

DESCRIPTION

Title of Invention

REFRIGERATOR

5 Technical Field

[0001]

The present disclosure relates to a refrigerator including a controller.

Background Art

[0002]

10 Refrigerators capable of preserving foods or other items in a supercooled state are known. It is also commonly known that the preservation period of the foods or other items is longer as the average value of preservation temperatures during the period of preservation is lower. Thus, the foods or other items preserved in such a refrigerator can be preserved in a long period, the time and trouble for thawing them can
15 be reduced, and they are unlikely to undergo degradation, such as the loss of nutrients, occurring with the thawing. The supercooled state is, however, an unstable state. That is, for example, vibrations arising from the opening and closing of a door in the refrigerator may cause the foods or other items to leave the supercooled state, and this may lead to freezing of them. Patent Literature 1 discloses a refrigerator that includes
20 a shock-absorbing member disposed between an inner wall of the refrigerator and a storage section that is housed inside the refrigerator and that allows foods or other items to be placed therein. By the use of that member, the refrigerator in Patent Literature 1 can suppress transmission of vibrations occurring when the door is opened and closed to the preserved foods or other items. In that way, the refrigerator in Patent
25 Literature 1 aims to maintain the supercooled state of the stored foods or other items by suppressing the transmission of vibrations to the foods or other items.

Citation List

Patent Literature

[0003]

Patent Literature 1: Japanese Unexamined Patent Application Publication No.
2013-148326

Summary of Invention

Technical Problem

[0004]

The refrigerator disclosed in Patent Literature 1, however, operates such that the foods or other items are in the supercooled state even during a time zone in which the user uses the refrigerator. To deal with a temperature rise caused by an inflow of air from outside the refrigerator when the door is opened, the refrigerator in Patent Literature 1 sends cold air to a storage compartment. That is, the storage compartment undergoes sudden temperature changes. Typically, the sudden temperature changes may cause the foods or other items to leave the supercooled state. Accordingly, the refrigerator disclosed in Patent Literature 1 tends to undergo sudden temperature changes occurring with the opening and closing of the door, and that may cause freezing of the preserved foods or other items.

[0005]

The present disclosure seeks to provide a refrigerator capable of operating such that a supercooled state of preserved foods or other items may be maintained and the freezing of those foods or other items may be avoided.

Solution to Problem

[0006]

A refrigerator according to an embodiment of the present disclosure includes a heat insulation casing whose inside defines a storage compartment for storing an object, the heat insulation casing having a box shape and having a front covered with a door, a temperature adjuster provided at the heat insulation casing and configured to adjust a temperature of the storage compartment, a controller provided at the heat insulation casing and configured to control the temperature adjuster, and a door opening detector provided at the heat insulation casing and configured to detect a number of times of door opening, the number of times of door opening representing a number of times the door is opened. The controller is configured to set a supercooling temperature as a target temperature in an unused time zone. The supercooling temperature is a temperature lower than a predetermined normal temperature. The target temperature is a temperature targeted in adjusting the

temperature of the storage compartment by the temperature adjuster such that a temperature of the object is equal to or lower than a freezing point. The unused time zone represents a time zone in which a frequency of opening and closing the door is low. The controller is also configured to set, as the unused time zone, a time zone in which the number of times of door opening detected by the door opening detector is lower than a threshold value. The controller is further configured to set a day having a time zone in which the number of times of door opening is in a predetermined special threshold value range in a period of time other than the unused time zone, as a special control day representing a day in which a special temperature is set as the target temperature.

[0006a]

A refrigerator according to another embodiment of the present disclosure includes a heat insulation casing whose inside defines a storage compartment for storing an object, the heat insulation casing having a box shape and having a front covered with a door, a temperature adjuster provided at the heat insulation casing and configured to adjust a temperature of the storage compartment, and a controller provided at the heat insulation casing and configured to control the temperature adjuster. The controller is configured to set a supercooling temperature as a target temperature in a unused time zone. The supercooling temperature is a temperature lower than a predetermined normal temperature. The target temperature is a temperature targeted in adjusting the temperature of the storage compartment by the temperature adjuster such that a temperature of the object is equal to or lower than a freezing point. The unused time zone represents a time zone in which a frequency of opening and closing the door is low. The controller is also configured to set an elevated temperature as the target temperature in the unused time zone after setting the supercooling temperature as the target temperature. The elevated temperature exceeds the normal temperature.

Advantageous Effects of Invention

[0007]

According to an embodiment of the present disclosure, the refrigerator cools an object, such as foods or other items, to temperatures at or below the freezing point in the unused time zone. In the unused time zone, the user does not frequently use the refrigerator. Thus, temperature changes caused by the opening and closing of the door in the refrigerator are small, and the foods or other items preserved in the

refrigerator remains in the supercooled state. Accordingly, the refrigerator can operate such that the supercooled state of the preserved foods or other items is maintained and the freezing of those foods or other items is avoided.

Brief Description of Drawings

[0008]

[Fig. 1] Fig. 1 is a front view illustrating a refrigerator 1 according to Embodiment 1.

[Fig. 2] Fig. 2 is a schematic diagram illustrating a chill compartment 32 according to Embodiment 1.

[Fig. 3] Fig. 3 is a functional block diagram illustrating a controller 7 according to Embodiment 1.

[Fig. 4] Fig. 4 is a flow chart illustrating the working of the controller 7 according to Embodiment 1.

[Fig. 5] Fig. 5 illustrates line charts representing the numbers of times of door opening and the temperatures of a storage compartment 22 according to Embodiment 1.

[Fig. 6] Fig. 6 is a flow chart illustrating the working of the controller 7 according to Embodiment 1.

[Fig. 7] Fig. 7 is a functional block diagram illustrating a controller 107
Embodiment 2.

[Fig. 8] Fig. 8 is a flow chart illustrating the working of the controller 107 according
to Embodiment 2.

5 [Fig. 9] Fig. 9 illustrates line charts representing the numbers of times of door
opening and the temperatures of the storage compartment 22 according to Embodiment
2.

[Fig. 10] Fig. 10 is a functional block diagram illustrating a controller 207
according to Embodiment 3.

10 [Fig. 11] Fig. 11 is a flow chart illustrating the working of the controller 207
according to Embodiment 3.

[Fig. 12] Fig. 12 illustrates line charts representing the numbers of times of door
opening and temperatures of the storage compartment 22 according to Embodiment 3.

15 [Fig. 13] Fig. 13 is a flow chart illustrating the working of the controller 207
according to Embodiment 3.

Description of Embodiments

[0009]

Embodiment 1

20 A refrigerator 1 according to Embodiment 1 is described below with reference to
the drawings. Fig. 1 is a front view illustrating the refrigerator 1 according to
Embodiment 1. Fig. 2 is a schematic diagram illustrating a chill compartment 32
according to Embodiment 1. As illustrated in Figs. 1 and 2, the refrigerator 1 includes
a heat insulation casing 2, a temperature adjuster 3, a temperature detector 4, a door
opening detector 5, a storing section 6, and a controller 7.

25 [0010]

(Heat insulation casing 2)

The heat insulation casing 2 has a substantially cuboid box shape and includes
an outer casing 11 forming an outer housing, an inner casing 12 disposed inside the
outer casing 11, and a heat insulator 13 charged between the outer casing 11 and the
30 inner casing 12. One example of the outer casing 11 may be made of steel. One

example of the inner casing 12 may be made of thin and hard acrylonitrile butadiene styrene (ABS) resin. One example of the heat insulator 13 may be rigid urethane foam. The inside of the heat insulation casing 2 is partitioned by a division plate 15 into a storage space 17, a cooling compartment (not illustrated), and an air channel 16.

5 The storage space 17 is partitioned by a division member 21 extending in the horizontal direction and the vertical direction into a plurality of storage compartments 22. The storage compartments 22 are spaces for storing objects, such as foods or other items, and are composed of a refrigerator compartment 31, the chill compartment 32, a versatile compartment 33, an ice-making compartment 34, a vegetable compartment 10 35, and a freezer compartment 36. Moreover, the front of the heat insulation casing 2 is covered with a plurality of doors 14 for opening or closing the storage compartments 22, respectively. The doors 14 are composed of a refrigerator compartment door 41, a versatile compartment door 43, an ice-making compartment door 44, a vegetable compartment door 45, and a freezer compartment door 46.

15 [0011]

(Refrigerator Compartment 31)

The refrigerator compartment 31 is in the uppermost location of the refrigerator 1, cools the foods or other items, and stores them. The refrigerator compartment 31 is maintained in a refrigeration temperature zone of, for example, about 3 degrees C by 20 the temperature adjuster 3. In the refrigerator compartment 31, a food storage shelf 42 is disposed in the horizontal direction. The foods or other items are placed on the food storage shelf 42, and they are refrigerated. The refrigerator compartment door 41 is positioned at the front of the refrigerator compartment 31. The refrigerator compartment door 41 consists of double doors for opening and closing the refrigerator 25 compartment 31. The refrigerator compartment door 41 is equipped with a setting action section 51 through which a user can perform actions for temperature settings and other settings for the storage compartments 22.

[0012]

(Chill Compartment 32)

The chill compartment 32 is a portion of the refrigerator compartment 31 and is surrounded by a food storage case 52 having a box shape with an open area as its upper surface. One example of the food storage case 52 may be made of polystyrene. The chill compartment 32 is maintained in a chill temperature zone of, for example, about 0 degrees C by the temperature adjuster 3. The chill temperature zone may range from -3 degrees C to 3 degrees C.

[0013]

(Versatile Compartment 33)

The versatile compartment 33 is disposed below the refrigerator compartment 31. The versatile compartment 33 may be maintained in a selected temperature zone, for example, a freezing temperature zone of, for example, about -18 degrees C or a soft-freezing temperature zone of, for example, about -7 degrees C, by the temperature adjuster 3. The soft-freezing temperature zone may range from -10 degrees C to -4 degrees C. The versatile compartment door 43 is positioned at the front of the versatile compartment 33. The versatile compartment door 43 is a pull-out door for opening and closing the versatile compartment 33.

[0014]

(Ice-Making Compartment 34)

The ice-making compartment 34 is next to the versatile compartment 33 and configured to produce and store ice. The ice-making compartment 34 is maintained in the freezing temperature zone of, for example, about -18 degrees C by the temperature adjuster 3. The ice-making compartment door 44 is positioned at the front of the ice-making compartment 34. The ice-making compartment door 44 is a pull-out door for opening and closing the ice-making compartment 34.

(Vegetable Compartment 35)

The vegetable compartment 35 is disposed below the versatile compartment 33 and the ice-making compartment 34 and configured to store mainly vegetables. The vegetable compartment 35 is maintained in a refrigeration temperature zone of, for example, about 6 degrees C by the temperature adjuster 3. In addition to the temperature, the humidity of the vegetable compartment 35 may be adjusted. The

vegetable compartment door 45 is positioned at the front of the vegetable compartment 35. The vegetable compartment door 45 is a pull-out door for opening and closing the vegetable compartment 35.

[0015]

5 (Freezer Compartment 36)

The freezer compartment 36 is disposed below the vegetable compartment 35 and configured to freeze and store the foods or other items. The freezer compartment 36 is maintained in the freezing temperature zone of, for example, about -18 degrees C by the temperature adjuster 3. The freezer compartment door 46 is positioned at the front of the freezer compartment 36. The freezer compartment door 46 is a pull-out door for opening and closing the freezer compartment 36.

[0016]

The number and arrangement of the storage compartments 22 are not limited to those described above.

15 [0017]

(Cooling Compartment, Air Channel 16)

The cooling compartment is provided at the rear portion of the heat insulation casing 2 and is a space where an air-blowing fan (not illustrated), a cooler (not illustrated), and other elements included in the temperature adjuster 3, which is described below, are arranged. The air channel 16 is provided at the rear portion of the heat insulation casing 2 and is a space that allows cold air produced by the cooler and sent by the air-blowing fan to pass therethrough.

[0018]

(Temperature Adjuster 3)

25 The temperature adjuster 3 is a device for adjusting the temperatures of the storage compartments 22. The temperature adjuster 3 includes a compressor (not illustrated), a condenser (not illustrated), an expansion section (not illustrated), the cooler (not illustrated), the air-blowing fan (not illustrated), and a damper 61. The compressor is configured to suck low-temperature and low-pressure refrigerant, compress the sucked refrigerant to refrigerant in a high-temperature and high-pressure

30

state, and discharge it. The condenser is configured to exchange heat between high-temperature and high-pressure refrigerant and air. The expansion section is a pressure reducing valve or an expansion valve for decompressing and expanding the refrigerant. The cooler is disposed upstream of the air channel 16, configured, as an evaporator, to exchange heat between the low-temperature and low-pressure refrigerant and air and to cool the air. The air-blowing fan is configured to blow the cold air produced by the cooler into the storage space 17. The damper 61 is configured to control the amount of the cold air to be sent to the storage space 17 by adjustment of its opening degree.

[0019]

Here, the working of the temperature adjuster 3 is described. In operation of the refrigerator 1, the refrigerant sucked into the compressor is compressed by the compressor, and is discharged therefrom in a high-temperature and high-pressure gas state. The refrigerant in the high-temperature and high-pressure gas state discharged from the compressor flows into the condenser. The refrigerant flowed into the condenser exchanges heat with air and condenses to liquid. The refrigerant in a liquid state flows into the expansion section, is decompressed and expanded, and becomes low-temperature and low-pressure refrigerant in a two-phase gas-liquid state. The refrigerant in the two-phase gas-liquid state flows into the cooler, which acts as the evaporator. The refrigerant flowed into the cooler exchanges heat with air, evaporates, and becomes gas. At that time, the inside of the heat insulation casing 2 is cooled by the cooled air. After that, the evaporated low-temperature and low-pressure refrigerant in the gas state is sucked into the compressor.

[0020]

(Temperature Detector 4, Door Opening Detector 5)

The temperature detector 4 is disposed on each of the storage compartments 22 and is configured to detect the temperature of the corresponding storage compartment 22. One example of the temperature detector 4 may be a thermistor. The door opening detector 5 is disposed on each of the doors 14 and is configured to detect the opening of the corresponding door 14.

[0021]

(Storing Section 6)

The storing section 6 stores the number of times of door opening, that number being the number of times the door opening detector 5 detects the opening of the door 14, at each given time. One example of the given time may be one hour.

[0022]

(Controller 7)

The controller 7 is disposed inside the heat insulation casing 2. The controller 7 is configured to set a target temperature and to control the temperature adjuster 3 such that the temperature detected by the temperature detector 4 in the chill compartment 32 reaches the target temperature. One example of the controller 7 may be configured to control the opening degree of the damper 61, the output of the compressor, the amount of air blown by the air-blowing fan, and other factors. The controller 7 may be configured to control the temperature adjuster 3 such that the temperature detected by the temperature detector 4 in the storage compartment 22 other than the chill compartment 32 reaches the target temperature.

[0023]

Fig. 3 is a functional block diagram illustrating the controller 7 according to Embodiment 1. As illustrated in Fig. 3, the controller 7 includes a storing unit 71, a setting unit 72, a determining unit 73, a normal cooling unit 74, and a supercooling unit 75. The storing unit 71, the setting unit 72, the determining unit 73, the normal cooling unit 74, and the supercooling unit 75 are algorithms.

[0024]

(Storing Unit 71)

The storing unit 71 is configured to cause the storing section 6 to store the number of times of door opening at each given time. One example of the storing unit 71 may be executed every time when the door opening detector 5 detects the opening and closing of the door 14.

[0025]

(Setting Unit 72)

The setting unit 72 is configured to set a time zone in which the number of times of door opening stored in the storing section 6 at each given time is smaller than a threshold value, as an unused time zone. The unused time zone is a time zone in which the frequency of opening and closing of the door 14 is low. That is, during the unused time zone, it is estimated that because a user is sleep, is out, or for some other reason, there is no action of them inside a house. One example used as the number of times of door opening may be an average value of the numbers of times of door opening in the same time zone in days in the latest week, except for today. That is, one example of the setting unit 72 may update the unused time zone on the basis of the number of times of door opening in which the numbers of times of door opening in the latest week, including the number of times of door opening in the previous day, are averaged after midnight on a daily basis. The threshold value is a predetermined number of times, and one example may be 0.3. The unused time zone may be set in advance.

[0026]

(Determining Unit 73)

The determining unit 73 is configured to determine whether the time zone in which the controller 7 is performing processing is the unused time zone.

[0027]

(Normal Cooling Unit 74)

The normal cooling unit 74 is configured to set a normal temperature as the target temperature in a time zone other than the unused time zone. One example of the normal temperature may be a predetermined temperature of about 0 degrees C.

[0028]

(Supercooling Unit 75)

The supercooling unit 75 is configured to set a supercooling temperature as the target temperature in the unused time zone such that the temperature of an object is equal to or lower than a freezing point. The supercooling temperature is a temperature lower than the normal temperature, and one example of the supercooling temperature may be about -3 degrees C. The setting of the supercooling temperature continues for

a supercooling time. The supercooling time is a time having a length equal to or shorter than the length of the unused time zone.

[0029]

Fig. 4 is a flow chart illustrating the working of the controller 7 according to Embodiment 1. Fig. 5 illustrates line charts representing the numbers of times of door opening and the temperatures of the storage compartment 22 according to Embodiment 1. The upper line chart in Fig. 5 represents the progression of the average number of times of door opening for the latest week, except for today. The middle line chart represents the progression of the number of times of door opening detected today. The lower line chart represents the progression of the temperature inside the chill compartment 32. A process of setting the unused time zone by the controller 7 is described with reference to Fig. 4. First, the storing unit 71 causes the storing section 6 to store the number of times of door opening at each given time (step S1). Next, the setting unit 72 sets the unused time zone (step S2). In Embodiment 1, as illustrated in Fig. 5, 18:00 to 24:00 is set as the unused time zone.

[0030]

Fig. 6 is a flow chart illustrating the working of the controller 7 according to Embodiment 1. A process of cooling the chill compartment 32 by the controller 7 is described with reference to Fig. 6. First, the determining unit 73 determines whether the time zone in which the processing is being performed is the unused time zone (step S5). When that time zone is not the unused time zone (No at step S5), the normal cooling unit 74 sets the normal temperature as the target temperature (step S6). When that time zone is the unused time zone (Yes at step S5), the supercooling unit 75 sets the supercooling temperature as the target temperature (step S7). At that time, as illustrated in the lower row in Fig. 5, the temperature inside the chill compartment 32 decreases to the supercooling temperature in the unused time zone. Then, after the lapse of the supercooling time, the normal cooling unit 74 sets the normal temperature as the target temperature (step S6). The controller 7 repeats such a process at regular intervals.

[0031]

According to Embodiment 1, the refrigerator 1 cools an object, such as foods or other items, to a temperature equal to or lower than a freezing point in the unused time zone. In the unused time zone, a user does not frequently use the refrigerator 1. Thus, temperature changes caused by the opening and closing of the door 14 in the refrigerator 1 are small, and the foods or other items preserved in the refrigerator 1 remains in the supercooled state. Accordingly, the refrigerator 1 can operate such that the supercooled state of the preserved foods or other items is maintained and the freezing of those foods or other items is avoided.

[0032]

According to Embodiment 1, the controller 7 is configured to set the unused time zone by using the door opening detector 5. Therefore, the controller 7 can set the unused time zone in accordance with the usage of the refrigerator 1 based on a real life of the user. That is, in the unused time zone, the door 14 in the refrigerator 1 is less frequently opened or closed. Accordingly, the refrigerator 1 can more reliably operate such that the supercooled state of the preserved foods or other items is maintained and the freezing of those foods or other items is avoided.

[0033]

Embodiment 2

Fig. 7 is a functional block diagram illustrating a controller 107 Embodiment 2. As illustrated in Fig. 7, Embodiment 2 differs from Embodiment 1 in that the controller 107 includes an elevated temperature unit 176. In Embodiment 2, the same sections as those in Embodiment 1 have the same reference numerals, the description of them is omitted, and points of difference from Embodiment 1 are mainly discussed.

[0034]

(Controller 107)

In a refrigerator 101, the controller 107 further includes the elevated temperature unit 176. The elevated temperature unit 176 is algorithm.

[0035]

(Elevated temperature Unit 176)

The elevated temperature unit 176 is configured to set an elevated temperature as the target temperature in the unused time zone. The elevated temperature is a temperature exceeding the normal temperature, and one example thereof may be 2 degrees C. The setting of the elevated temperature continues for an elevated temperature time after the lapse of the supercooling time. The elevated temperature time is a predetermined time having a length equal to or shorter than the length of the unused time zone.

[0036]

Fig. 8 is a flow chart illustrating the working of the controller 107 according to Embodiment 2. Fig. 9 illustrates line charts representing the numbers of times of door opening and the temperatures of the storage compartment 22 according to Embodiment 2. The upper to lower line charts in Fig. 9 correspond to the upper to lower line charts in Fig. 5, respectively. A process of cooling the chill compartment 32 by the controller 107 is described with reference to Fig. 8. First, the determining unit 73 determines whether the time zone in which the processing is being performed is the unused time zone (step S15). When that time zone is not the unused time zone (No at step S15), the normal cooling unit 74 sets the normal temperature as the target temperature (step S16).

[0037]

When that time zone is the unused time zone (Yes at step S15), the supercooling unit 75 sets the supercooling temperature as the target temperature (step S17). At that time, as illustrated in the lower row in Fig. 9, the temperature inside the chill compartment 32 decreases to the supercooling temperature in the unused time zone. After the lapse of the supercooling time, the elevated temperature unit 176 sets the elevated temperature as the target temperature (step S18). At that time, as illustrated in the lower row in Fig. 9, the temperature inside the chill compartment 32 rises to the elevated temperature in the unused time zone. Moreover, after the lapse of the elevated temperature time, the normal cooling unit 74 sets the normal temperature as the target temperature (step S16). The controller 107 repeats such a process at regular intervals.

[0038]

According to Embodiment 2, the controller 107 includes the elevated temperature unit 176. Therefore, the refrigerator 101 raises the temperatures of the foods or other items by the end of the unused time zone. That is, the foods or other items preserved in the refrigerator 101 in a period of time other than the unused time zone are not frozen or are in a state where their freezing percentages are low. Accordingly, the refrigerator 101 can further reduce the time and trouble for thawing the foods or other items.

[0039]

Embodiment 3

Fig. 10 is a functional block diagram illustrating a controller 207 according to Embodiment 3. As illustrated in Fig. 10, Embodiment 3 differs from Embodiment 2 in that the controller 207 further includes a special setting unit 277, a special determining unit 278, a special supercooling unit 279, and a special elevated temperature unit 280. In Embodiment 3, the same sections as those in Embodiment 2 have the same reference numerals, the description of them is omitted, and points of difference from Embodiment 2 are mainly discussed.

[0040]

(Controller 207)

In a refrigerator 201, the controller 207 further includes the special setting unit 277, the special determining unit 278, the special supercooling unit 279, and the special elevated temperature unit 280. The special setting unit 277, the special determining unit 278, the special supercooling unit 279, and the special elevated temperature unit 280 are algorithms.

[0041]

(Special Setting Unit 277)

The special setting unit 277 is configured to set a day having a time zone in which the number of times of door opening stored in the storing section 6 is in a predetermined special threshold value range in a period of time other than the unused time zone, as a special control day. The special control day represents a day where a special temperature is set as the target temperature. Estimated examples of the

special control day may include holidays. One example of the special threshold value range may be a predetermined number of times, such as a range of not more than 0.5. The special setting unit 277 is executed at each given time. The special setting unit 277 may be executed every time the door opening detector 5 detects the opening and closing of the door 14. The special control day may be set in advance.

[0042]

(Special Determining Unit 278)

The special determining unit 278 is configured to determine whether the day the controller 207 is performing processing is the special control day. When the determining unit 73 determines that the time zone the controller 207 is performing processing is the unused time zone, the special determining unit 278 is executed. The special determining unit 278 may be executed subsequently to the execution of the special setting unit 277 at each given time.

[0043]

(Special Supercooling Unit 279)

The special supercooling unit 279 is configured to set a special supercooling temperature as the target temperature in the unused time zone in the special control day such that the temperature of an object is equal to or lower than a freezing point. The special supercooling temperature is a temperature that exceeds the supercooling temperature and that is lower than the normal temperature. The setting of the special supercooling temperature continues for a special supercooling time. The special supercooling time is a predetermined time having a length equal to or shorter than the length of the unused time zone.

[0044]

(Special Elevated Temperature Unit 280)

The special elevated temperature unit 280 is configured to set a special elevated temperature as the target temperature in the unused time zone in the special control day. The special elevated temperature is a temperature that exceeds the normal temperature and that is lower than the elevated temperature. The setting of the special elevated temperature continues for a special elevated temperature time after the lapse

of the special supercooling time. The special elevated temperature time is a predetermined time having a length equal to or shorter than the length of the unused time zone.

[0045]

5 Fig. 11 is a flow chart illustrating the working of the controller 207 according to Embodiment 3. Fig. 12 illustrates line charts representing the numbers of times of door opening and temperatures of the storage compartment 22 according to Embodiment 3. The upper to lower line charts in Fig. 12 correspond to the upper to lower line charts in Figs. 5 and 9, respectively. A process of setting the unused time zone and the special control day by the controller 207 is described with reference to Fig. 11. First, the storing unit 71 causes the storing section 6 to store the number of times of door opening at each given time (step S21). Next, the special setting unit 277 sets the special control day (step S22). As illustrated in the middle row in Fig. 12, because the number of times of door opening is zero in today's all time zones, today is set as the special control day. Lastly, the setting unit 72 sets the unused time zone (step S23). At that time, as illustrated in Fig. 12, 18:00 to 24:00 is set as the unused time zone.

[0046]

Fig. 13 is a flow chart illustrating the working of the controller 207 according to Embodiment 3. A process of cooling the chill compartment 32 by the controller 207 is described with reference to Fig. 13. First, the determining unit 73 determines whether the time zone in which the processing is being performed is the unused time zone (step S15). When that time zone is not the unused time zone (No at step S25), the normal cooling unit 74 sets the normal temperature as the target temperature (step S26).

[0047]

25 When that time zone is the unused time zone (Yes at step S25), the special determining unit 278 determines whether today is the special control day (step S27). When today is not the special control day (No at step S27), the supercooling unit 75 sets the supercooling temperature as the target temperature (step S28). Thus, as illustrated in Fig. 12, the temperature inside the chill compartment 32 decreases to the supercooling temperature in the unused time zone. After the lapse of the supercooling

time, the elevated temperature unit 176 sets the elevated temperature as the target temperature (step S29). Thus, as illustrated in Fig. 12, the temperature inside the chill compartment 32 rises to the elevated temperature in the unused time zone. Moreover, after the lapse of the elevated temperature time, the normal cooling unit 74 sets the normal temperature as the target temperature (step S26).

[0048]

When today is the special control day (Yes at step S27), the special supercooling unit 279 sets the special supercooling temperature as the target temperature (step S30). Thus, as illustrated in the lower row in Fig. 12, the temperature inside the chill compartment 32 decreases to the special supercooling temperature in the unused time zone. After the lapse of the special supercooling time, the special elevated temperature unit 280 sets the special elevated temperature as the target temperature (step S31). Thus, as illustrated in the lower row in Fig. 12, the temperature inside the chill compartment 32 rises to the special elevated temperature in the unused time zone. Moreover, after the lapse of the special elevated temperature time, the normal cooling unit 74 sets the normal temperature as the target temperature (step S26). The controller 207 repeats such a process at regular intervals.

[0049]

According to Embodiment 3, the controller 207 includes the special supercooling unit 279 configured to set the special supercooling temperature, which exceeds the supercooling temperature, as the target temperature. Typically, the probability of opening and closing the door 14 in the unused time zone in a special control day, such as a holiday, is higher than that on a normal day. Here, for the foods or other items that are not in the supercooled state, as the temperature is lower, they more easily leave the supercooled state when the door 14 is opened and closed. In Embodiment 3, as described above, the special supercooling temperature, which exceeds the supercooling temperature, is set as the target temperature. Thus, the foods or other items preserved in the refrigerator 201 are not easily frozen even when the door 14 is opened and closed. Accordingly, the refrigerator 201 can more reliably operate such

that the supercooled state of the preserved foods or other items is maintained and the freezing of those foods or other items is avoided.

[0050]

According to Embodiment 3, the controller 207 includes the special elevated temperature unit 280 configured to set the special elevated temperature, which is lower than the elevated temperature, as the target temperature. Typically, the probability of opening and closing the door 14 in the unused time zone in a special control day, such as a holiday, is higher than that on a normal day. In addition, while the temperature inside the storage compartment 22 is high, if the door 14 is opened and closed, the temperature of the foods or other items drastically rises, and thus their quality in preservation may degrade. Here, in Embodiment 3, as described above, the special elevated temperature, which is lower than the elevated temperature, is set as the target temperature. Accordingly, the refrigerator 201 can suppress the increase in temperature of the foods or other items preserved and can maintain their quality in preservation even when the door 14 is opened and closed.

[0051]

Each of the controller 7, the controller 107, and the controller 207 may be dedicated hardware or a CPU (central processing unit, also called a processing unit, an arithmetic unit, microprocessor, microcomputer, or processor) capable of executing a program stored in the storing section 6. When each of the controller 7, the controller 107, and the controller 207 is dedicated hardware, each of the controller 7, the controller 107, and the controller 207 may correspond to a single circuit, a composite circuit, an application specific integrated circuit (ASIC), a field-programmable gate array (FPGA), or combinations thereof. Each of the functional sections achieved by the controller 7, the controller 107, and the controller 207 may be achieved by individual hardware, or the functional sections may be achieved by one piece of hardware.

[0052]

When each of the controller 7, the controller 107, and the controller 207 is a CPU, the functions performed by the controller 7, the controller 107, and the controller 207 are achieved by software, firmware, or a combination of software and firmware. The

software and firmware are described as programs and are stored in the storing section 6. The CPU achieves the functions by reading the programs from the storing section 6 and executing them. Here, examples of the storing section 6 may include nonvolatile or volatile semiconductor memory, including random-access memory (RAM), read-only memory (ROM), flash memory, erasable programmable ROM (EPROM), and electrically erasable programmable ROM (EEPROM). Some of the functions of the controller 7, the controller 107, and the controller 207 may be achieved by dedicated hardware, and some other functions of them may be achieved by the software or firmware.

Reference Signs List

[0053]

1: refrigerator, 2: heat insulation casing, 3: temperature adjuster, 4: temperature detector, 5: door opening detector, 6: storing section, 7: controller, 11: outer casing, 12: inner casing, 13: heat insulator, 14: door, 15: division plate, 16: air channel, 17: storage space, 21: division member, 22: storage compartment, 31: refrigerator compartment, 32: chill compartment, 33: versatile compartment, 34: ice-making compartment, 35: vegetable compartment, 36: freezer compartment, 41: refrigerator compartment door, 42: food storage shelf, 43: versatile compartment door, 44: ice-making compartment door, 45: vegetable compartment door, 46: freezer compartment door, 51: setting action section, 52: food storage case, 61: damper, 71: storing unit, 72: setting unit, 73: determining unit, 74: normal cooling unit, 75: supercooling unit, 101: refrigerator, 107: controller, 176: elevated temperature unit, 201: refrigerator, 207: controller, 277: special setting unit, 278: special determining unit, 279: special supercooling unit, 280: special elevated temperature unit.

CLAIMS

[Claim 1]

A refrigerator comprising:

5 a heat insulation casing whose inside defines a storage compartment for storing an object, the heat insulation casing having a box shape and having a front covered with a door;

a temperature adjuster provided at the heat insulation casing and configured to adjust a temperature of the storage compartment;

10 a controller provided at the heat insulation casing and configured to control the temperature adjuster; and

a door opening detector provided at the heat insulation casing and configured to detect a number of times of door opening, the number of times of door opening representing a number of times the door is opened,

15 wherein the controller is configured to set a supercooling temperature as a target temperature in a unused time zone, the supercooling temperature being a temperature lower than a predetermined normal temperature, the target temperature being a temperature targeted in adjusting the temperature of the storage compartment by the temperature adjuster such that a temperature of the object is equal to or lower than a freezing point, the unused time zone representing a time zone in which a frequency of opening and closing the door is low,

20 wherein the controller is configured to set, as the unused time zone, a time zone in which the number of times of door opening detected by the door opening detector is lower than a threshold value, and

25 wherein the controller is configured to set a day having a time zone in which the number of times of door opening is in a predetermined special threshold value range in a period of time other than the unused time zone, as a special control day representing a day in which a special temperature is set as the target temperature.

[Claim 2]

30 The refrigerator of claim 1, wherein the controller is configured to set a special supercooling temperature as the target temperature in the unused time zone in the

special control day such that the temperature of the object is equal to or lower than the freezing point, the special supercooling temperature being a temperature that exceeds the supercooling temperature and that is lower than the normal temperature.

[Claim 3]

5 The refrigerator of claim 1 or 2, wherein the controller is configured to set an elevated temperature as the target temperature in the unused time zone after setting the supercooling temperature as the target temperature, the elevated temperature exceeding the normal temperature.

[Claim 4]

10 The refrigerator of claim 3, wherein the controller is configured to set a special elevated temperature as the target temperature in the unused time zone in the special control day, the special elevated temperature being a temperature that exceeds the normal temperature and that is lower than the elevated temperature.

[Claim 5]

15 A refrigerator comprising:

 a heat insulation casing whose inside defines a storage compartment for storing an object, the heat insulation casing having a box shape and having a front covered with a door;

 a temperature adjuster provided at the heat insulation casing and configured to
20 adjust a temperature of the storage compartment; and

 a controller provided at the heat insulation casing and configured to control the temperature adjuster,

 wherein the controller is configured to set a supercooling temperature as a target
25 temperature in a unused time zone, the supercooling temperature being a temperature lower than a predetermined normal temperature, the target temperature being a temperature targeted in adjusting the temperature of the storage compartment by the temperature adjuster such that a temperature of the object is equal to or lower than a freezing point, the unused time zone representing a time zone in which a frequency of opening and closing the door is low, and

wherein the controller is configured to set an elevated temperature as the target temperature in the unused time zone after setting the supercooling temperature as the target temperature, the elevated temperature exceeding the normal temperature.