

DESCRIPTION

Title of Invention

REFRIGERATOR

Technical Field

5 [0001]

The present disclosure relates to a refrigerator that has a function of bringing an object to be cooled into a supercooled state.

Background Art

[0002]

10 In general, in order that the quality of an object to be cooled, such as food, be maintained when the object is preserved in a refrigerator, it is preferable that a temperature in the refrigerator be kept at a temperature at which the object does not freeze and which is as low as possible. As a method of achieving such preservation, a method of preserving the object in a supercooled state has been proposed. The
15 supercooled state means a state in which even when the temperature of the object reaches the freezing point or below, freezing of the object does not start and the object is in a non-frozen state. However, when the object is preserved at the freezing point or below (for example, 0 degrees C or below), there is a possibility that the supercooled state will be ended because of an impact or for some cause, and ice crystals will be
20 generated on the object. Then, if the object is left as it is after the supercooled state is ended, freezing of the object advances, as a result of which the quality of the object is reduced because of cell damage caused by freezing.

[0003]

To avoid such a problem, in a given refrigerator that is disclosed, a low-
25 temperature step and a temperature raising step are repeatedly carried out; and in the low-temperature step, the temperature in the refrigerator is set to a temperature below the freezing point of an object to be cooled, and in the temperature raising step, the temperature in the refrigerator is set to a temperature higher than the freezing point (see Patent Literature 1, for example). In the refrigerator disclosed in Patent Literature 1,
30 even in the case where the supercooled state of the object is ended in the low-

temperature step, and as a result, ice crystals generates on the object and freezing of the object starts, the ice crystals generated when the object leaves the supercooled state can be melted by starting the temperature raising step at a predetermined timing. Then, the low-temperature step is re-performed to cause the object to be in the supercooled state, and the supercooled state of the object can be stably maintained.

Citation List

Patent Literature

[0004]

Patent Literature 1: Japanese Patent No. 5847235

Summary of Invention

Technical Problem

[0005]

However, in the refrigerator disclosed in Patent Literature 1, since a freezer compartment is provided below a supercooling storage compartment, a heater that is a heating device is embedded in a boundary wall between these compartments to prevent the supercooling storage compartment from being excessively cooled due to heat transfer, and the heater is formed to have such a size that the heater covers the entire case. Consequently, the cost of the heater is increased.

[0006]

Furthermore, a return air passage in the refrigerator (a return air passage in a supercooling preservation compartment) is provided in a rear region in the refrigerator compartment and close to a bottom surface of the refrigerator compartment, and is located parallel to an air vent that allow cooling air to be supplied to the refrigerator compartment. Therefore, part of the air vent for cooling air is located close to an inlet of the return air passage, as a result of which part of cooling air takes a shortcut, and thus an object to be cooled cannot be efficiently cooled.

[0007]

The present disclosure is applied to solve the above problem, and relates to a refrigerator that can efficiently cool an object to be cooled, and can reduce the cost of a heating device.

Solution to Problem

[0008]

A refrigerator according to an embodiment of the present disclosure includes a heat insulating box body and a partition wall. The heat insulating box body includes: a refrigerator compartment including a compartment and a supercooling preservation compartment provided above the compartment; and a freezer compartment provided above the refrigerator compartment. The temperature in the compartment included in the refrigerator compartment is set to fall within a refrigeration temperature zone. The temperature in the supercooling preservation compartment is set to a supercooling temperature that is lower than the refrigerator temperature zone, and that is lower than or equal to a freezing temperature. The temperature in the freezer compartment is set to fall within a freezing temperature zone. The partition wall is provided between the refrigerator compartment and the freezer compartment, and includes a return air passage for the refrigerator compartment and a first heating device in the partition wall. A return air passage inlet is provided on a front side of the refrigerator compartment to allow air in the refrigerator compartment to flow into the return air passage. An air outlet is provided on a rear side of the refrigerator compartment to allow cooling air to be blown from the air outlet. The first heating device is provided so as not to overlap with the return air passage as viewed in plan view.

Advantageous Effects of Invention

[0009]

In the refrigerator according to an embodiment of the present disclosure, since the return air passage inlet is provided on the front side of the refrigerator compartment, cooling air can be efficiently blown from the air outlet provided on the rear side of the refrigerator compartment. Furthermore, a return port is inevitably located farther from the return air passage inlet than the air outlet. Therefore, even if the air velocity of cooling air is reduced, it is possible to efficiently cool an object to be cooled, without causing the cooling air to take a shortcut. Furthermore, the first heating device is provided not so as to overlap with the return air passage as viewed in plan view, and the first heating device does not completely cover the entire supercooling preservation

compartment. Therefore, the cost of the first heating device can be reduced.

Brief Description of Drawings

[0010]

[Fig. 1] Fig. 1 is a front view schematically illustrating an external appearance of a refrigerator according to Embodiment 1 of the present disclosure.

[Fig. 2] Fig. 2 is a first internal configuration diagram schematically illustrating an internal configuration of the refrigerator according to Embodiment 1 of the present disclosure.

[Fig. 3] Fig. 3 is a second internal configuration diagram schematically illustrating the internal configuration of the refrigerator according to Embodiment 1 of the present disclosure.

[Fig. 4] Fig. 4 is a plan view schematically illustrating the inside of a partition wall that isolates a freezer compartment and a refrigerator compartment of the refrigerator according to Embodiment 1 of the present disclosure.

[Fig. 5] Fig. 5 is a plan view schematically illustrating a cross section of a supercooling preservation compartment of the refrigerator according to Embodiment 1 of the present disclosure.

[Fig. 6] Fig. 6 is an internal configuration diagram schematically illustrating a configuration of a refrigerator according to Embodiment 2 of the present disclosure.

[Fig. 7] Fig. 7 is an internal configuration diagram schematically illustrating the configuration of a refrigerator according to Embodiment 3 of the present disclosure.

[Fig. 8] Fig. 8 is a vertical sectional view schematically illustrating a configuration of a multi-layer shelf included in the refrigerator according to Embodiment 3 of the present disclosure.

[Fig. 9] Fig. 9 is a plan view schematically illustrating the multi-layer shelf included in the refrigerator according to Embodiment 3 of the present disclosure.

[Fig. 10] Fig. 10 is a vertical sectional view schematically illustrating a configuration of a multi-layer shelf included in a refrigerator according to Embodiment 4 of the present disclosure.

Description of Embodiments

[0011]

Embodiments of the present disclosure will be described with reference to the drawings. In each of the following figures, components that are the same as or equivalent to those in a previous figure are denoted by the same reference signs, and their descriptions will thus be omitted or simplified as appropriate. The shape, size, and arrangement of components as illustrated in each of the figures can be changed as appropriate within the scope of the present disclosure. Furthermore, the positional relationship (for example, in the vertical direction) between components described in the present specification is, in principle, that in the case where a refrigerator 100 is installed in a usable state. In the following figures including Fig. 1, the relationship in size and shape between the components may differ from that between actual components.

[0012]

Embodiment 1

Fig. 1 is a front view schematically illustrating an external appearance of a refrigerator 100 according to Embodiment 1 of the present disclosure. Fig. 2 is a first internal configuration diagram schematically illustrating an internal configuration of the refrigerator 100 according to Embodiment 1 of the present disclosure. Fig. 3 is a second internal configuration diagram schematically illustrating the internal configuration of the refrigerator 100 according to Embodiment 1 of the present disclosure. Fig. 4 is a plan view schematically illustrating the inside of a partition wall 7 that isolates a freezer compartment 2 and a refrigerator compartment 3 of the refrigerator 100 according to Embodiment 1 of the present disclosure. Fig. 5 is a plan view schematically illustrating a cross section of a supercooling preservation compartment 5 of the refrigerator 100 according to Embodiment 1 of the present disclosure.

[0013]

[Configuration of Refrigerator 100]

As illustrated in Fig. 1, the refrigerator 100 according to Embodiment 1 includes a heat insulating box body 1 that is open on a front side of the heating insulating box body 1, and that has a storage space in the heat insulating box body 1. Although it is not illustrated in detail in the figure, the heat insulating box body 1 includes an outer box

made of steel, an inner box made of a resin, and a heat insulating material filled in a space provided between the outer box and the inner box. The storage space provided in the heat insulating box body 1 is partitioned by a plurality of partition members into a plurality of storage compartments in which objects to be cooled are preserved. For example, as illustrated in Fig. 2, the refrigerator 100 according to Embodiment 1 includes, as the plurality of storage compartments, the freezer compartment 2 that is the uppermost one of the storage compartments, the refrigerator compartment 3 that is provided below the freezer compartment 2, and a vegetable compartment 4 that is provided in a lowermost region in the refrigerator compartment 3. In the configuration in which the refrigerator compartment 3 is located below the freezer compartment 2, the kinds and the number of storage compartments included in the refrigerator 100 are not limited to the kinds and number of the storage compartments described above. In the following, it is assumed that the object to be cooled is food.

[0014]

As illustrated in Fig. 2, cooling devices that cool the inside of respective storage compartments are provided in a rear region in the refrigerator 100. As the cooling devices, for example, a compressor 6 that compresses and discharges refrigerant, a cooler 8 that operates as an evaporator and cools air, and a fan 9 that moves cold air generated by the cooler 8 are provided. Furthermore, in the rear region in the refrigerator 100, a cooling air passage 10 is provided. The cooling air passage 10 is an air passage in which old air flows, and the cooler 8, the fan 9, etc., are provided. A refrigerant discharge side of the compressor 6 is connected with a condenser (not illustrated), and a refrigerant suction side of the compressor 6 is connected with the cooler 8. The cooler 8 operates as an evaporator, and causes heat exchange to be performed between refrigerant that passes through the cooler 8 and air that flows through the cooling air passage 10, to thereby generate cold air. The compressor 6 and the cooler 8 form together with the condenser (not illustrated) and an expansion unit (not illustrated), a refrigeration cycle circuit. The fan 9 supplies cold air to the freezer compartment 2, the refrigerator compartment 3, and the vegetable compartment 4 through the cooling air passage 10.

[0015]

The cooling air passage 10 is provided to extend in a vertical direction in the refrigerator 100 from an upper region to a lower region in the refrigerator 100 and provided in an inner wall panel 50a (see Fig. 3) formed at a housing 50. To be more specific, as illustrated in Fig. 2, the cooling air passage 10 is provided behind the freezer compartment 2, the refrigerator compartment 3, and the vegetable compartment 4. The cooling air passage 10 includes a first air passage 10a and a second air passage 10b. The first air passage 10a is a passage for use in sending cold air to the supercooling preservation compartment 5 in the refrigerator compartment 3, which will be described later. The second air passage 10b is a passage for use in sending cold air to a compartment 12 in the refrigerator compartment 3. Furthermore, in the first air passage 10a, a first damper 11a is provided, and in the second air passage 10b, a second damper 11b is provided. The first damper 11a adjusts the amount of cold air that passes through the first air passage 10a, by changing the opening degree of the first damper 11a. The second damper 11b adjusts the amount of cold air that passes through the second air passage 10b, by changing the opening degree of the second damper 11b.

[0016]

Cold air is caused to exchange heat with refrigerant at the cooler 8 by the operation of the refrigeration cycle circuit, and is thus cooled. The cooled cold air is then supplied by the fan 9 to the storage compartments, such as the freezer compartment 2 and the refrigerator compartment 3, through the cooling air passage 10 provided in the rear region in the refrigerator 100. The cold air that has passed through the refrigerator compartment 3 and other compartments is returned to the cooler 8 through return air passages 16 as illustrated in Fig. 3, and is re-cooled and sent to each of the storage compartments.

[0017]

The refrigerator 100 also includes a controller 200. This controller 200 is a central processing unit (also referred to as a CPU, a processing unit, an arithmetic unit, a microprocessor, a microcomputer, or a processor) that executes a program stored in

dedicated hardware or a memory, for example.

[0018]

The temperatures in the storage compartments are detected by respective temperature sensors (not illustrated) provided in the storage compartments. The controller 200 controls various components in the refrigerator 100 to cause the temperatures detected by the temperature sensors to reach temperatures set at the storage compartments. For example, the controller 200 controls the opening degree of the first damper 11a provided in the first air passage 10a, the opening degree of the second damper 11b provided in the second air passage 10b, the output of the compressor 6, the output of a heater 14, the amount of air to be sent by the fan 9, etc.

[0019]

<Freezer Compartment 2>

The freezer compartment 2 is a storage compartment whose internal temperature is set to a freezing temperature zone that is temperature range of less than 0 degrees C (for example, - 18 degrees C or below). As illustrated in Figs. 2 and 3, the freezer compartment 2 is provided above the refrigerator compartment 3, and stores food to be frozen. In the freezer compartment 2, a first door 17a that is a swing door (for example, a double leaf swing door) is provided to open and close an opening portion of the freezer compartment 2. It should be noted that the first door 17a of the freezer compartment 2 may be provided as either a double leaf swing door or a single leaf swing door. When the first door 17a is opened or closed, the freezer compartment 2 will be made open or closed to the outside of the refrigerator 100.

[0020]

<Refrigerator Compartment 3>

The refrigerator compartment 3 includes the compartment 12 and the supercooling preservation compartment 5. The compartment 12 is a storage compartment whose internal temperature is set to fall within a refrigeration temperature zone (for example, approximately 3 to 5 degrees C) to store food. The supercooling preservation compartment 5 is a storage compartment that preserves food in a supercooled state in which the temperature in supercooling preservation compartment 5

is lower than the temperature in the compartment 12. It should be noted that the temperature in the supercooling preservation compartment 5 is a supercooling temperature of approximately 0 to -3 degrees C, which is the freezing point (freezing temperature) of food or below, for example. As illustrated in Fig. 2, the refrigerator compartment 3 is provided with shelves 27 on which, for example, food is placed. At an opening portion formed on a front side of the refrigerator compartment 3, a second door 17b that is a swing door (for example, a double leaf swing door) is provided to open and close the opening portion. It should be noted that the second door 17b of the refrigerator compartment 3 may be provided as either a double leaf swing door or a single leaf swing door. Furthermore, the inner wall panel 50a as illustrated in Fig. 3 corresponds to a rear wall in the refrigerator compartment 3. As illustrated in Figs. 2 and 3, in the refrigerator 100 according to Embodiment 1, the supercooling preservation compartment 5 is provided above the compartment 12, that is, it is provided in an uppermost region in the refrigerator compartment 3.

[0021]

As described above, the supercooling preservation compartment 5 is a storage compartment that preserves food in the supercooled state. Therefore, the supercooling preservation compartment 5 is a storage compartment suitable for preservation of food, such as meat, fish, processed meat or processed fish. The supercooling preservation compartment 5 is provided with a storage container (not illustrated) and a front wall 13. Furthermore, on the front side of the refrigerator compartment 3 (in a region close to the door), that is, in a region located outward of the front wall 13 of the supercooling preservation compartment 5, return air passage inlets 18 are provided to allow air in the supercooling preservation compartment 5 to flow into the return air passages 16.

[0022]

The storage container is a container that stores food to be preserved in the supercooling preservation compartment 5. The storage container may be, for example, a drawer-type container that can be moved in a front-back direction of the container that is a direction in which the container is moved between a front side and a

rear side of the container, along rails (not illustrated) provided on inner surfaces of side walls of the supercooling preservation compartment 5. It should be noted that the rails may be provided on a shelf 27 that forms a bottom of the supercooling preservation compartment 5. However, it is not indispensable that the rails are provided. A user
5 draws the storage container from the supercooling preservation compartment 5. Since the storage container has an opening formed in an upper surface of the storage container, the user can put food into and take out food from the storage container through the opening. The storage container is formed of, for example, polystyrene as well as a storage container of a common refrigerator. However, the material of the
10 storage container is not limited to polystyrene.

[0023]

The front wall 13 is fixed to the partition wall 7 that will be described later or a sidewall such that the front wall 17 is rotatable at the opening portion in a space located in front of the supercooling preservation compartment 5. When the storage container
15 is drawn, the front wall 13 is rotated to an open position.

[0024]

It should be noted that the controller 200 controls the opening degree of the second damper 11b to adjust the amount of air to be supplied to the refrigerator compartment 3, whereby the temperature in the refrigerator compartment 3 is adjusted.
20 Furthermore, the controller 200 controls the opening degree of the first damper 11a to adjust the amount of air to be supplied to the supercooling preservation compartment 5, and the controller 200 adjusts the output of the heater 14 (also referred to as "first heating device") that will be described later, whereby the temperature in the supercooling preservation compartment 5 is adjusted.

25 [0025]

<Vegetable Compartment 4>

The vegetable compartment 4 is a storage compartment whose internal temperature is set to fall within a refrigeration temperature zone (for example, approximately 3 to 7 degrees C) and is higher than that in the refrigerator compartment
30 3. The vegetable compartment 4 is a storage compartment that has a space for

storing food, and that is particularly suitable for refrigeration of vegetables. As illustrated in Figs. 2 and 3, the vegetable compartment 4 is provided in the lowermost region in the refrigerator compartment 3.

[0026]

<Partition Wall 7>

As illustrated in Fig. 2, the partition wall 7 is a wall provided between the freezer compartment 2 and the refrigerator compartment 3. The partition wall 7 isolates the freezer compartment 2 and the refrigerator compartment 3 from each other, and particularly isolates the freezer compartment 2 and the supercooling preservation compartment 5 located in the uppermost region in the refrigerator compartment 3. As illustrated in Fig. 3, the partition wall 7 contains a heat insulating material 15 for preventing cooling by heat transfer from the freezer compartment 2 to the supercooling preservation compartment 5. The partition wall 7 also has the return air passages 16 and the return air passage inlets 18 through which cold air from the refrigerator compartment 3 is sucked into the return air passages 16. The return air passage inlets 18 are formed on the front side of the refrigerator compartment 3. As illustrated in Fig. 4, the return air passages 16 provided in the partition wall 7 are located in the heat insulating material 15 in the partition wall 7, such that the return air passages 16 do not overlap with the heater 14 that will be described later, as viewed in plan view. As illustrated in Fig. 3, a return port 28 is provided on a rear side (back side) of the partition wall 7, and allows air from the refrigerator compartment 3 to flow into the cooling air passage 10.

[0027]

<Heater 14>

As illustrated in Figs. 2 and 3, the heater 14 is provided in the partition wall 7 that is located on an upper surface of the supercooling preservation compartment 5 and isolates the supercooling preservation compartment 5 and the freezer compartment 2. The heater 14 is a heating device for temperature adjustment, and heats food in the supercooling preservation compartment 5 to raise the temperature of the food. The heater 14 is provided to heat food, and is used in a temperature raising step in a

supercooling preservation process. In the supercooling preservation process, it is necessary to prevent food from being frozen due to excessive cooling. Therefore, the heater 14 is used to heat food that has been excessively cooled. The heater 14 is located on the upper surface of the supercooling preservation compartment 5, and can thus heat food in the supercooling preservation compartment 5.

[0028]

[Maintenance of Supercooled State]

A temperature environment in which food in the supercooling preservation compartment 5 is kept in the supercooled state will be described. In order that water change into ice, the water needs to have part where ice crystals grow, that is, an ice nucleus at a small molecular level. It is considered that in supercooled liquid, aggregation and dispersion of molecules are repeated due to oscillation, thus causing aggregation (cluster) of molecules having various sizes. When the cluster is extremely small, molecules in the cluster are in a bonded state of ice. However, molecules on the surface of the cluster cannot be bonded, and are thus unstable, as a result of which some molecules are separated from the cluster.

[0029]

Unless the radius of the cluster exceeds a certain critical radius, the cluster cannot stably exist, and does not become ice crystal. Therefore, even if the temperature of the cluster reaches the solidifying point or below, the cluster does not start freezing. This state is the supercooled state. In the case where even one cluster having the critical radius or greater is generated, ice crystals are generated using such a cluster as a nucleus, and the supercooled state is ended. When the temperature drops to be low, it is more highly possible that the supercooled state will be ended. Also, due to disturbance such as a physical impact, the inside of liquid greatly oscillates, and a cluster having the critical radius or more is generated, and the supercooled state is ended.

[0030]

It should be noted that food is a mixture of substances, and thus in many cases, ice crystals are generated while the substances are used as a nucleus. In the case

where food is preserved at a freezing point or below (for example, 0 degrees C or below), there is a possibility that the supercooled state will be ended due to an impact or for other causes, and ice crystals will generate at the food. If the food is left as it is after the supercooled state is ended, freezing of the food advances, and the quality of the food drops due to cell damage caused by freezing.

[0031]

In view of the above, in the refrigerator 100 according to Embodiment 1, the low-temperature step and the temperature raising step are controlled. In the low-temperature step, the temperature in the refrigerator is set to a temperature lower than the freezing point of food. In the temperature raising step, the temperature in the refrigerator is set to a temperature higher than the freezing point. Then, a temperature environment in the supercooling preservation compartment 5, which is a space for preserving food, is adjusted, and the food is cooled without being given a stimulus such as rapid drop of the temperature, whereby the food is kept in the supercooled state.

To be more specific, in order to maintain the supercooled state, it is preferable that the "temperature range" in the supercooling preservation compartment 5 be set to a range from -4 to 0 [degrees C]. Also, in order to maintain the supercooled state, it is preferable that "temperature distribution" in the supercooling preservation compartment 5 be made uniform.

[0032]

[Flow of Cold Air]

The flow of cold air generated in the cooler 8 will be described with reference to Figs. 2 and 3. Arrows in Figs. 2 and 3 indicate the flow of cold air. Cold air generated in the cooler 8 is divided into cold air that passes through the fan 9 and flows toward the freezer compartment 2 and cold air that flows toward the refrigerator compartment 3. The cold air that flows toward the refrigerator compartment 3 passes through the cooling air passage 10, and is divided, by the first damper 11a and the second damper 11b, into cold air that flows toward the supercooling preservation compartment 5 in the refrigerator compartment 3 and cold air that flows toward the compartment 12 in the refrigerator compartment 3. The cold air that flows toward the refrigerator

compartment 3 passes over the shelves 27, and gently rises upwards on the front side of the refrigerator compartment 3 and flows toward the return air passages 16.

[0033]

As illustrated in Figs. 2 and 5, the cold air that flows toward to the supercooling preservation compartment 5 is blown from an air outlet 19 that communicates with the first damper 11a. Part of the cold air blown from the air outlet 19 flows into a space located in front of the supercooling preservation compartment 5 through a space provided between the front wall 13 and the shelf 27. The cold air that has flowed into the space located in front of the supercooling preservation compartment 5 joins cold air that flows toward the upper region in the refrigerator compartment 3 while cooling a space in the refrigerator compartment 3 that is other than a region where the supercooling preservation compartment 5 is provided. Then, the cold air flows in the return air passage inlets 18, passes through the return air passages 16, and returns to the cooling air passage 10 through the return port 28.

[0034]

As described above, the refrigerator 100 according to Embodiment 1 includes the heat insulating box body 1 and the partition wall 7. The heat insulating box body 1 includes the refrigerator compartment 3 and the freezer compartment 2. The refrigerator compartment 3 includes the compartment 12 whose internal temperature is set to fall within the refrigeration temperature zone, and the supercooling preservation compartment 5 which is provided above the compartment 12 and whose internal temperature is set to the supercooling temperature that is lower than the refrigerator temperature zone and that is lower than or equal to the freezing temperature. The freezer compartment 2 is provided above the refrigerator compartment 3, and the temperature in the freezer compartment 2 is set to fall within the freezing temperature zone. The partition wall 7 is provided between the refrigerator compartment 3 and the freezer compartment 2. Also, in the partition wall 7, the first heating device and the return air passages 16 for the refrigerator compartment 3 are provided. On the front side the refrigerator compartment 3, the return air passage inlets 18 are provided to allow air in the refrigerator compartment 3 to flow into the return air passage 16. On

the rear side of the refrigerator compartment 3, the air outlet 19 is provided to allow cooling air to be blown out from the air outlet 19. The first heating device is provided so as not to overlap with the return air passages 16 as viewed in plan view.

[0035]

5 In the refrigerator 100 according to Embodiment 1, since the return air passage inlets 18 are provided on the front side of the refrigerator compartment 3, cooling air can be efficiently blown from the air outlet 19 provided on the rear side of the refrigerator compartment 3. Furthermore, since the return air passages 16 are located apart from the air outlet 19, even if the velocity of cooling air is reduced, an object to be cooled can
10 be efficiently cooled without causing the cooling air to take a shortcut.

[0036]

In an existing refrigerator, due to the location of an air passage, it is highly possible that cooling air will take a shortcut to the return port 28 if a certain velocity of the cooling air is not ensured. Therefore, in order to prevent the cooling air to take a
15 shortcut, in the existing refrigerator, it is necessary to ensure a velocity of air that is higher than or equal to a certain velocity. In contrast, in Embodiment 1, since specific constraints are not imposed on the velocity of cooling air, an object to be cooled can be cooled with cooling air that flows at a low velocity suitable for supercooling preservation, without causing the object to be quickly frozen.

20 [0037]

Furthermore, the first heating device is located such that the first heating device does not overlap with the return air passages 16 as viewed in plan view, and does not completely cover the supercooling preservation compartment 5. Therefore, the area of the heater can be reduced, and the cost of the first heating device can thus be reduced.
25 Furthermore, a temperature raising performance of the first heating device can be improved by increasing a heat generation density thereof, whereby the electric energization rate of the first heating device can be reduced and supercooling preservation can be performed efficiently.

[0038]

30 Furthermore, if the return air passages 16 were provided in a lower region in the

refrigerator compartment 3, and the return air passage inlet were provided in the front region in the refrigerator compartment 3, it would be possible that if liquid from food, such as meat juice, or a food residue, spills, the return air passage 16 will be clogged with the spilled liquid or residue. Therefore, it has been hard to provide the return air passage in the front region, in order to maintain the quality of the refrigerator 100. Thus, the return air passages 16 are basically provided in the rear region. By contrast, in the refrigerator 100 according to Embodiment 1, the return air passages 16 are provided above the refrigerator compartment 3. Therefore, even if liquid from food, such as meat juice, or food residue spills, there is no possibility of the return air passage 16 being clogged. Thus, the return air passages 16 can be provided on the front side of the refrigerator compartment 3.

[0039]

In the refrigerator 100 according to Embodiment 1, the heat insulating material 15 is provided in the partition wall 7. In the refrigerator 100 according to Embodiment 1, since the heat insulating material 15 is provided in the partition wall 7, it is possible to prevent cooling by heat transfer from the freezer compartment 2 to the supercooling preservation compartment 5.

[0040]

Embodiment 2

Embodiment 2 of the present disclosure will be described. However, regarding Embodiment 2, components that are the same as or equivalent to those in Embodiment 1 will be denoted by same reference signs, and their descriptions will not be repeated if they have already been made.

[0041]

Fig. 6 is an internal configuration diagram schematically illustrating a configuration of a refrigerator 100 according to Embodiment 2 of the present disclosure.

[0042]

As illustrated in Fig. 6, in the refrigerator 100 according to Embodiment 2, a heat transfer member 20 is provided on a lower side of the partition wall 7 that forms the upper surface of the supercooling preservation compartment 5. In such a manner,

since the heat transfer member 20 is provided on the lower side of the partition wall 7, heat from the heater 14 whose heat generation density is higher can be efficiently transferred. Therefore, freezing of food can be more reliably prevented, and the energization time of the heater 14 can be shortened.

5 [0043]

In an existing structure, since a heater is provided on a lower surface of a supercooling preservation compartment, it is hard to provide the heat transfer member 20 in a lower region in the supercooling preservation compartment. This is because from the viewpoint of storage of food, if the heat transfer member 20 were provided in
10 the lower region in the supercooling preservation compartment, food could not easily be placed. Although the heat transfer member 20 can be provided in a flat state on a bottom surface of the supercooling preservation compartment, in this case, unlike Embodiment 2, it is not possible to ensure a large heat transfer area or obtain a sufficient effect.

15 [0044]

By contrast, in Embodiment 2, the heat transfer member 20 is provided on the lower side of the partition wall 7 that forms the upper side of the supercooling preservation compartment 5, whereby heat from the heater 14 whose heat generation density is higher can be further efficiently transferred while it is ensured that food can be
20 easily placed.

[0045]

It should be noted that preferably, the heat transfer member 20 should be made of a substance having a high thermal conductivity, for example, a metal substance such as aluminum. Furthermore, preferably, the heat transfer member 20 should be shaped
25 to have irregularities in order to ensure that the heat transfer area is as large as possible.

[0046]

As described above, in the refrigerator 100 according to Embodiment 2, the heat transfer member 20 is provided in the upper region in the supercooling preservation compartment 5. In the refrigerator 100 according to Embodiment 2, since the heat
30

transfer member 20 is provided in the upper region in the supercooling preservation compartment 5, freezing of food can be more reliably prevented, and the energization time of the heater 14 can be shortened.

[0047]

Furthermore, in the refrigerator 100 according to Embodiment 2, the heat transfer member 20 is made of a metal substance. In the refrigerator 100 according to Embodiment 2, since the heat transfer member 20 is made of a metal substance, the heat transfer member 20 has a high thermal conductivity, and heat from the heater 14 whose heat generation density is higher is more efficiently transferred.

[0048]

Embodiment 3

Embodiment 3 of the present disclosure will be described. However, regarding Embodiment 3, components that are the same as or equivalent to those in Embodiment 1 and/or Embodiment 2 will be denoted by the same reference signs, and their descriptions will not be repeated if they have already been made.

[0049]

[Multi-Layer Shelf 21]

Fig. 7 is a schematic view illustrating an internal configuration of a refrigerator 100 according to Embodiment 3 of the present disclosure. Fig. 8 is a vertical sectional view schematically illustrating a configuration of a multi-layer shelf 21 included in the refrigerator 100 according to Embodiment 3 of the present disclosure. Fig. 9 is a plan view schematically illustrating the multi-layer shelf 21 included in the refrigerator 100 according to Embodiment 3 of the present disclosure.

The configuration of the multi-layer shelf 21 according to Embodiment 3 will be described with reference to Figs. 7 to 9.

[0050]

As illustrated in Fig. 7, the refrigerator 100 according to Embodiment 3 includes the multi-layer shelf 21 at a lower surface of the supercooling preservation compartment 5. As illustrated in Fig. 8, the multi-layer shelf 21 is formed such that a plurality of plate-like shelf members 22 made of, for example, glass, a resin or other material, are

stacked, with spaces interposed between the plate-like shelf members 22.

Furthermore, the spaces formed between the adjacent shelf members 22 are sealed, with air provided between the adjacent shelf members 22. This air acts to reduce, for example, the degree of convection during heat fluctuations in the multi-layer shelf 21, and maintain a static state of the multi-layer shelf 21. Therefore, the multi-layer shelf 21 has high heat insulating properties. It should be noted that portions of the multi-layer shelf 21 which are sealed, with air provided between the adjacent shelf members 22, will be referred to as static air layers 23.

[0051]

It is not indispensable that air is provided in the spaces between the shelf members 22; that is, no air may be provided in the spaces. For example, a spacer or spaces (not illustrated) may be provided in one or each of the spaces between the shelf members 22 to maintain the distance between the spaces and the durability of the multi-layer shelf 21 or the spaces. Alternatively, the spaces between the adjacent shelf members 22 are sealed, with another transparent gas provided in the spaces instead of air.

[0052]

As illustrated in Fig. 9, a resin frame 24 is attached to outer peripheries of the shelf members 22 to enable the multi-layer shelf 21 to be set in the refrigerator 100.

The multi-layer shelf 21 is configured such that the plurality of shelf members 22 are stacked, with spaces provided between the shelf members 22, and the outer peripheries of the shelf members 22 are covered with rubber or a silicon member to seal the spaces, thereby preventing air from flowing from the outside into the static air layers 23. In the above case, air to be provided in the static air layers 23 may be dehumidified, and then be provided in the static air layers 23, whereby the amount of moisture contained in the air in the static air layers 23 is smaller. It should be noted that in the case where the static air layers 23 have such airtightness as to enable the static air layers 23 to prevent outside air from flowing into the static air layers 23, the resin frame 24 may be directly attached to the shelf members 22 without covering the outer peripheries of the shelf members 22 with rubber or a silicon members to seal the spaces.

[0053]

Preferably, a thickness T2 of each of the static air layers 23 should be set to 3 mm or less. This is because in the case where the thickness of each static air layer 23 is greater than 3 mm, air easily flows in each static air layer 23, and as a result, the heat insulating properties of each static air layer 23 are reduced since air is not static. A thickness T1 of each of the shelf members 22 is not limited to a specific thickness. However, if the shelf member 22 is excessively thick, the weight of the multi-layer shelf 21 is increased. It is therefore preferable that the thickness T1 of each shelf member 22 be set to, for example, 3 mm or less.

[0054]

Fig. 8 illustrates a configuration where three shelf members 22 are provided and two static air layers 23 are provided, but this illustration is not limiting. For example, two or four or more shelf members 22 may be used, and one or three or more static air layers 23 may be formed.

[0055]

Since the multi-layer shelf 21 has the above configuration and the multi-layer shelf 21 is provided on the lower side of the supercooling preservation compartment 5, the multi-layer shelf 21 has higher heat insulating properties than an existing shelf. Therefore, cooling and temperature adjustment of the supercooling preservation compartment 5 can be more reliably performed than in Embodiment 1. Furthermore, since the heat insulating properties of the multi-layer shelf 21 are improved, it is possible to reduce a cooling influence on the storage compartment located below the supercooling preservation compartment 5. In addition to the above, by increasing the size of the supercooling preservation compartment 5 in the vertical direction, the internal volume of the supercooling preservation compartment 5 can be increased.

[0056]

Basically, the temperature distribution in the supercooling preservation compartment 5 needs to be kept uniform in the horizontal direction and the height direction. The temperature distribution characteristic in the horizontal direction is determined based on a flow rate balance at the air outlet 19 through which cold air is

supplied to the supercooling preservation compartment 5. On the other hand, the temperature distribution characteristic in the height direction is determined based on the heat insulating properties of the supercooling preservation compartment 5. This is because in general, cold air easily collects in a lower region, and therefore, in the refrigerator 100 according to Embodiment 3, an amount of heat easily enters the supercooling preservation compartment 5 through the multi-layer shelf 21 that forms the lower surface of the supercooling preservation compartment 5.

[0057]

For example, in an existing refrigerator, a chilling compartment in a refrigerator compartment is divided into an upper chilling compartment and a lower chilling compartment, and the lower chilling compartment is used as a supercooling preservation compartment, in order that the supercooling preservation compartment be provided not directly adjacent to the refrigerator compartment whose internal temperature higher than the temperature in the supercooling preservation compartment.

[0058]

An amount of heat basically transfers from a region having a larger amount of heat to a region having a smaller amount of heat to seek to maintain the balance between the amounts of heat in these regions. In other words, a heat flux concentratedly collects in a region having a small amount of heat. Therefore, heat transfers from a region to another region such that the temperatures of these regions are made uniform. Therefore, in the case where the supercooling preservation compartment and the refrigerator compartment are disposed adjacent to each other in the vertical direction, the amount of heat in the refrigerator compartment transfers to the supercooling preservation compartment, and the temperature in the lower region of the supercooling preservation compartment thus tends to rise to differ from that in the upper region of the supercooling preservation compartment. It is therefore hard to keep the above temperature distribution uniform in the height direction.

[0059]

In view of the above, in the refrigerator 100 according to Embodiment 3, as illustrated in Fig. 7, the heat insulating properties of the multi-layer shelf 21 that forms

the lower surface of the supercooling preservation compartment 5 are improved, whereby it is possible to prevent entrance of a heat flux from the refrigerator compartment 3 and reduce a temperature rise in the lower region of the supercooling preservation compartment 5. Therefore, unlike the existing refrigerator, it is unnecessary to provide an upper chilling compartment that forms an intermediate temperature region between the refrigerator compartment and the supercooling preservation compartment. Therefore, for example, the space volume of a portion that corresponds to the upper chilling compartment can be used as the internal volume of the refrigerator compartment or the internal volume of the supercooling preservation compartment, that is, the internal volume of the supercooling preservation compartment 5 can be increased, whereby a larger number of foodstuffs can be supercooling-preserved, and the usability is improved.

[0060]

As described above, in the refrigerator 100 according to Embodiment 3, the multi-layer shelf 21 is provided at the lower surface of the supercooling preservation compartment 5, and the multi-layer shelf 21 is formed such that the plurality of plate-like shelf members 22 are stacked, with spaces provided between the shelf members 22, and the spaces are sealed, with gas provided in the spaces.

[0061]

In the refrigerator 100 according to Embodiment 3, the multi-layer shelf 21 is provided at the lower surface of the supercooling preservation compartment 5 to increase the heat insulating properties, whereby a heat flux can be prevented from entering the supercooling preservation compartment 5 from the refrigerator compartment 3, and a temperature rise in the lower region of the supercooling preservation compartment 5 can be reduced.

[0062]

Embodiment 4

Embodiment 4 of the present disclosure will be described. However, regarding Embodiment 4, components that are the same as or equivalent to those in any of Embodiments 1 to 3 will be denoted by same reference signs, and their descriptions will

not be repeated if they have already been made.

[0063]

Fig. 10 is a vertical sectional view schematically illustrating a configuration of a multi-layer shelf 21 included in a refrigerator 100 according to Embodiment 4 of the present disclosure.

The configuration of the multi-layer shelf 21 according to Embodiment 4 will be described with reference to Fig. 10.

[0064]

As illustrated in Fig. 10, in the multi-layer shelf 21 according to Embodiment 4, a rib member 26 is provided in the static air layer 23 formed between the shelf members 22 such that the rib member 26 are formed in the shape of a lattice as viewed in plan view. Although it is not particularly limited, it is assumed that a vertical cross section of the rib member 26 according to Embodiment 4 has an inverted U shape in order to ensure stability. Furthermore, a wire heater 25 (also referred to as "second heating device") is provided in the rib member 26. The wire heater 25 as well as the heater 14 operates as a heating device for temperature adjustment that heats food in the supercooling preservation compartment 5 to raise the temperature of the food. In such a manner, since the wire heater 25 is provided in the rib member 26, it is possible to increase the heat generation density of the heater in the multi-layer shelf 21, and thus improve the temperature raising performance.

[0065]

It is assumed that the wire heater 25 has a diameter of approximately Φ 2 to 3 mm. It is preferable that the thickness of the entire rib member 26 be approximately 5 to 7 mm. Referring to Fig. 10, the wire heater 25 is provided only in the rib member 26 in the uppermost one of the static air layers 23. However, it is not indispensable that the wire heater 25 is provided in only one static air layer 23.

[0066]

The wire heater 25 is provided in the multi-layer shelf 21 as described above, and can thus supply an amount of heat to food in the supercooling preservation compartment 5 in the temperature raising step as an assist function for the heater 14.

Therefore, it is possible to more reliably prevent freezing of food in the height direction of the supercooling preservation compartment 5, and prevent occurrence of dew condensation at the shelf members 22 in the multi-layer shelf 21.

[0067]

Regarding Embodiments 1 to 4, although it is described above that the controller 200 adjusts the temperature of the supercooling preservation compartment 5 by controlling the first damper 11a, the heater 14, and the wire heater 25, it is not limiting. For example, the controller 200 may adjust the temperature of the supercooling preservation compartment 5 by controlling only the wire heater 25 without controlling the first damper 11a.

[0068]

Furthermore, although it is described above by referring to by way of example the case where the wire heater 25 is the heating device provided in the multi-layer shelf 21 that forms the lower surface of the supercooling preservation compartment 5, it is not limiting. As the heating device, for example, a heat exchanger or a Peltier element may be used as long as the heating device is provided in the rib member 26.

[0069]

As described above, in the refrigerator 100 according to Embodiment 4, the second heating device is provided in the multi-layer shelf 21. In the refrigerator 100 according to Embodiment 4, the second heating device is provided in the multi-layer shelf 21, and can thus supply an amount of heat to food in the supercooling preservation compartment 5 in the temperature raising step as an assist function for the first heating device.

[0070]

Embodiment 5

Embodiment 5 of the present disclosure will be described. In Embodiment 5, components that are the same as those of any of Embodiments 1 to 4, and their description will not be repeated if they have already been made.

[0071]

The supercooling preservation compartment 5 according to Embodiment 5 can be

used as either a partial compartment or a chilling compartment; that is, the supercooling preservation compartment 5 can be switched between the partial compartment and the chilling compartment. When the supercooling preservation compartment 5 is used as the partial compartment, the temperature therein is set to fall within a negative temperature zone that is set in the vicinity of -3 degrees C. When the supercooling preservation compartment 5 is used as the chilling compartment, the temperature therein is set to fall within a positive temperature zone that is set in the vicinity of 1 degree C. As a result, it is possible to select a temperature zone suitable for food to be preserved, and thus improve the usability for a user.

[0072]

The object to be cooled that is made to be in a supercooled state in the supercooling preservation compartment 5 of the refrigerator 100 of the above embodiment is not limited to food. For example, the object to be cooled may be a substance harvested from the natural world, such as raw flesh of a small animal that is not edible. Alternatively, the object to be cooled may be raw flesh of an animal for experiment, such as a clone animal. In other words, as the object to be cooled, any object can be applied, as long as it can be preserved in a supercooled state.

Reference Signs List

[0073]

1 heat insulating box body, 2 freezer compartment, 3 refrigerator compartment, 4 vegetable compartment, 5 supercooling preservation compartment, 6 compressor, 7 partition wall, 8 cooler, 9 fan, 10 cooling air passage, 10a first air passage, 10b second air passage, 11a first damper, 11b second damper, 12 compartment, 13 front wall, 14 heater, 15 heat insulating material, 16 return air passage, 17a first door, 17b second door, 18 return air passage inlet, 19 air outlet, 20 heat transfer member, 21 multi-layer shelf, 22 shelf member, 23 static air layer, 24 resin frame, 25 wire heater, 26 rib member, 27 shelf, 28 return port, 50 housing, 50a inner wall panel, 100 refrigerator, 200 controller.

CLAIMS

[Claim 1]

A refrigerator comprising:

5 a heat insulating box body including: a refrigerator compartment including a compartment and a supercooling preservation compartment provided above the compartment; and a freezer compartment provided above the refrigerator compartment, an internal temperature of the compartment included in the refrigerator compartment being set to fall within a refrigeration temperature zone, an internal temperature of the supercooling preservation compartment being set to a supercooling temperature that is
10 lower than the refrigerator temperature zone, and that is lower than or equal to a freezing temperature, an internal temperature of the freezer compartment being set to fall within a freezing temperature zone: and

a partition wall provided between the refrigerator compartment and the freezer compartment, and including a return air passage for the refrigerator compartment and a
15 first heating device in the partition wall,

wherein a return air passage inlet is provided on a front side of the refrigerator compartment to allow air in the refrigerator compartment to flow into the return air passage,

20 an air outlet is provided on a rear side of the refrigerator compartment to allow cooling air to be blown from the air outlet, and

the first heating device is provided so as not to overlap with the return air passage as viewed in plan view.

[Claim 2]

25 The refrigerator of claim 1, wherein a heat insulating material is provided in the partition wall.

[Claim 3]

The refrigerator of claim 1 or claim 2, wherein the return air passage inlet is provided above the refrigerator compartment to allow air in the compartment and the supercooling preservation compartment included in the refrigerator compartment to flow
30 into the return air passage through the return air passage inlet.

[Claim 4]

The refrigerator of any one of claims 1 to 3, wherein the supercooling preservation compartment is allowed to be used as either a partial compartment or a chilling compartment and to be switched between the partial compartment and the chilling compartment, an internal temperature of the partial compartment being set to fall within a negative temperature zone that is lower than the supercooling temperature, an internal temperature of the chilling compartment being set to fall within a positive temperature zone that is higher than the supercooling temperature.

[Claim 5]

The refrigerator of any one of claims 1 to 4, wherein a heat transfer member is provided in an upper region in the supercooling preservation compartment.

[Claim 6]

The refrigerator of claim 5, wherein the heat transfer member is made of a metal substance.

[Claim 7]

The refrigerator of any one of claims 1 to 6, wherein a multi-layer shelf is provided at a lower surface of the supercooling preservation compartment, and

in the multi-layer shelf, a plurality of plate-like shelf members are stacked, with a space provided between the plurality of plate-like shelf members, and the space is sealed, with gas provided in the space.

[Claim 8]

The refrigerator of claim 7, wherein a second heating device is provided in the multi-layer shelf.

[Claim 9]

The refrigerator of claim 8, wherein the second heating device is a wire heater.