pitch of the fins 16 on the downstream side be set
to 5 mm, and that the fin pitch of the fins 16 on the upstream side be set to from about
7.5 mm to about 10 mm.

[0045]

30 The fin pitch of the fins 16 is not limited to the above-mentioned values, and

may appropriately be modified without departing from the gist of the present invention.

Further, the shape of the fins 16 is not particularly limited, and there may be applied, for example, plate fins, corrugated fins, louver fins, or slit fins.

[0046]

5 Further, as a measure against clogging of the fins 16, which may be caused due to frost formation on the cooling device 11, the pre-cooling device 13 is provided on the upstream side of the cooling device 11 in the airflow direction. Similarly to the cooling device 11, the pre-cooling device 13 includes a refrigerant pipe 15 and fins 16. The fins 16 of the pre-cooling device 13 are stacked at a preset regular fin pitch.

10 [0047]

The pre-cooling device 13 is arranged on the upstream side of the cooling device 11 in the airflow direction, and hence a larger amount of frost is formed on the pre-cooling device 13 than on the cooling device 11. Consequently, the fin pitch of the fins 16 in the pre-cooling device 13 is larger than the fin pitch in the cooling device 11, and is, for example, set in a range of from about 10 mm to about 15 mm.

15 [0048]

The fin pitch of the fins 16 in the pre-cooling device 13 is also not particularly limited, and may appropriately be modified without departing from the gist of the present invention.

20 Similarly to the cooling device 11, the shape of the fins 16 is also not particularly limited, and there may be applied, for example, plate fins, corrugated fins, louver fins, or slit fins.

[0049]

25 In each of the cooling device 11 and the pre-cooling device 13, the pipe heater 17 is provided.

The pipe heater 17 is provided to be incorporated between the fins 16 of each of the cooling device 11 and the pre-cooling device 13, and is configured to remove the frost adhering to each of the cooling device 11 and the pre-cooling device 13. The pipe heater 17 can directly heat each of the cooling device 11 and the pre-cooling device 13 through heat conduction, and hence can efficiently remove the frost in a

short period of time.

[0050]

[Flow of Air in Refrigerator]

Next, a flow of air in the refrigerator 1 according to Embodiment 1 is described.

5 First, when the air-sending fan 12 is rotated, chilled air from the cooling device 11 is sent to each of the storage compartments to cool each of the storage compartments.

10 The air having flowed into the refrigerator compartment 2 circulates through the refrigerator compartment 2 to cool the inside of the refrigerator compartment 2, and passes through an air passage (not shown) provided on a back surface side of the refrigerator 1 to flow into the vegetable compartment 6.

15 The air having flowed into the vegetable compartment 6 circulates through the vegetable compartment 6 to cool the inside of the vegetable compartment 6. Then, the return air from the vegetable compartment 6 flows into the cooling compartment 10 through the vegetable compartment return port 24.

Further, the air having flowed into the freezer compartment 5 circulates through the freezer compartment 5 to cool the inside of the freezer compartment 5. Then, the return air from the freezer compartment 5 flows into the cooling compartment 10 through the freezer compartment return port 23.

20 Similarly, the air having flowed into each of the storage compartments such as the ice-making compartment 3 and the versatile compartment 4 cools the inside of each of the storage compartments, and the return air from each of the storage compartments flows into the cooling compartment 10 through a return port (not shown).

25 [0051]

[Flow of Defrost Water]

Next, a flow of the defrost water generated when the frost is removed is described.

30 Fig. 7 is an explanatory schematic view for illustrating an example of a flow of defrost water 40 when the frost is removed in the refrigerator 1 of Fig. 1. Fig. 8 is an

explanatory schematic view for illustrating another example of the flow of the defrost water 40 when the frost is removed in the refrigerator 1 of Fig. 1.

[0052]

As illustrated in Fig. 7, the frost adhering to the cooling device 11 turns into the defrost water 40 when the frost is removed. The defrost water 40 drips, and passes through the clearance Y between the freezer compartment return port 23 and the cooling device 11. Then, after the defrost water 40 drips onto the drip tray 21, the defrost water 40 is discharged to the outside through the drain 22.

[0053]

In this case, when passing through the clearance Y between the freezer compartment return port 23 and the cooling device 11, the defrost water 40 may drip onto the airflow direction plates 25 in some cases. When the defrost water 40 having dripped onto the airflow direction plates 25 as described above remains on the airflow direction plates 25 as it is, there is a fear in that the defrost water 40 turns into frost again to clog the freezer compartment return port 23.

[0054]

However, the airflow direction plates 25 in Embodiment 1 are each formed to be inclined downward from the horizontal direction from the freezer compartment side to the cooling device 11 side. Consequently, the defrost water 40 having dripped onto the airflow direction plates 25 is returned to the clearance Y between the freezer compartment return port 23 and the cooling device 11 along the inclination of the airflow direction plates 25.

[0055]

As described above, when the airflow direction plates 25 inclined to the lower side from the freezer compartment side to the cooling device 11 side are provided in the freezer compartment return port 23, the defrost water 40 generated when the frost is removed can be guided to the drip tray 21 without causing the defrost water 40 to remain on the airflow direction plates 25. Consequently, clogging of the freezer compartment return port 23 with the frost resulting from the defrost water 40 remaining on the airflow direction plates 25 can be prevented.

[0056]

Meanwhile, there is conceivable a case in which the defrost water 40 having dripped onto the airflow direction plates 25 passes over the airflow direction plates 25 to enter the freezer compartment 5. When the defrost water 40 enters the freezer compartment 5 as described above, there is a fear in that frost adhesion and dew adhesion occur in the inside of the freezer compartment 5.

[0057]

However, in Embodiment 1, the inclined portion 27 protruding to the freezer compartment 5 side is provided on the wall located below the freezer compartment return port 23. Consequently, as illustrated in Fig. 8, the defrost water 40 having entered the freezer compartment 5 flows along the inclined portion 27 to be guided to the drain hole 28 opened at the bottom on the lower portion side. Then, the defrost water 40 guided to the drain hole 28 is discharged into the cooling compartment 10 through the drain hole 28 to drip onto the drip tray 21, and then, is discharged to the outside through the drain 22.

[0058]

As described above, the inclined portion 27 protruding to the freezer compartment 5 side and the drain hole 28 are opened on the wall located below the freezer compartment return port 23. Thus, even when the defrost water 40 enters the freezer compartment 5, the defrost water 40 can be discharged to the inside of the cooling compartment 10. Consequently, frost adhesion and dew adhesion in the inside of the freezer compartment 5, which may be caused due to the defrost water 40 having entered the freezer compartment 5, can be prevented.

[0059]

[Effect by Heat-conductive wall]

Next, an effect obtained by providing the heat-conductive wall 26 between the freezer compartment return port 23 and the cooling device 11 is described.

[0060]

Fig. 9 is a schematic view for illustrating temperature measurement positions in the cooling device 11 of Fig. 6. Fig. 10 is a graph for showing temperature

measurement results at the measurement positions in Fig. 9 in a case in which the heat-conductive wall 26 is provided and a case in which the heat-conductive wall 26 is not provided.

In this example, as illustrated in Fig. 9, first, the cooling device 11 was divided into nine sections in an up-and-down direction and a right-and-left direction. Next, the surface temperature of the fins 16 in the cooling device 11 when the frost was removed was measured at parts "a" to "i" indicated by circles corresponding to the respective divided sections both in a case in which the heat-conductive wall 26 having a width of about 100 mm was provided between the freezer compartment return port 23 and the cooling device 11 at the vicinity of the center of the cooling device 11 and a case in which the heat-conductive wall 26 was not provided. Then, on the basis of these measurement results, average temperatures at an upper portion, a center portion, and a lower portion of the fins 16 were calculated, and the effectiveness of the heat-conductive wall 26 was examined.

[0061]

The reference symbol "a" indicates a position of an upper left portion of the fins 16. The reference symbol "b" indicates a position of an upper middle portion of the fins 16. The reference symbol "c" indicates a position of an upper right portion of the fins 16.

The reference symbol "d" indicates a position of a middle left portion of the fins 16. The reference symbol "e" indicates a position of a center portion of the fins 16. The reference symbol "f" indicates a position of a middle right portion of the fins 16.

The reference symbol "g" indicates a position of a lower left portion of the fins 16. The reference symbol "h" indicates a position of a lower middle portion of the fins 16. The reference symbol "i" indicates a position of a lower right portion of the fins 16.

[0062]

As a result of the examination, as shown in Fig. 10, at each of the upper portions, the middle portions, and the lower portions of the fins 16, the temperature in the case in which the heat-conductive wall 26 was provided was increased as

compared to the case in which the heat-conductive wall 26 was not provided.

With this result, it has been found that, when the heat-conductive wall 26 is provided, heat generated when the frost is removed can efficiently be spread to the entire cooling device 11.

[0063]

As described above, in Embodiment 1, the airflow direction plates 25 inclined to the lower side from the freezer compartment 5 side to the cooling device 11 side are provided in the freezer compartment return port 23. Consequently, the defrost water 40 can be prevented from remaining on the airflow direction plates 25. Thus, clogging of the freezer compartment return port 23 with the frost resulting from the defrost water 40 remaining on the airflow direction plates 25 can be prevented.

[0064]

Further, such airflow direction plates 25 are provided, and in addition, the minimum interval in the clearance Y between the freezer compartment return port 23 and the cooling device 11 is set to be equal to or smaller than the minimum interval in the clearance X in the bypass air passage 30 formed between the cooling device 11 and the isolation wall 20. Consequently, the space in the inside of the refrigerator 1 can efficiently be utilized, thereby the capacity of the refrigerator 1 can be further increased.

[0065]

Further, on the wall located below the freezer compartment return port 23, the inclined portion 27 protruding to the freezer compartment 5 side is formed, and the drain hole 28 is opened at the bottom of the inclined portion 27 on the lower portion side. Thus, the defrost water 40 having entered the freezer compartment 5 can be discharged to the inside of the cooling compartment 10. Consequently, frost adhesion and dew adhesion in the inside of the freezer compartment 5, which may be caused due to the defrost water 40 having entered the freezer compartment 5, can be prevented.

[0066]

Still further, the heat-conductive wall 26 to which the heat conductive part is

bonded is provided between the freezer compartment return port 23 and the cooling device 11. Thus, heat generated when the frost is removed can be efficiently spread to the entire cooling device 11.

5 Reference Signs List

[0067]

1 refrigerator 1A housing 2 refrigerator compartment 2A
refrigerator compartment storage case 2B refrigerator compartment storage
rack 2C chilled compartment 2D chilled compartment storage case 3 ice-
10 making compartment 3A ice-making compartment storage case 4 versatile
compartment 5 freezer compartment 5A freezer compartment storage case
6 vegetable compartment 6A vegetable compartment storage case 7
operation panel 8 heat-insulating partition wall 9 machine chamber 10
cooling compartment 11 cooling device 12 air-sending fan 13 pre-
15 cooling device 14 heater 14A heater roof 15 refrigerant pipe 16 fin
17 pipe heater 20 isolation wall 21 drip tray 22 drain 23
freezer compartment return port 23a first opening plane 23b second opening plane
24 vegetable compartment return port 25 airflow direction plate 26
heat-conductive wall 27 inclined portion 28 drain hole 30 bypass air
20 passage 40 defrost water

CLAIMS

[Claim 1]

A refrigerator, comprising:

a storage compartment configured to perform at least one of freezing and
5 refrigerating of food;

a cooling compartment including

a cooling device provided on a back surface side of the storage
compartment, and configured to generate chilled air for cooling the storage
compartment, and

10 a heater provided below the cooling device, and configured to melt frost
adhering to the cooling device; and

an isolation wall partitioning the storage compartment and the cooling
compartment from each other,

the isolation wall including

15 a chilled air return port having a first opening plane opened to a cooling
compartment side, and a second opening plane opened to a storage
compartment side, and configured to allow communication between the
storage compartment and the cooling compartment, to cause return air from
the storage compartment to flow into the cooling compartment, and

20 an airflow direction plate provided at the chilled air return port, and
inclined downward from the storage compartment side toward a cooling device
side,

a minimum interval in a gap defined between the first opening plane of the
chilled air return port and a surface of the cooling device on the storage compartment
25 side being equal to or smaller than a minimum interval in a gap defined between a
surface of the isolation wall on the cooling compartment side and the surface of the
cooling device on the storage compartment side.

[Claim 2]

30 The refrigerator of claim 1, further comprising an inclined portion formed below

the chilled air return port of the isolation wall, the inclined portion having a valley shape protruding downward to the storage compartment side.

[Claim 3]

- 5 The refrigerator of claim 1 or 2, further comprising a heat-conductive wall provided between the chilled air return port and the cooling device, the heat-conductive wall being configured to transfer heat from the heater to the cooling device.

[Claim 4]

- 10 The refrigerator of claim 3, wherein the heat-conductive wall has a heat conductive part provided on a surface of the heat-conductive wall on the cooling device side.

[Claim 5]

- 15 The refrigerator of any one of claims 1 to 4, wherein a width of the chilled air return port in a side-surfaces direction is within an effective heat generating range within which heat is transferred from the heater.

[Claim 6]

- 20 The refrigerator of any one of claims 1 to 5, wherein a lower end of the chilled air return port is located above a lower end of the cooling device.

[Claim 7]

- 25 The refrigerator of any one of claims 1 to 6,
 wherein the storage compartment includes at least a freezer compartment, and
 wherein the chilled air return port comprises a freezer compartment return port configured to cause return air from the freezer compartment to flow into the cooling compartment.