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DESCRIPTION

REFREGERATOR

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TECHNBICAL FIELD

This invention relates to a refrigerator having functions related to cooking.

BACKGROUND ART

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A lot of research on food preservative function of refrigerator has been made for a refrigerator. Among the preservative function, many fast-freezing techniques have been developed for storing the food without sacrificing its quality, in which the food is quickly passed through a temperature zone of -1°C to -5°C a greatest ice-growing zone for the food. Meat and fish are thereby stored for a long time without dripping, securing a high preservative quality.

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Most recently, development of fast-cooling function of a hot food and a short-time-chilling function of beverage of a room temperature have been made, adding a preparatory cooking function to the refrigerator.

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As a conventional technology of a refrigerator for a cooking device, not for a preparatory cooking device, one can refer to Japanese Patent Unexamined Publication No. H4-73583. In this technology, a food material is frozen for a certain period of time and is immersed in seasoning liquid, and then temperature of the food is raised. With this treatment, the seasoning progressively impregnates into the food, and a pickle is made. Constitution of the cooking device is explained with reference to Fig. 13.

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Refrigerator 101 is divided into refrigerating compartment 102 and freezing compartment 103 by a dividing wall. Low-temperature cooking chamber 104 has shielding material 105 around its outer periphery, and its front

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opening portion is covered with hinged-type door 106. Cooling device 109 is composed of compressor 107 compressing refrigerant for liquidation and cooler 108 evaporating the liquidated refrigerant for cooling. Cool air produced by cooling device 109 is forcibly sent into low-temperature-cooking-chamber 104 through airflow-duct 111 by air-blower 110. Upper heater 112 and lower heater 113 are placed on upper side and lower side of low-temperature-cooking-chamber 104, constituting heating device 114.

Operating panel 116 is for setting up cooking temperature and time for each food material 115 in low-temperature-cooking-chamber 104. With this set up, an appropriate temperature management becomes possible for each food. Thus, when food material 115 is placed in low-temperature-cooking-chamber 104, and time and temperature for food material 115 is set with operating panel 116, the cool air produced in cooler 109 is circulated by air blower 110 inside low-temperature-cooking-chamber 104, freezing food material 115 for a predetermined period of time and causing plasmolysis of the food material, thereby preparing a condition where seasoning may impregnate into the food material. Succeeding, upper and lower heaters 112 and 113 of heating device 114 heat food material 115, facilitating the seasoning around the food impregnates into the food. Thus, freezing causes plasmolysis of the food without help of salt, and the seasoning impregnates into the food, making a sodium-reduced pickle. By creating an environment in which the seasoning material may easily impregnates into the food material, cooking time for the pickle is reduced.

However, in above conventional constitution, refrigerator's function is limited only to making a pickle, so a dead space is left when the pickle is not made, and a task of inefficient use of refrigerator space is remained.

Besides above, because the low-temperature-cooking-chamber is placed in the refrigerating compartment, time is requires to freeze the food, therefore a

user has to wait for long time to make the pickle.

Moreover, because the food is frozen then thawed, water content of the food is separated with the plasmolysis, running out of the food and start smelling.

Further, because the freeze/thaw cooking is limited only to make the pickle, the freeze/thaw cooking function is not effectively utilized for other food material or food.

Still further, because the heating devices are placed in upper and lower sides of the cooling chamber, power consumption for freeze/thaw cooking increases, making hard for the refrigerator to save energy.

SUMMARY OF THE INVENTION

According to an aspect of the present invention, there is provided a refrigerator comprising a cooling device; a heating device heating and thawing a food which is frozen or mildly frozen by the cooling device; and a freeze/thaw cooking compartment preserving the food after the cooling and the heating, wherein, the heating device is installed on a bottom inside the freeze/thaw cooking compartment, wherein, the freeze/thaw cooking compartment includes a case for placing a food for freeze/thaw cooking; and a space between the case and the heating device with a predetermined distance, wherein, the cooling device causes plasmolysis of the food consisting a freezing process, and the heating device softens the food plasmolyzed in the freezing process to get a predetermined cooking condition consisting a heating process, wherein, the refrigerator repeats at least one cycle of the freezing process and the thawing process.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a longitudinal view of a main portion of a refrigerator in accordance with exemplary embodiment 1 of the present invention.

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Fig. 2 is a longitudinal view of a main portion of a refrigerator in accordance with exemplary embodiment 2 of the present invention.

Fig. 3 is a front view of a refrigerator in accordance with exemplary embodiment 3 of the present invention.

Fig. 4 is a front view of a refrigerator in accordance with exemplary embodiment 4 of the present invention.

Fig. 5 is a longitudinal view of a main portion of a refrigerator in accordance with exemplary embodiment 5 of the present invention.

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Fig. 6 is a longitudinal view of a main portion of refrigerator in accordance with exemplary embodiment 6 of the present invention.

Fig. 7 is a longitudinal view of a main portion of a refrigerator in accordance with exemplary embodiment 7 of the present invention.

5 Fig. 8 is a longitudinal view of a main portion of a refrigerator in accordance with exemplary embodiment 8 of the present invention.

Fig. 9 is a longitudinal view of a main portion of a refrigerator in accordance with exemplary embodiment 9 of the present invention.

10 Fig. 10 is a front view of a refrigerator in accordance with exemplary embodiment 10 of the present invention.

Fig. 11 is a block diagram controlling the refrigerator in accordance with exemplary embodiment 10.

Fig. 12 is a timing chart showing actions in frosting and thawing cooking processes of the refrigerator in accordance with exemplary embodiment 10.

15 Fig. 13 is a longitudinal view of a conventional refrigerator.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Exemplary embodiment of a refrigerator in this invention is described hereinafter with reference to drawings. Detailed description of some
20 constitution is omitted so long as the constitution is the same as in a conventional refrigerator.

The refrigerator in this invention includes a refrigeration cycle composed of a refrigerant compressor, a refrigerant vaporizer and a heat exchanger, a heating material including a foam urethane maintaining a temperature in the
25 refrigerator, an air blower including a propel-fan and a sirocco-fan, a temperature sensor including a thermistor, and a control circuit controlling operation of the refrigerator based on predetermined temperature and time. However, because any of these constituent members are conventionally used,

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detailed illustration and operational description are excluded.

(Exemplary Embodiment 1)

Fig. 1 is a longitudinal view of a main portion of a refrigerator in accordance with exemplary embodiment 1 of the present invention.

5 As shown in Fig. 1, a drawer-type freeze/thaw cooking compartment 1 is equipped with door 2, and is surrounded by insulating material 3 around its peripheries. Case 4 is incorporated in freeze/thaw cooking compartment 1. Airflow duct 5 has damper 6 halfway inside airflow duct 5 and is openly
10 connected to freeze/thaw cooking compartment 1. Cool air produced in a refrigeration cycle (not illustrated) is discharged into the compartment out of cool air discharge mouth 7, constituting an air flow in the compartment.

In lower surface of freeze/thaw cooking compartment 1 is dividing part 8. In dividing part 8, heater 9 a heating device preferably an aluminum foil heater is embedded. As the heating device, a radiant heater or a magnetron
15 can be used as long as it is installed in a place other than on dividing part 8. Food 10 for being preserved or freeze/thaw cooked is placed on heat-transmitting plate 11 made of high thermal-conductive material such as aluminum. Sensor 13 controls temperature for cooling control and heating control.

20 Next, working principle of exemplary embodiment 1 of this invention is explained. Food 10 is placed on heat-transmitting plate 11 and stored in freeze/thaw cooking compartment 1. Food preserving temperature zones include a freezing temperature zone of about -18°C , a mild-freezing temperature zone of about -3°C , an ice temperature zone of about -1°C , a chilled temperature
25 zone of about 1°C , a refrigerating and vegetable preserving temperature zone of about 4°C , and a wine preserving temperature zone of 8°C .

The cool air produced in the refrigeration cycle (not illustrated) is sent in airflow duct 5 and is discharged out of discharge mouth 7 for cooling food 10.

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Damper 6 placed inside halfway of airflow duct 5 controls amount of cool air flow and maintains temperature inside the compartment within a preservative temperature for the object food.

Heater 9 placed in dividing part 8 is utilized as a temperature
5 compensator in the preservative function preventing temperature from falling
down by under-shooting especially at outside the freezing temperature zone.
The preservative function is preferably switchable so that it may select, not just
a single temperature zone, but one out of several temperature zones. When the
refrigerator is in a freeze/thaw cooking function, the cool air produced in the
10 refrigeration cycle (not illustrated), sent in airflow duct 5 and discharged out of
cool-air discharge mouth 7 freezes the food to be freeze/thaw cooked, then heater
9 placed in dividing part 8 thaws the food. When the freeze/thaw cooking
function is over, the function is switched over to the preservative function, where
the food can be preserved in one of the temperature zones out of the freezing
15 temperature zone of about -18°C , the mild-freezing temperature zone of about
 -3°C , the ice temperature zone of about -1°C , the chilled temperature zone of
about 1°C , the refrigerating and the vegetable preserving temperature zone of
about 4°C , and the wine preserving temperature zone of 8°C .

Next, the freeze/thaw cooking is specifically explained. Food 10 is placed
20 on heat-transmitting plate 11 and put in freeze/thaw cooking compartment 1.
The food is first cooled by the cool-air discharged through cool-air discharge
mouth 7 until its temperature falls down and freezes the food. With this
freezing treatment, moisture content in cellular tissue of food 10 is iced, and its
expanded-volume plasmolyzes the food. Following, supply of the cool-air from
25 discharge mouth 7 is stopped and heater 9 is energized. Heat-transmitting
plate 11 transmits the heat of heater 9 to food 10, and the food is defrosted.

Food 10 is softened, plasmolyzed by freezing and loosing the moisture
content of cellular tissue, and secures a prescribed cooking condition for the

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food is secured. The prescribed cooking condition is referred to a state where food 10, such as a fresh vegetable-cut of Chinese radish, Chinese cabbage, carrot, onion and cucumber, is dehydrated and softened as if it is rubbed with salt and exposed in water, but not dehydrated and softened by salt.

- 5 If food 10 is a meat-cut with seasoning around it, the condition is referred to a state where the meat-cut is softened and the seasoning may permeate the meat-cut.

- If food 10 is a dairy product including yogurt and raw-cream, the condition is referred to a state where moisture content is separated from solid
10 component so that the yogurt gets a new sensory taste like fresh cheese and the raw cream is ready to be processed into hand-made butter with little churning.

- As described, the cooling and heating cycle accelerates the impregnation of seasoning and water into food 10 so that a sodium-reduced pickle or a food with new sensory taste is simply prepared. Because the softening is easily
15 facilitated with the cooling and heating cycle, it becomes an effective preliminary cooking treatment before actual cooking, therefore cooking time is reduced and energy for heating and lighting is saved.

- The cooling and heating cycle needs to be repeated at least one time. But, because several times of repetition increases a degree of impregnation, an
20 appropriate number of cycling can be selected for food 10 for its kind and cooking purpose balancing a degree of impregnation, a desired sensory taste and a process time.

- An end temperature of cooling process is specified to be the freezing temperature zone. However, it is not always necessary to cool the food down to
25 -18°C, and freezing process can be suspended at a higher temperature in the freezing temperature zone, or at a temperature in the mild-freezing temperature zone (which is ordinarily -3 °C, but -1°C to -5°C depending on kind of food and chilling temperature of the food). An appropriate cooking condition at a higher

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temperature is obtained by choosing an ice-crystallization ratio of the food and a size of ice-crystal grown in the food. In this case, because freezing temperature is not extremely low, thawing is easy, therefore the repetition of freezing and thawing is also easy.

5 As described, the refrigerator in accordance with exemplary embodiment 1 of this invention effectively uses the cooling device cooling with the cool-air produced in the refrigeration cycle (not illustrated) and sent through airflow duct 5 to be discharged from cool-air discharge mouth 7, and the heating device heating with heater 9 accommodated in dividing part 8. Because both devices
10 are effectively used not only for the preservative function but also for the freeze/thaw cooking function, a refrigerator satisfying both the preservative function and the cooking function is provided, making a variety of meals available for people.

When a conventional refrigerator stores a hot food before cooled, the food
15 raises temperature of already existing food, so the user is recommended to cool the food before storing. However, because freeze/thaw cooking compartment 1 is surrounded by insulating material 13 preventing heat to radiate to other compartment, the hot food, such as rice just boiled and wrapped up or put in a lunch-box and stuff like a potato for salad or an onion for hamburger which need
20 rough heat removal, is stores straightforward in the compartment for cooling and for removing heat.

Thus, another function for cooling a hot food, as it is heated, is added. Freeze/thaw cooking compartment 1 efficiently utilized and an added value of the refrigerator is enhanced. Here, 'hot' stands for a temperature of 25°C or
25 more.

Heater 9 placed in dividing part 8 is used as a temperature compensator preventing a temperature drop in the preservative function, especially the temperature drop by under shooting outside the freezing temperature zone.

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But, the heater is also be utilized as a heating device in a defrosting function.

Being added the defrosting function, freeze/thaw cooking compartment 1 is much effectively utilized, further enhancing the added value of the refrigerator.

5 In addition to above, deodorizing device 50 installed in case 4 in freeze/thaw cooking compartment 1 removes an odor diffused from moisture-content separated from the food plasmolyzed by freezing and thawing. Deodorizing device 50 can be installed in any position as long as the device does not interfere with cool-air flow in case 4 and in freeze/thaw cooking
10 compartment 1. The device is preferably installed in an area where the cool-air is circulated such as in the mouth area where the cool-air is drawn into the compartment.

Still in addition, case 4 placed in freeze/thaw cooking compartment 1, being coated with an antimicrobial agent or made of a material including the
15 antimicrobial agent, prevents propagation of bacteria in the freeze/thaw cooked food. Any container specialized for freeze/thaw cooking function in the compartment prevents diffusion of the odor by controlling propagation of bacteria as long as it is coated with the antimicrobial agent or is made of the material including the antimicrobial agent, ensuring a long time preservation of
20 the food.

(Exemplary Embodiment 2)

Fig. 2 is a longitudinal view of a main portion of a refrigerator in accordance with exemplary embodiment 2 of the present invention. Fig. 2 shows freeze/thaw cooking compartment 1 is positioned on top of freezing
25 compartment 14, cooling device 15 is installed in a back side of freezing compartment 14, and fan 16 is installed in an upper part of cooling device 15.

In this constitution, fan 16 supplies cool-air produced by cooling device 15 with freeze/thaw cooking compartment 1 through airflow duct 5 and air

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discharge mouth 7. Because freeze/thaw cooking compartment 1 is positioned on top of freezing compartment 14 adjacent to freezing compartment 14, airflow duct 5 can be short therefore air flow resistance is small, so that the cool air is efficiently and sufficiently introduced into the compartment. This arrangement freezes a food fast during a cooling process of freeze/thaw cooking, thereby cooking cycle is shortened and cooking efficiency is enhanced.

(Exemplary Embodiment 3)

Fig. 3 is a front view of a refrigerator in accordance with exemplary embodiment 3 of the present invention. Fig. 3 shows that freezing-temperature-zone chamber 17 includes freezing-compartment 18, ice-making compartment 19, and freeze/thaw cooking compartment 1, and that refrigerating-temperature zone chamber 20 includes refrigerating compartment 21 and vegetable-storing compartment 22. First cooler 23 is accommodated in freezing-temperature-zone chamber 17 and second cooler 24 is accommodated in refrigerating-temperature zone chamber 20. First cooler 23 is set at an evaporation temperature of about -30°C , a low temperature to cool freezing-temperature-zone chamber 17, and second cooler 24 is set at an evaporation temperature between about -5°C and about -20°C , a relatively higher temperature to prevent dry up of inside the chamber and to enhance food preservative function.

In this constitution, freeze/thaw cooking compartment 1 is cooled by first cooler 23.

With this arrangement, because first cooler 23 having the lower evaporation temperature cools freeze/thaw cooking compartment 1, first cooler 23 conducts a freeze/thaw function as well as cooking function, while second cooler 24 enhances a food preservative function.

(Exemplary Embodiment 4)

Fig. 4 is a front view of a refrigerator in accordance with exemplary

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embodiment 4 of the present invention. Fig.4 shows that freeze/thaw cooking compartment 1 is installed between refrigerating compartment 21 and vegetable-storing compartment 22, freezing compartment 18 is placed under vegetable-storing compartment 22, first cooler 23 is accommodated in freezing compartment 18, and second cooler 24 is accommodated in refrigerating compartment 21.

In this constitution, freeze/thaw cooking compartment 1 is cooled by second cooler 24.

In this arrangement, because freeze/thaw cooking compartment 1 is cooled by second cooler 24, first cooler 23 is not influenced by heat caused in a heating process of the freeze/thaw cooking, so that degradation of quality of a food stored in freezing compartment 18, a temperature-rise-sensitive compartment, is prevented, and first cooler 23 is not required to have an extra cooling capacity particularly to prevent the degradation of the food quality.

In exemplary embodiment 4 of the present invention, freeze/thaw cooking compartment 1 is positioned in around a central part of the refrigerator, so that a user can easily put in and out a food without bending himself/herself, i.e., an easy-handling refrigerator is provided. Food material is often put in a bowl and immersed in liquid such as in seasoning and water, therefore a layout easy for the user to put in and out further increases their convenience.

(Exemplary Embodiment 5)

Fig. 5 is a longitudinal view of a main portion of a refrigerator in accordance with exemplary embodiment 5 of the present invention. Fig. 5 shows that fan 30 is installed in an upper inside of freeze/thaw cooking compartment 1 or in downwind of cool-air discharge mouth. The fan draws a cool-air from cool-air discharge mouth 7 into the compartment making a cool-air flow route.

In this constitution, fan 30 draws the cool air, which is produced in the

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refrigeration cycle (not illustrated) and discharged out of discharge mouth 7 going through airflow duct 5 and damper 6 in the duct 5, into freeze/thaw cooking compartment 1 and blows the air directly to food 10, composing an air flow route. Because fan 30 circulates the cool-air inside, uneven temperature distribution in freeze/thaw cooking compartment 1 is effectively minimized.

Fan 30 is rotated while heater 9 a heating device embedded in dividing part 8 is thawing the food. Installed in the upper side in freeze/thaw cooking compartment 1 and rotated during heating, fan 30 improves heat conductive ratio of food 10 and enhances heat exchange efficiency. Thus, freezing time and thawing time are reduced.

(Exemplary Embodiment 6)

Fig. 6 is a longitudinal view of a main portion of refrigerator in accordance with exemplary embodiment 6 of the present invention. Fig. 6 shows connecting duct 31 connects airflow duct 5 and a side part of fan 30 where cool-air is drawn.

In this constitution, the cool-air which is produced in the refrigeration cycle (not illustrated) and sent into airflow duct 5 through damper 6 in duct 5 is drawn into the compartment by fan 30 through connecting duct 31 without being lost, so cooling efficiency is improved and freezing time is reduced.

As illustrated in Fig. 6, by rotating fan 30 installed in an upper side in freeze/thaw cooking compartment 1, temperature inside freeze/thaw cooking compartment 1 is averaged. So, wherever temperature-control sensor 13 controlling temperature inside freeze/thaw cooking compartment 1 is installed, even in a place where the sensor does not directly touch case 4, temperature of food 10 can be detected. Even if freeze/thaw cooking compartment 1 is a drawer type, detective accuracy is maintained.

Temperature-control sensor 13 is a sensor to control the temperature inside freeze/thaw cooking compartment 1. Therefore, by temperature

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controlling all functions including a preservative function, a freeze/thaw function, a function for cooling a hot food as heated, and a defrosting function, constituent control components of sensor 13 can be simplified.

(Exemplary Embodiment 7)

5 Fig. 7 is a longitudinal view of a main portion of a refrigerator in accordance with exemplary embodiment 7 of the present invention. Fig. 7 shows that a drawer type of freeze/thaw cooking compartment 1 is equipped with door 2 and is surrounded by insulating material 3, and case 4 is incorporated in freeze/thaw cooking compartment 1. Airflow duct 5
10 incorporates damper 6 in half way of the duct, and is opened to freeze/thaw cooking compartment 1 for introducing cool-air produced by refrigeration cycle (not illustrated) into the compartment. The cool air is discharged from discharge mouth 7 constituting an air flow route.

On an bottom surface of freeze/thaw cooking compartment 1 is dividing
15 part 8. On dividing part 8, heater 9 a heating device preferably of an aluminum foil is embedded. Heat-transmitting plate 11 made of aluminum or other high thermal-conductive material places food 10 on it for freeze/thaw cooking or for storing. Space 12 is left between heater 9 and heat-transmitting plate 11 with a predetermined distance. Sensor 13 for
20 controlling temperature is for cooling control and heating control.

A working principle of exemplary embodiment of 7 is explained next. Food
10 is placed on heat-transmitting plate 11 and stored in freeze/thaw cooking compartment 1. The food is then frozen by cool-air which is produced by the refrigeration cycle (not illustrated), sent in airflow duct 5 and discharged out of
25 discharge mouth 7. By placing the food on heat-transmitting plate 11 composed of aluminum or other high thermal-conductive material, cooling efficiency of the food is improved thereby freezing time is reduced. After frozen, food 10 is thawed by heater 9 embedded on dividing part 8, where heat-

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transmitting plate 11 composed of aluminum or other high thermal-conductive material enhances conductivity of heat from heater 9, thereby improving heat efficiency, reducing thawing time, and minimizing inconsistencies in thawing food 10.

5 By repeating at least one cycle of freezing process and thawing process, an effective freeze/thaw cooking is achieved.

In the cooking process, because space 12 is left between heater 9 and heat-transmitting plate 11 with the predetermined distance, heat by heater 9 is not directly conveyed to heat-transmitting plate 11 but is indirectly conveyed to
10 the plate, which prevents heat to distribute unevenly or locally overheats the food. Therewith, inconsistent thawing of food 10 hardly occurs and a cooking quality is maintained.

As described, the refrigerator in exemplary embodiment of this invention includes the cooling device cooling the food with the cool-air produced in the
15 refrigeration cycle (not illustrated), sent in airflow duct 5 and discharged out of cool air discharge mouth 7, the heating device heating the food with heater 9 embedded in dividing part 8, and heat-transmitting plate 11 composed of high thermal-conductive material such as aluminum. Because the heat-transmitting plate is effectively used in the cooling process and the heating
20 process of the freeze/thaw cooking which are repeated at least one cycle, an efficient freeze/thaw cooking is realized, therewith freeze/thaw time is shortened and power consumption is saved.

Next, freeze/thaw cooking is specifically explained. Food 10 is place on heat-transmitting plate 11 and is stored in freeze/thaw cooking
25 compartment 1. First, the cool-air is introduced through discharge mouth 7 to cool food 10. Temperature of the food falls down until the food is frozen. At this freezing process, moisture-content in cellular tissue in the food is frozen and expanded volume of the moisture plasmolyzes the food. Then, supply of the

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cool air from discharge mouth 7 is stopped and heater 9 is powered allowing heat-transmitting plate 11 heated by heater 9 to convey the heat to food 10 for defrosting.

Food 10 is softened as it loses the moisture-content out of destroyed cells, and the prescribed cooking condition is secured to the food.

By repeating aforementioned cooling and heating process, impregnation of seasoning and water into food 10 is progressed, and a sodium-reduced pickle or a food having a new sensory taste is simply prepared. The softening of the food is easily made and it becomes a useful preliminary arrangement for actual cooking, reducing cooking time and saving heating and lighting energy.

(Exemplary Embodiment 8)

Fig. 8 is a longitudinal view of a main portion of a refrigerator in accordance with exemplary embodiment 8 of the present invention. Fig. 8 shows radiant heater 54 is placed in an upper part of freeze/thaw cooking compartment 1.

In this constitution, radiant heat from radiant heater 54 effectively irradiates food 10 in case 4. The heat also fills in case 4 and directly radiant heats food 10. At the same time, heating by air convection is facilitated. Therewith, heating capacity to the food 10 is increased and thawing time for the food is reduced in freeze/thaw cooking. As a heating device, a magnetron utilizing high-frequency heating can be used instead of radiant heater 54, with which thawing time is further reduced.

(Exemplary Embodiment 9)

Fig. 9 is a longitudinal view of a main portion of a refrigerator in accordance with exemplary embodiment 9 of the present invention. Fig. 9 shows that fan 30 is placed in an upper part of freeze/thaw cooking compartment 1. In this constitution, fan 30 draws cool-air coming through airflow duct 5 and discharged out of discharge mouth 7 into freeze/thaw cooking

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compartment 1 and directs the cool-air to food 10. Air in freeze/thaw cooking compartment 1 is thus circulated and cooling efficiency is improved and freezing time is reduced.

Heating efficiency is also improved, when heater 9 embedded in the
5 dividing part of the compartment is heating, by fan 30 blowing the hot-air onto food 10 and circulating the air in freeze/thaw cooking compartment 1, thereby improving heating efficiency and reducing thawing time. Thus, the food is efficiently frozen and thawed.

In above circumstances, the air in space 12 between heat-transmitting
10 plate 11 placing food 10 and heater 9 is forcibly circulated by fan 30. Because cooling and heating food 10 at its bottom is also progressed, freezing and thawing efficiency is further enhanced.

Fan 30 is driven only when freeze/thaw cooking function is working, but is stopped when preservative function other than the freeze/thaw function is
15 working, thereby food 10 is prevented from drying by useless circulation of the air in the compartment, and waste of electric power during the preservative function is avoided.

Fan 30 is not basically driven during the preservative function, yet may be driven for a short period of time when a certain predetermined condition is
20 met, such as when a certain period of stopping condition is over. Being occasionally rotated, fan 30 is prevented from being locked with dews and frosts grown to freeze around fan 30, therewith normal operation is secured and reliability of fan 30 is enhanced.

(Exemplary Embodiment 10)

25 Fig. 10 is a front view of a refrigerator in accordance with exemplary embodiment 10 of the present invention. Fig. 11 is a block diagram controlling freeze/thaw cooking process of the refrigerator in accordance with exemplary embodiment 10. Fig. 12 is a timing chart showing actions of the refrigerator in

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accordance with exemplary embodiment 10.

Figs. 10 to 12 show that operating button 57 is on operating panel 56 which controls freeze/thaw cooking function. Operating button 57 can be a touch switch composed of a liquid crystal panel.

5 When operating button 57 on operating panel 56 is pushed, at least one cycle of cooling process 58 and heating process 59 starts, with the cooling process freezing a food into frozen state with cold-air produced in refrigeration cycle (not illustrated), and the heating process thawing the food with a heating device (not illustrated) starts, followed by preserving process 60 preserving the food after
10 freeze/thaw cooked.

Timer 61 sets time for cooling process 58 and heating process 59. Temperature controlling sensor 62 for other chamber controls temperature in compartments other than freeze/thaw cooking compartment 1.

A working principle of exemplary embodiment 10 of this invention is
15 explained next. Hereinafter, a word 'about' before temperature indication stands for $\pm 2^{\circ}\text{C}$, and a tolerance in ambient temperature range is $\pm 2^{\circ}\text{C}$.

As is shown in Fig. 12, the food is first frozen in cooling process 58 with cool-air produced in refrigeration cycle (not illustrated), with food temperature reaches freezing temperature 64 after passing through maximum ice-crystal
20 growing zone 63 in about -1°C to -5°C . Some food material or food needs to be retained in freezing temperature 64 where plasmolysis rate is increased and effective freeze/thaw cooking is obtained.

In next heating process 59, the food is thawed by the heating device till the temperature goes up to an end of thawing-end-temperature zone 65.
25 Repeating above cooling process 58 and heating process 59 at least one time, the food frozen and thawed is preserved at preserving temperature zone 66 in preserving process 60. In this series of freeze/thaw cooking process, if freezing temperature of cooling process 58 is set at -5°C or less, most of the food gets

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sufficiently high ice-crystal growing ratio enough to be served for freeze/thaw cooking, so that it is not necessary to limit food material for pickle but a variety of food material can be cooked.

By specifying 30 minutes or more of cooling process time in maximum
5 ice-crystal growing zone 63 of about -1°C to -5°C , plasmolysis of the food material or the food in maximum ice-crystal growing zone 63 is facilitated, and freeze/thaw cooking efficiency is improved.

By setting freezing temperature of cooling process 58 at about -5°C , and thawing-ending-temperature zone 65 of heating process 59 at about 0°C , and
10 repeating cycle of cooling process 58 and heating process 59 at least one time between 0°C and 5°C , ice-growing in a kind of food material or a food which is hard to be plasmolyzed in the maximum ice-growing zone is facilitated so that the food material or the food is served for freeze/thaw cooking.

Thus, freeze/thaw cooking of the kind of food material or the food in so called
15 a mild-freezing is available.

By setting a temperature of preserving temperature zone 66 in preserving process 60 at about 0°C , the food after freeze/thaw cooking stays unfrozen so that the food is easily cooked, and the food after the freeze/thaw cooking can be preserved for long time.

20 In exemplary embodiment 10, cooling process 58 and heating process 59 are time-controlled by timer 61. Time control is an easier method than a temperature control method which senses an end of a process with temperature. Over time or short time processing caused by distribution of temperature sensing accuracy is thereby prevented and a uniform cooking is provided.

25 Time control with timer 61 is preferably added as a protective control means to the temperature sensing process control, therewith much stable freeze/thaw cooking quality can be maintained.

Furthermore, by enabling operating button 57 to input a kind of food and

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an amount of food, and to fix freezing temperature 64 and a number of cycle of cooling process 58 and heating process 59, the food material or the food for freeze/thaw cooking can be finely controlled, bringing about an appropriate freeze/thaw cooking effect.

5 Still more, by defining the food material or the food which is suitable for freeze/thaw cooking, and alerting a user the food material or the food not suitable for freeze/thaw cooking with a display on operating panel 56, waste of food by wrong cook can be prevented beforehand.

10 Still further more, equipped with a temperature rise preventing controller, a food in other compartment is prevented from being heated by heat of another food heated in the freeze/thaw cooking chamber. The controller in this case senses temperature rise of temperature control sensor 62 controlling temperature of other room, during a time when freeze/thaw cooking function is working, or at a time when the freeze/thaw cooking is over and cooked food is
15 stored for preservation; the controller then suspends freeze/thaw cooking function or inactivates cooling process 58 for controlling temperature rise in the other room. Because temperature rise of the other room is thus controlled, a storing quality of the refrigerator is maintained.

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INDUSTRIAL APPLICABILITY

This invention relates to a refrigerator having a cooking function of a food. The refrigerator is equipped with a freeze/thaw cooking compartment which cools and heats the food, and preserves the food in cold after the food is cooled and heated. A cooling feature of the refrigerator is thus efficiently utilized for
25 both a preservative function and a cooking function, increasing added-value of the refrigerator. A heating feature prevents the food from overheated while the food is thawed. Thus, the refrigerator efficiently freezes and thaws the food, contributing to an improvement of diet of people.

CLAIMS

1. A refrigerator comprising:

a cooling device;

a heating device heating and thawing a food which is frozen or mildly
5 frozen by the cooling device; and

a freeze/thaw cooking compartment preserving the food after the cooling
and the heating,

wherein, the heating device is installed on a bottom inside the freeze/thaw
cooking compartment,

10 wherein, the freeze/thaw cooking compartment includes:

a case for placing a food for freeze/thaw cooking; and

a space between the case and the heating device with a
predetermined distance.

15 Wherein, the cooling device causes plasmolysis of the food consisting a
freezing process, and the heating device softens the food plasmolyzed in the
freezing process to get a predetermined cooking condition consisting a heating
process,

Wherein, the refrigerator repeats at least one cycle of the freezing process
and the thawing process.

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2. A refrigerator as defined in claim 1,

further including a freezing compartment and a refrigerating
compartment,

25 wherein the freeze/thaw cooking compartment is located adjacent to the
freezing compartment.

3. A refrigerator as defined in one of claim 1 and claim 2,

wherein the cooling device includes a first cooler cooling the freezing compartment, and a second cooler cooling the refrigerating compartment,

wherein the first cooler cools the freeze/thaw cooking compartment.

- 5 4. A refrigerator as defined in one of the claims of claim 1 to claim 3,

wherein the freeze/thaw cooking compartment has the refrigerating compartment in an upper part of thereof, and the freezing compartment in a lower part thereof.

- 10 5. A refrigerator as defined in one of claim 1 and claim 2,

wherein the cooling device includes a first cooler cooling the freezing compartment and a second cooler cooling the refrigerating compartment,

wherein the second cooler cools the freeze/thaw cooking compartment.

- 15 6. A refrigerator as defined in one of the claims of claim 1 to claim5, further including:

a fan placed in an upper inside surface of the freeze/thaw cooking compartment circulating a cool air from the cooling device; and

a heating device placed in a lower inside surface of the freeze/thaw cooking compartment.

- 20 7. A refrigerator as defined in one of claims of claim 1 to claim6,

wherein the fan is installed in front of a cool air discharge mouth which is accommodated in a rear part the freeze/thaw cooking compartment.

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8. A refrigerator a defined in claim7, further including a connecting duct connecting the fan and the cool air discharge mouth.

9. A refrigerator as defined in one of the claims of claim 1 to claim 8, wherein the freeze/thaw cooking compartment includes a function to cool a heated food material or a heated food as heated.
- 5
10. A refrigerator as defined in one of the claims of claim 1 to claim 9, wherein the freeze/thaw cooking compartment includes a thawing function.
11. A refrigerator as defined in one of the claims of claim 1 to claim 10, further including a deodorizing device installed in the freeze/thaw cooking compartment.
- 10
12. A refrigerator as defined in one of the claims of claim 1 to claim 11, wherein a case accommodated in the freeze/thaw cooking compartment is rendered to antimicrobial treatment.
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13. A refrigerator as defined in claim 1, further including a heat-transmitting plate placed on a bottom of the case, with at least a surface of the plate contacting the food is made of a high thermal-conductive material.
- 20
14. A refrigerator as defined in claim 13, further including a heating device heating with one of radiant heat and high-frequency heat, in an upper part of the freeze/thaw cooking compartment.
15. A refrigerator as defined in one of claim 13 and claim 14,
- 25 further including a fan installed in an upper part of the freeze/thaw cooking compartment for circulating a cool air introduced from the cooling device and enhancing heat efficiency when the heating device embedded in a dividing

part is working.

wherein the fan is rotated only when freeze/thaw cooking function is working.

5 16. A refrigerator as defined in claim 15, wherein the fan is rotated for a fixed period of time in a preserving function other than the freeze/thaw cooking function, based on a predetermined condition.

17. A refrigerator as defined in one of claim 13 and claim 14, wherein a freezing
10 temperature of the freezing process is set at -5°C or less.

18. A refrigerator as defined in one of claim 1 and claim 14, wherein the freezing process and the thawing process is repeated in a neighborhood of 0°C and a neighborhood of -5°C .

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19. A refrigerator as defined in one of claim 13 and claim 14, wherein a period of time is established for the freezing process and the thawing process.

20. A refrigerator as defined in one of claim 13 and claim 14,
20 wherein a freezing temperature is established for each food material and food for freeze/thaw cooking in the freezing process,
wherein one of the freezing process is selectable.

21. A refrigerator as defined in one of claim 13 and claim 14, further including a
25 device telling an inappropriate food material or a food for the freeze/thaw cooking.

22. A refrigerator as defined in one of claim 13 and claim 14, further including a protective device protecting the refrigerating compartment and the freezing compartment from temperature rise when the food after freeze/thaw cooking is in preserved therein.

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23. A refrigerator as defined in claim 1, wherein the freeze/thaw cooking compartment freezes a food material or a food then soften the food material or the food.

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24. A refrigerator as defined in claim 23, wherein the food material or the food is preserved in frozen status.

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25. A refrigerator as defined in one of the claims of claim 23 and claim 24, wherein a freezing speed of at least 30 minutes of passing time in -1 to -5°C is specified for the freezing process.

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26. A refrigerator as defined in one of the claims of claim 23, claim 24 and claim 25, wherein the freezing process and the thawing process are repeated at least one cycle,

wherein the food after the thawing process is preserved in a preserving temperature zone in a neighborhood of 0°C.

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ABSTRACT

Food (10) is placed on heat-transmitting plate (11) in case (4) accommodated in freeze/thaw cooking compartment (1) of a refrigerator and is frozen by cool air drawn into an upper inside of the compartment through airflow duct (5), then the food is heated by heater (9) installed on a bottom inside of the compartment indirectly through space (12). This freezing and thawing cycle is repeated at least one time, therewith food (10) is impregnated with seasoning and water, and the food is preserved in cold as it is cooked. Thus, a refrigerator satisfying both a cooking function and a preserving function is provided.

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