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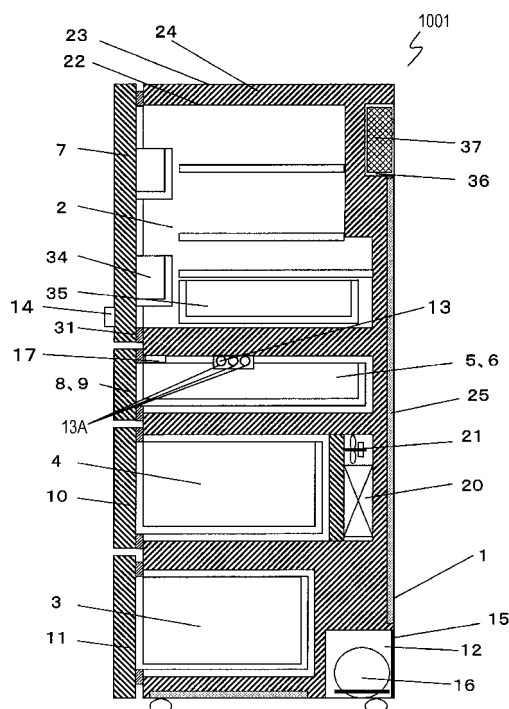
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(54) **REFRIGERATOR**

(57) A refrigerator includes a body having regions partitioned with a thermal insulating wall, a storage compartment provided in one of the regions, an illuminator provided in the storage compartment, and a controller operable to set a temperature of the storage compartment to a plurality of temperature ranges. The illuminator emits light having a plurality of colors. The controller is operable to select color from the colors corresponding to the set temperature range, and to allow the illuminator to emit light having the selected color. This refrigerator allows users to check the internal temperature of each compartment, and thus, to use the refrigerator conveniently.

Fig. 1



Description

TECHNICAL FIELD

[0001] The invention relates to a refrigerator.

BACKGROUND ART

[0002] In recent years, in order to meet various customer needs, refrigerators having high food preservability and high usability from the viewpoint of human engineering have been marketed widely.

[0003] Fig. 12 is a cross-sectional view of a conventional refrigerator disclosed in Japanese Patent Laid-Open Publication No.2000-186883. The refrigerator includes a body 1 having a thermal insulating structure. Body 1 includes refrigerating compartment 2 at the upper part thereof, lower freezing compartment 3 at the lower part thereof, vegetable compartment 4 adjacent to refrigerating compartment 2 and between refrigerating compartment 2 and freezing compartment 3, ice making compartment 5, switchable compartment 6 provided in parallel to ice making compartment and between vegetable compartment 4 and freezing compartment 3, hinged door 7 in front of refrigerating compartment 2, and drawer doors 8 that are provided in front of vegetable compartment 4, freezing compartment 3, ice making compartment 5, and switchable compartment 6 and that are pulled out together with containers.

[0004] This structure positions refrigerating compartment 2, which is used most frequently, at the same height as the eyes of a user, hence being used conveniently. A woman having an average height can take out food from vegetable compartment 4, which is second most frequently used, without bending her back. The woman having the average height can pull out drawer doors 8 of ice making compartment 5 and switchable compartment 6 and take out ice and food from the compartments, without bending her back, thus reducing physical load to the users.

[0005] This conventional refrigerator prevents the user to determine what kind of food is stored in each compartment and to check the internal temperature of each compartment. In particular, this refrigerator prevents the user to determine what kind of food is stored in the switchable compartment and to check the internal temperature of the switchable compartment which can be switched to plural temperatures, such as a refrigerating temperature, a freezing temperature, and an intermediate temperature between the refrigerating and freezing temperatures.

[0006] Fig. 13 is a front view of a conventional refrigerator disclosed in Japanese Patent Laid-Open Publication No.2002-13864. The refrigerator includes refrigerating compartment 502 at the uppermost part of a body, switchable compartment 506 below refrigerating compartment 502, ice making compartment 505 that is provided in parallel to switchable compartment 506 below refrigerating compartment 502 of the body; switchable

compartment 506, ice making compartment 507 parallel to the ice making compartment, switchable compartment 506, freezing compartment 503 provided at the lowermost part of the body, and vegetable compartment 504 between switchable compartment 506 and freezing compartment 503.

[0007] This structure positions refrigerating compartment 502, what is most frequently used, at the same height as eyes of a user, hence being used conveniently. A woman having an average height can take out food from vegetable compartment 4, which is second most frequently used, without bending her back. In addition, the woman having the average height can pull out drawer doors 508 of ice making compartment 505 and switchable compartment 506 and take out ice and food from the compartments without bending her back, thus reducing physical loads to the users. Thus, in the refrigerator, the layout of each compartment is determined based on their usage, hence allowing the user to use the refrigerator conveniently.

[0008] The conventional refrigerator prevents the user to determine what kind of food is stored in each compartment and to check the internal temperature of each compartment. In particular, in a storage compartment having plural regions having different temperatures, the user can hardly determine what kind of food is stored in each region and to check the temperature set to each region.

SUMMARY OF THE INVENTION

[0009] A refrigerator includes a body having regions partitioned with a thermal insulating wall, a storage compartment provided in one of the regions, an illuminator provided in the storage compartment, and a controller operable to set a temperature of the storage compartment to a plurality of temperature ranges. The illuminator emits light having a plurality of colors. The controller is operable to select color from the colors corresponding to the set temperature range, and to allow the illuminator to emit light having the selected color.

[0010] This refrigerator allows users to check the internal temperature of each compartment, and thus, to use the refrigerator conveniently.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Fig. 1 is a cross-sectional view of a refrigerator according to Exemplary Embodiment 1 of the present invention.

Fig. 2 is a cross-sectional view of a refrigerator according to Exemplary Embodiment 2 of the invention.

Fig. 3 is a cross-sectional view of a refrigerator according to Exemplary Embodiment 3 of the invention.

Fig. 4 is a cross-sectional view of an illuminator of the refrigerator according to Embodiment 3.

Fig. 5 is a cross-sectional view of a refrigerator ac-

cording to Exemplary Embodiment 4 of the invention.
 Fig. 6 is a cross-sectional view of a refrigerator according to Exemplary Embodiment 5 of the invention.
 Fig. 7 is a cross-sectional view of a refrigerator according to Exemplary Embodiment 6 of the invention.
 Fig. 8 is a cross-sectional view of a refrigerator according to Exemplary Embodiment 7 of the invention.
 Fig. 9 is a cross-sectional view of an illuminator of the refrigerator according to Embodiment 7.
 Fig. 10 is a cross-sectional view of a refrigerator according to Exemplary Embodiment 8 of the invention.
 Fig. 11 is a cross-sectional view of a storage case of the refrigerator according to Embodiment 8.
 Fig. 12 is a cross-sectional view of a conventional refrigerator.
 Fig. 13 is a front view of another conventional refrigerator.

REFERENCE NUMERALS

[0012]

1, 201	Body
2, 202, 302	Refrigerating Compartment
3	Freezing Compartment
4	Vegetable Compartment
6, 206, 306	Switchable Compartment (Storage Compartment)
12, 212	Machinery Compartment
13, 313	Illuminator (First Illuminator)
13A, 313A	Light Source
501, 601	Body
502	Refrigerating Compartment
512	Machinery Compartment
513	Illuminator
518	Thermal Insulator
519	Illuminator (First Illuminator)
535	Storage Case (Storage Compartment)
699	Illuminator (Second Illuminator)

DETAIL DESCRIPTION OF THE PREFERRED EMBODIMENTS EXEMPLARY EMBODIMENT 1

[0013] Fig. 1 is a cross-sectional view of refrigerator 1001 according to Exemplary Embodiment 1 of the present invention. Refrigerator 1001 includes body 1. Body 1 includes inner case 22, outer case 23, and thermal insulating wall 24 formed by injecting foam thermal insulator between inner case 22 and outer case 23. Inner case 22 is formed by forming rigid resin, such as ABS resin by vacuum forming. Outer case 23 is made of metal material, such as a pre-coat steel sheet. The foam thermal insulator employs, for example, rigid urethane foam, phenol foam, or styrene foam. The insulator may preferably employ hydrocarbon-based cyclopentane to prevent global warming.

[0014] Vacuum thermal insulator 25 is adhered securely onto the outer case with an adhesive, such as a

hot-melt adhesive, in a space between inner case 22 and outer case 23 before the thermal insulator is foamed. Vacuum thermal insulator 25 has a thin plane shape to be placed inside the wall thickness of body 1. The adhesive is coated on the entire surface of vacuum thermal insulator 25 to be prevented from having air mixed therein. Vacuum thermal insulator 25 is unitarily foamed with foam thermal insulator 24 to form body 1. Vacuum thermal insulator 25 has a thermal insulating performance that is 5 to 20 times higher than that of foam thermal insulator 24 to improve the thermal insulating performance of thermal insulating wall 24.

[0015] Body 1 is partitioned into plural thermal insulating regions having storage compartments therein, respectively. A hinged door is provided in an upper compartment, and a drawer door is provided in a lower compartment. Specifically, body 1 is partitioned into refrigerating compartment 2, switchable compartment 6, ice making compartment 5, vegetable compartment 4, and freezing compartment 3 in this order from the upper end thereof. Switchable compartment 6 and ice making compartment 5 are arranged laterally and have drawer shapes. Vegetable compartment 4 and freezing compartment 3 have drawer shapes. The thermal insulating regions are provided with insulating doors via gaskets 31, respectively. Hinged door 7 of refrigerating compartment 2, drawer door 8 of switchable compartment 6, drawer door 9 of ice making compartment 5, drawer door 10 of vegetable compartment 4, and drawer door 11 of freezing compartment 3 are provided in this order from the upper end of body 1.

[0016] Hinged door 7 of the refrigerating compartment has door pocket 34 functioning as a storage space. Plural shelves 8 are provided in the refrigerator. Storage case 35 is provided at the lowermost part of refrigerating compartment 2.

[0017] The temperature of refrigerating compartment 2 is generally set within the range from 1°C to 5°C having a lower temperature preventing food or other substances from freezing. However, a user can arbitrarily set the temperature of refrigerating compartment 2 according to the kind of items to be stored. The temperature of refrigerating compartment 2 may be set to a relatively high temperature of about 10°C to storing wine or root vegetables.

[0018] The internal temperature of storage case 35 is set to a relatively low temperature ranging from -3°C to 1°C to maintain freshness of meat, fish, and milk products. The temperature of vegetable compartment 4 is generally set to a temperature equal to or slightly higher than that of refrigerating compartment 2, that is, a temperature ranging from 2°C to 7°C. A lower internal temperature of vegetable compartment 4 maintains freshness of leaf vegetables for a longer time.

[0019] The user can change the internal temperature of switchable compartment 6. The internal temperature of switchable compartment 6 can be changed within a predetermined temperature range from the temperature of the freezing compartment to the temperature of the

refrigerating compartment and the vegetable compartment. The user activates operating panel 14 on hinged door 7 of the refrigerating compartment to adjust the internal temperature of switchable compartment 6. The internal temperature of switchable compartment 6 is detected by detector 17. Ice making compartment 5 is an independent box for storing ice. Refrigerator 1001 has an automatic ice maker automatically making ice, and stores the ice in ice making compartment 5. The internal temperature of ice making compartment 5 is set to a freezing temperature range to store ice. However, the internal temperature of ice making compartment 5 may be set in a temperature range slightly higher than the freezing temperature range just for storing ice.

[0020] The internal temperature of freezing compartment 3 is generally set in the range from -22°C to -18°C in order to freeze food. The internal temperature of freezing compartment 3 may be set in the range from -30°C to -25°C in order to keep freezing food in a better condition.

[0021] Body 1 includes machinery compartment 12 at a rear lower side thereof. Body 1 further includes machinery compartment 36 above machinery compartment 12.

[0022] A refrigeration cycle includes compressor 16 provided in machinery compartment 12, a condenser, a capillary, serving as a decompression device, and evaporator 20 which are connected to each other in a loop shape. Cooling fan 21 forcibly causes evaporator 20 to execute convection thermal exchange. The condenser may be cooled down forcibly with air from a fan. The condenser may be attached onto inside of outer case 23 to allow heat to transmit to the case to be cooled down with natural air. Alternatively, the condenser may be provided in a partition between thermal insulating doors and connected to a pipe for preventing water drops from entering.

[0023] Plural evaporators may be switched according to compartments or a set temperature by a flow controller, such as a motor-driven three-way valve, or plural capillaries may be switched. When compressor 16 stops, refrigerant gas may stop circulating.

[0024] Controller 37 for controlling the refrigeration cycle is sealed with a detachable cover and is arranged in machinery compartment 36. Machinery compartment 12 is substantially sealed with detachable rear cover 15.

[0025] Evaporator 20, a component of the refrigeration cycle, and cooling fan 21 are provided behind vegetable compartment 4 positioned at the middle part. This structure enlarges the volume and depth of freezing compartment 3, a storage compartment provided at the lowest part.

[0026] Vegetable compartment 4 at the middle part and freezing compartment 3 at the lowest part may be reversed, thereby enlarging the volume and depth of vegetable compartment 4.

[0027] Illuminator 13 is provided on a top surface in switchable compartment 6. Upon being turned on, illuminator 13 illuminates the inside of switchable compartment

6. When the user pulls out drawer door 8 to take out food from switchable compartment 6, light emitted from illuminator 13 leaks to the outside of switchable compartment 6, so that the user can recognize light and the color of the light. According to Embodiment 1, illuminator 13 includes plural light sources 13A emits lights having colors different from each other. Controller 37 turns on and off light sources 13A.

[0028] An operation of refrigerator 1001 will be described below.

[0029] First, an operation of the refrigeration cycle will be described below. The refrigeration cycle operates in response to signals output from controller 37 according to a set temperature to perform a cooling operation. Refrigerant having a high temperature and a high pressure is discharged from compressor 16. The refrigerant has its heat dissipated to change into liquid refrigerant by the condenser, and has its pressure reduced by the capillary, thus reaching evaporator 20 as liquid refrigerant having a low temperature and a low pressure.

[0030] The refrigerant in evaporator 20 is heat exchanged with air in the refrigerator sent by cooling fan 21, and is evaporated. A damper distributes cool air having a low temperature to the compartments to reduce the internal temperatures of the compartments. If the refrigerator includes plural evaporators or decompression devices, the flow controller supplies the refrigerant to evaporators 20 requiring the refrigerant. The refrigerant discharged from evaporator 20 is supplied to compressor 16. The refrigeration cycle operates repetitively to cool the inside of the refrigerator.

[0031] The internal temperature of switchable compartment 6 can be changed in several stages from a freezing temperature range to a refrigerating temperature range, according to the user's purpose or favorite. According to Embodiment 1, the internal temperature of switchable compartment 6 can be changed to a refrigerating temperature of 3°C, a freezing temperature of -18°C, a partial freezing temperature of -3°C which is an intermediate temperature between the refrigerating temperature and the freezing temperature, and a chilled temperature of 0°C. When the user activates operating panel 14 to change the temperature of switchable compartment

6, light sources 13A of illuminator 13 emit light having color predetermined corresponding to the temperatures,

[0032] Each of light sources 13A is implemented by a light-emitting diode (LED). LEDs which emit red light, green light, and blue light, respectively, are provided on a single board. The LEDs are controlled to switch up to seven colors of light.

[0033] The setting of the color of light emitted from illuminator 13 at each temperature is not limited. According to Embodiment 1, the color corresponding to a relatively high refrigerating temperature is determined to be green, which provides mild feeling, and the color corresponding to a relatively low freezing temperature is determined to be blue, which provides cool feeling. In ad-

dition, the color corresponding to an intermediate temperature, particularly, a partial freezing temperature for storing meat and fish is determined to be violet, which provides clean feeling. The color corresponding to a chilled temperature suitable for storing milk products or processed foodstuffs is determined to be white.

[0034] The change in the color of light according to the set temperature enables the user to visibly recognize the set temperature of switchable compartment 6 and the change of the temperature of switchable compartment 6. The color allows the user to realize what kind of food to be stored in switchable compartment 6 based on the color of light. Thus, the refrigerator 1001 facilitates the user to store food suitable for the set temperature of switchable compartment 6, thus preventing the user from being confused.

[0035] The color of light emitted from the illuminator makes the user feel that switchable compartment 6 is clean and that the food stored in switchable compartment 6 is effectively refrigerated, thereby satisfying the user to refrigerator 1001.

[0036] The wavelength of light emitted from illuminator 13 is not limited. If the light emitted from illuminator 13 includes ultraviolet ray, the ultraviolet ray can inactivate genes of microorganisms that are floating in the storage compartment or deposited onto the wall of the storage compartment or the surface of food, and the proliferation of microorganisms. This operation maintains the hygienic conditions in the storage compartment, and delays the discoloration, foul odor, and slime on the surface of food caused by microorganisms. Therefore, refrigerator 1001 can improve the preservability of food with the light including ultraviolet ray emitted from illuminator 13, and sanitarily store food.

[0037] Some kinds of mushrooms and fishes contain a lot of precursors of vitamin D. Ultraviolet ray is emitted to the precursors, and excites molecules of the precursors to cause the precursors to transform into vitamin D. Thus, refrigerator 1001 can store food while increasing the content of vitamin D in specific food stored in the storage compartment with illuminator 13 emitting ultraviolet ray.

[0038] Light source 13A may be a fairy lamp, a light-emitting diode, a fluorescent lamp, or an ultraviolet lamp, but is not limited. The light-emitting diode generates little heat and has a low running cost, high durability, and high compatibility, thus being preferable.

[0039] Plural light sources 13A in a single compartment may be placed at one position, or may be placed at different positions.

[0040] In refrigerator 1001 according to Embodiment 1, illuminator 13 may emit light having color different from ordinary color when the internal temperature of switchable compartment 6 increases due to the opening of the door. That is, controller 37 controls illuminator 13 to emit light having one of plural colors until a predetermined period of time elapses after the door opens. When the predetermined period of time elapses after the door

opens, controller 37 controls illuminator 13 to emit light having color different from the previous color. The door is opened for a long time and raises the internal temperature of the storage compartment, accordingly affecting food stored in the storage compartment. In particular, in the storage compartment having its set temperature below zero, when the door is opened for a long time and raises the temperature, water in frozen food evaporates. Then, if the opened door is closed, the evaporating water is frozen again, hence causing the food to be covered with frost. In this case, the quality of food, such as the outward appearance, taste, and the texture of food, deteriorates. The door is opened for a long time when food is put into the refrigerator or is taken out from the refrigerator, or when the user forgets to close the door of the refrigerator. Particularly when the user forgets to close the door, the door often opens for a long time. In addition to a conventional alarm sound notifying that the door of the refrigerator opens, a visible alarm with illuminator 13 can be used to notify that the door of the refrigerator opens for a long time.

[0041] Detector 17 detects the internal temperature of the storage compartment. When the internal temperature of the storage compartment rise, controller 37 changes the color of light emitted from illuminator 13 to predetermined color as to notify the user that the door opens for a long time. This operation prevents the quality of items, such as food or ice, stored in the storage compartment from deteriorating, and prevents an increase of power consumption required to return the internal temperature immediately before the door is opened, thereby reducing consumed energy.

[0042] The color of light emitted from illuminator 13 that notifies the user of the rising of the internal temperature of the storage compartment is not limited to the predetermined color. According to color dynamics, a red-dish color is suitable for representing caution, warning, and danger, and is noticeable to the human eyes. Thus, the color is preferably red.

[0043] If illuminator 13 emits yellow light, the user recognizes the opening of the door easily since yellow is noticeable to the human eyes. Since both a visually handicapped person and a normal person can view yellow as the same color, illuminator 13 emitting yellow light can be used for both the visually handicapped person and the normal person, hence providing a convenient refrigerator 1001.

[0044] Illuminator 13 is controlled by controller 37 based on the detection result of by detector 17. A temperature sensor may be used as detector 17. In this case, when the temperature sensor detects a predetermined temperature, controller 37 changes the color of light emitted from illuminator 13 based on the detected temperature. Detector 17 may be a door switch for detecting the opening or closing of the door. In this case, when the door switch detects the opening of the door, the controller may change the color of light after a predetermined time has elapsed.

[0045] In refrigerator 1001 according to Embodiment 1, switchable compartment 6 is positioned under refrigerating compartment 2 and above vegetable compartment 4 and freezing compartment 3. This layout enables a woman having an average height to open the door of switchable compartment 6 and to take out food from switchable compartment 6 without bending her back, thus providing a convenient refrigerator 1001. In addition, a woman having an average height can open vegetable compartment 4, which is frequently used, and put a heavy vegetable into vegetable compartment 4 and take it out from vegetable compartment without bending her back. This layout allowing the user to conveniently use vegetable compartment 4 can reduce physical load on the user for using refrigerator 1001.

[0046] According to Embodiment 1, considering the usability of the refrigerator, a hinged door is used for the refrigerating compartment, and drawer doors are used for the other compartments. However, the invention is not limited thereto.

[0047] In switchable compartment 6 of refrigerator 1001 according to Embodiment 1, the color of the light emitted from illuminator 13 allows the user to realize what kind of items is stored in switchable compartment 6 and to recognize the set temperature, thus providing convenient refrigerator 1001.

[0048] According to Embodiment 1, the color of light emitted from illuminator 13 changes according to the internal temperature of switchable compartment 6 and a set temperature range. Detector 17 such as a temperature sensor may detect the internal temperature of switchable compartment 6. Controller 37 may control illuminator 13 to emit predetermined color light based on the detected temperature,

[0049] According to Embodiment 1, illuminator 13 is provided in switchable compartment 6 capable of switching a temperature range. For example, illuminator 13 may be provided in freezing compartment 3 or vegetable compartment 4, and controller 37 may control illuminator 13 to emit light having predetermined color corresponding to adjustable temperature ranges of the compartments. This structure can notify the user of the adjustable temperature so as to prevent overcooling and reduce energy consumption, hence providing a convenient refrigerator.

[0050] Further, illuminator 13 does not necessarily emit light having plural colors, but may emit light having only predetermined color corresponding to the internal temperature of the storage compartment or to the image of food stored in the storage compartment. Alternatively, illuminators 13 for emitting different color may be provided in the storage compartments. In this case, each illuminator 13 may emit light having color selected corresponding to each set temperature range of each storage compartment.

EXEMPLARY EMBODIMENT 2

[0051] Fig. 2 is a cross-sectional view of refrigerator

2001 according to Exemplary Embodiment 2 of the present invention. Illuminator 213 is provided in switchable compartment 206. Machinery compartment 212 housing main components of a refrigeration cycle, such as compressor 216 and a condenser, is provided at the rear part of body 201 and above refrigerating compartment 202.

[0052] In a conventional refrigerator, the machinery compartment is arranged behind freezing compartment 203, which is located at the lowest part of body 201, hence reducing the volume of freezing compartment 203. According to this embodiment, machinery compartment 212 is provided at the rear upper part of refrigerating compartment 202, which is not used effectively in the conventional refrigerator. This structure allows a space corresponding to the machinery compartment in the conventional refrigerator to be used as a storage compartment, hence increasing the volume of freezing compartment 203 without increasing the size of the refrigerator.

[0053] In the conventional refrigerator, in order to compensate for the insufficient volume of freezing compartment 203 located at the lowest part of body 201, the internal temperature of switchable compartment 206 is frequently set to a freezing temperature. According to this embodiment, the volume of freezing compartment 203 is large, and accordingly, switchable compartment 206 can be used for various purposes other than freezing, hence allowing the user to store food in a wider temperature range. Thus, switchable compartment 206 can be used for various purposes according to circumstances, and effectively utilizes the function of notifying the user of the change of the temperature based on the color of light emitted from illuminator 213.

EXEMPLARY EMBODIMENT 3

[0054] Fig. 3 is a cross-sectional view of refrigerator 3001 according to exemplary Embodiment 3 of the present invention. In refrigerator 3001, illuminator 313 is provided on a ceiling surface of switchable compartment 306, and operating panel 314 is provided on inner wall 302A of refrigerating compartment 302.

[0055] Fig. 4 is a cross-sectional view of illuminator 313 provided in switchable compartment 306. Illuminator 313 includes light-emitting diode (LED) 326 that emits ultraviolet ray having a peak wavelength of 387 nm, LED 327 that emits blue light having a peak wavelength of 468 nm, board 328 having LEDs 326 and 327 and controller 328A mounted thereon, and cover 329 that covers LEDs 326 and 327 and board 328. Illuminator 313 is provided on the ceiling surface of switchable compartment 306 at a substantially central portion of switchable compartment 306 or a position leaning to the front side from the central portion. LEDs 326 and 327 emit light in a downward direction. Cushion 330 provided between cover 329 and switchable compartment 306, and projections 331A and 331B provided around cover 329 prevent water drops from entering.

[0056] In refrigerator 3001, only when the internal temperature of switchable compartment 306 is set to a low temperature range, such as a chilled temperature range, a freezing temperature, or a partial freezing temperature range from 0°C to -7°C through operating panel 314, controller 328A turns on LEDs 326 and 327, but does not turn on LEDs 326 and 327 in a temperature range that is higher than the low temperature range.

[0057] The chilled temperature range, the freezing temperature, or the partial freezing temperature range from 0°C to 7°C is used for storing items having a short shelf life, such as milk products, meat, or fishes while the items are partially frozen between a frozen state and a non-frozen state. These temperature ranges allows the items to be stored in the switchable compartment for a longer time than in a refrigerating temperature range and to be cooked easier than those in the refrigerating temperature range. For example, the items stored at these temperature ranges can be easy to cut with a knife. However, in these temperature ranges, food seems to be frozen, but the percentage of the food that is actually frozen is considerably lower than that in the freezing temperature range. In the food, an enzyme reaction, a lipid oxidation reaction, and the proliferation of microorganisms are progressed, and the quality of food deteriorates with time. Therefore, fresh foods stored in these temperature ranges need to be used within one or two weeks. However, since the food seems to be frozen, the user may consider that the food stored in these temperature ranges can be stored as long as frozen food, and stores the food in the switchable compartment for a long time, hence causing the food to be decayed.

[0058] In order to solve these problems, in refrigerator 3001 according to Embodiment 3, when the internal temperature of switchable compartment 306 is set within the freezing temperature range, controller 328A does not turn on illuminator 313. However, only when the internal temperature of switchable compartment 306 is set within the chilled temperature range, the freezing temperature, or the partial freezing temperature range that is higher than the freezing temperature range, controller 328A turns on illuminator 313. When illuminator 313 illuminates switchable compartment 306, the user recognizes that the internal temperature of switchable compartment 306 is set to a low temperature suitable for storing, for example, fresh foods for a short time. That is, the user can visually recognize whether the temperature of switchable compartment 306 is set to the freezing temperature or a low temperature based on light emitted from the illuminator. In the low temperature range in which illuminator 313 is turned on, the food is prevented from being left for a long time, and accordingly eliminates waste of food, hence providing convenient refrigerator 3001.

[0059] Illuminator 313 includes LED 326 emitting ultraviolet ray and LED 327 emitting blue light, and emits purplish blue light in switchable compartment 306. This purplish blue light makes the user feel that switchable compartment 306 is a clean storage compartment suit-

able for storing meat or fishes.

[0060] The ultraviolet ray emitted from LED 326 influences genes of microorganisms that are floating in switchable compartment 306 or deposited to the wall surface of switchable compartment 306 or the surface of food, and inactivates the proliferation of microorganisms. Thus, the refrigerator can maintain hygienic conditions in the storage compartment, and thus delay the discoloration, foul odor, and slime on the surface of food caused by microorganisms. Therefore, illuminator 313 emitting the ultraviolet ray improves the preservability of food and sanitarily stores food.

[0061] In general, ultraviolet ray emitted to food for a long time facilitates lipid oxidation of the food, and may cause the quality of the food to deteriorate. However, the ultraviolet ray is emitted to meat or fishes for a short time, such as one or two weeks, and hence, does not cause serious problems. In addition, illuminator 313 includes an LED, which emits an amount of light smaller than that emitted from other kinds of lamps, accordingly reducing the effect of light on the lipid oxidation. Since the LED generates little heat, light emitted from the LED affects less on cooling efficiency than other kinds of lamps.

[0062] Illuminator 313 is provided at a substantially central portion of switchable compartment 306 or at a position leaning to the front from the half of the depth of switchable compartment 306. This arrangement allows visible light emitted from illuminator 313 to reach the front side easily. When drawer door 308 of switchable compartment 306 is pulled out, a large amount of light is emitted to the outside, hence being recognized by the user easily.

[0063] According to Embodiment 3, in order to diffuse light in switchable compartment 306, illuminator 313 is placed at the substantially central portion of the ceiling surface of the switchable compartment, such that an illumination surface of illuminator 313 faces downward. Therefore, light can be emitted to the entire bottom of the switchable compartment.

[0064] In addition, in order to emit light to every portion of switchable compartment 6, a portion of cover 329 is provided with fine irregularities on the surface thereof to have a polarizing function, thereby easily diffusing light. Alternatively, a process providing the cover with the polarizing function, a polarizing plate, and a transparent portion may be provided in cover 329 to diffuse light as to allow the light to reach places the light can hardly reach.

[0065] Furthermore, cover 329 includes protruding portion 329C protruding from ceiling surface 306A of the switchable compartment. Protruding portion 329C diffuses light in lateral directions in the refrigerator, thereby allowing light to reach the places the light can hardly reach.

[0066] The light diffused in the refrigerator is recognized by the user easily. In addition, when the user views blue light illuminating the inside of the refrigerator, the visible effect of blue makes the user feel that switchable compartment 206 is a clean compartment that is suitable

for storing meat and fishes, thus improving the impression of the refrigerator.

[0067] Protruding portion 329C includes flat portion 329A and slanting portion 329B provided around flat portion 329A. Flat portion 329A is directly under LEDs 326 and 327. Light is emitted through flat portion 329A to a portion directly under illuminator 313. Light is emitted from the illuminator in the horizontal direction through slanting portion 329B. Alternatively, flat portion 329A may have a portion having a polarizing function, and slanting portion 329B may be formed of a transparent cover having high light-transmittance. This structure diffuses light in the horizontal direction in the refrigerator.

[0068] The fine irregularities among processes providing the polarizing function makes the inside of the cover invisible more than transparent cover 329, and makes the controller and wires connected to the controller invisible. This structure facilitates the diffusing of light due to the polarizing effect. The fine irregularities are provided on the portion of the surface of the cover the user easily sees to prevent the user from seeing the inside of cover 329, thus improving the impression of illuminator 313.

[0069] A material of cover 329 of illuminator 313 is not limited to a specific material, and may preferably be resin having high light-transmittance and durability for ultraviolet ray. A position to which the fine irregularities are provided to have a polarizing function is determined, so that the user cannot see board 328 in the cover. This improves the appearance of illuminator 313 and impression of switchable compartment 306 including illuminator 313.

[0070] Illuminator 313 is provided on ceiling surface 306A of switchable compartment 306, hence being prevented from being contaminated and from being directly seen by the user.

EXEMPLARY EMBODIMENT 4

[0071] Fig. 5 is a cross-sectional view of refrigerator 5001 according to Exemplary Embodiment 4 of the present invention. Body 501 includes outer case 523, inner case 522 in outer case 523, and thermal insulating wall 524 formed by injecting foam thermal insulator between inner case 522 and outer case 523. Inner case 522 is formed by forming rigid resin, such as ABS resin by vacuum forming. Outer case 523 is made of metal material, such as a pre-coat steel sheet. The foam thermal insulator employs, for example, rigid urethane foam, phenol foam, or styrene foam. The insulator may preferably employ hydrocarbon-based cyclopentane to prevent global warming.

[0072] Vacuum thermal insulator 525 is adhered securely onto the outer case with an adhesive, such as a hot-melt adhesive, in a space between inner case 522 and outer case 523 before the thermal insulator is foamed. Vacuum thermal insulator 525 has a thin plane shape to be placed inside the wall thickness of body 501. The adhesive is coated on the entire surface of vacuum thermal insulator 525 to be prevented from having air

mixed therein. Vacuum thermal insulator 525 is unitarily foamed with foam thermal insulator 524 to form body 501. Vacuum thermal insulator 525 has a thermal insulating performance that is 5 to 20 times higher than that of foam thermal insulator 524 to improve the thermal insulating performance of thermal insulating wall 524.

[0073] Body 501 is partitioned into plural thermal insulating regions having storage compartments therein, respectively. A hinged door is provided in an upper compartment, and a drawer door is provided in a lower compartment. Switchable compartment 506 and ice making compartment 505 are arranged laterally and have drawer shapes. The thermal insulating regions are provided with insulating doors via gaskets 532, respectively. Hinged door 507 of refrigerating compartment 502, drawer door 508 of switchable compartment 506, drawer door 509 of ice making compartment 505, drawer door 510 of vegetable compartment 504, and drawer door 511 of freezing compartment 503 are provided in this order from the upper end of body 1.

[0074] Hinged door 507 has door pocket 34 functioning as a storage space. Plural shelves 588A to 588C are provided in the refrigerator. Storage case 535 partitioned with a resin cover is provided under storage shelf 588C located at the lowest position.

[0075] Illuminator 519 is provided in refrigerating compartment 502, and illuminator 513 is provided in storage case 535.

[0076] The temperature of refrigerating compartment 502 is generally set within the range from 1°C to 5°C having a lower temperature preventing food or other substances from freezing. However, a user can arbitrarily set the temperature of refrigerating compartment 502 according to the kind of items to be stored. The temperature of refrigerating compartment 2 may be set to a relatively high temperature of about 10°C to storing wine or root vegetables.

[0077] The internal temperature of storage case 535 is set to a relatively low temperature ranging from -7°C to 10°C to maintain freshness of meat, fish, and milk products. The temperature of vegetable compartment 504 is generally set to a temperature equal to or slightly higher than that of refrigerating compartment 502, that is, a temperature ranging from 2°C to 7°C. A lower internal temperature of vegetable compartment 504 maintains freshness of leaf vegetables for a longer time.

[0078] The user can change the internal temperature of switchable compartment 506. The internal temperature of switchable compartment 506 can be changed within a predetermined temperature range from the temperature of the freezing compartment to the temperature of the refrigerating compartment and the vegetable compartment. Ice making compartment 505 is an independent box for storing ice. Refrigerator 1001 has an automatic ice maker automatically making ice, and stores the ice in ice making compartment 505. The internal temperature of ice making compartment 5 is set to a freezing temperature range to store ice. However, the internal

temperature of ice making compartment 5 may be set in a temperature range slightly higher than the freezing temperature range just for storing ice.

[0079] The internal temperature of freezing compartment 503 is generally set in the range from -22°C to -18°C in order to freeze food. The internal temperature of freezing compartment 503 may be set in the range from -30°C to -25°C in order to keep freezing food in a better condition.

[0080] Operating panel 514 is provided on the inner wall of refrigerating compartment 502. The user can activate the operating panel to change the temperature of each storage compartment.

[0081] Body 501 has machinery compartment 512 behind freezing compartment 503. Body 501 further has machinery compartment 536 at the rear side above machinery compartment 512.

[0082] A refrigeration cycle includes compressor 516 provided in machinery compartment 512, a condenser, a capillary, serving as a decompression device, and evaporator 520 which are connected to each other in a loop shape. Cooling fan 521 forcibly causes evaporator 520 to execute convection thermal exchange. The condenser may be cooled down forcibly with air from a fan. The condenser may be attached onto inside of outer case 523 to allow heat to transmit to the case to be cooled down with natural air. Alternatively, the condenser may be provided in a partition between thermal insulating doors and connected to a pipe for preventing water drops from entering.

[0083] Refrigerator 5001 may include a flow controller, such as a motor-driven three-way valve. The flow controller controls the switching between plural evaporators or plural capillaries according to storage compartment or a set temperature. When compressor 16 stops, refrigerant gas may stop circulating.

[0084] Controller 537 for controlling the refrigeration cycle is sealed with a detachable cover and is arranged in machinery compartment 536. Machinery compartment 512 is substantially sealed with detachable rear cover 515.

[0085] Evaporator 520, a component of the refrigeration cycle, and cooling fan 521 are provided behind vegetable compartment 504 positioned at the middle part. This structure enlarges the volume and depth of freezing compartment 503, a storage compartment provided at the lowest part.

[0086] Vegetable compartment 504 at the middle part and freezing compartment 503 at the lowest part may be reversed, thereby enlarging the volume and depth of vegetable compartment 504.

[0087] Illuminator 519 is provided in the back of refrigerating compartment 502. Illuminator 513 is provided on the ceiling surface of storage case 535. Illuminators 519 and 513 illuminate entire of refrigerating compartment 502 and an inside of storage case 535, respectively. When the user opens hinged door 507 of refrigerating compartment 502, the user can see light emitted from

illuminators 519 and 513. The temperature in refrigerating compartment 502 is constant, and the color of light emitted from illuminator 519 does not change. The internal temperature of storage case 535 can be changed. Illuminator 513 includes plurality light sources 513A emitting lights having different colors. Light sources 513A are turned on or off by controller 537.

[0088] An operation of refrigerator 5001 will be described below.

[0089] First, an operation of the refrigeration cycle will be described below. The refrigeration cycle operates in response to signals output from controller 537 according to a set temperature to perform a cooling operation. Refrigerant having a high temperature and a high pressure is discharged from compressor 516. The refrigerant has its heat dissipated to change into liquid refrigerant by the condenser, and has its pressure reduced by the capillary, thus reaching evaporator 520 as liquid refrigerant having a low temperature and a low pressure.

[0090] The refrigerant in evaporator 520 is heat exchanged with air in the refrigerator sent by cooling fan 521, and is evaporated. A damper distributes cool air having a low temperature to the compartments to reduce the internal temperatures of the compartments. If the refrigerator includes plural evaporators or decompression devices, the flow controller supplies the refrigerant to evaporators 520 requiring the refrigerant. The refrigerant discharged from evaporator 520 is supplied to compressor 516. The refrigeration cycle operates repetitively to cool the inside of the refrigerator.

[0091] The internal temperature of switchable compartment 506 can be changed in several stages from a freezing temperature range to a refrigerating temperature range, according to the user's purpose or favorite. According to Embodiment 4, the internal temperature of switchable compartment 506 can be changed to a refrigerating temperature ranging from 5°C to 0°C and a partial freezing temperature or a chilled temperature ranging from 0°C to -7°C. When the user activates operating panel 14 to change the temperature of switchable compartment 506, the controller 537 allows illuminator 513 to emit light having color predetermined corresponding to the temperatures.

[0092] According to this embodiment, illuminator 519 employs a fluorescent lamp to emit white light in refrigerating compartment 502, but the type of illuminator or the color of light emitted from the illuminator is not particularly limited. A light-emitting diode (LED) is used as illuminator 513. Illuminator 513 includes a board having LEDs emitting, for example, red light, green light, and blue light mounted thereon. Controller 537 controls the turning on and off of the LEDs to emit light having seven colors. Controller 537 may control the turning on and off of the LEDs to emit light having a single color or having two colors according to the number of temperature ranges to be changed, but the invention is not limited thereto.

[0093] The color of light emitted from illuminator 513 in each temperature range is not particularly limited. Ac-

cording to this embodiment, for example, white light identical the color of light from illuminator 519 is used at a refrigerating temperature. The color of light emitted at a relatively low temperature, such as a partial freezing temperature, suitable for storing fresh foods, such as meat and fishes, is determined to be violet which provides the user with cool and fresh feeling. The color of light emitted at a chilled temperature suitable for storing milk products or processed foodstuffs, is determined to be yellowish green providing the user with intermediate color feeling.

[0094] When the temperature of storage case 535 and the temperature of refrigerating compartment 502 are set to the same value, illuminator 513 may be turned off, thereby reducing power consumption or running costs.

[0095] The color of light changing according to the set temperature allows the user to visibly recognize the set temperature of storage case 535 or a change of the temperature of storage case 535. In addition, the user can easily determine what kind of items is stored in storage case 535 based on the color of light. When the set temperature of storage case 535 is different from that of refrigerating compartment 502, illuminator 513 emits color light different from that of illuminator 519. Therefore, the color of light emitted from illuminator 513 allows the user to recognize immediately that different temperatures are set to partitioned regions in the storage compartment. Thus, the user can store food suitable for the temperature set in each partitioned region, thus easily using refrigerator 5001.

[0096] The color of light makes the user feel that storage case 535 is clean or that food stored in storage case 535 is effectively refrigerated, hence satisfying the user to the refrigerator.

[0097] The wavelength of light emitted from the illuminator is not limited to a specific value. If the light emitted from the illuminator includes an ultraviolet ray, the ultraviolet ray can influence genes of microorganisms that are floating in the regions or adhered to the wall of the regions or the surface of food, and inactivate the proliferation of microorganisms. This operation maintains the hygienic conditions in the storage compartment, and delays the discoloration, foul odor, and slime on the surface of food caused by microorganisms. Therefore, refrigerator 5001 can improve the preservability of food with the light including ultraviolet ray emitted from the illuminator, and sanitarily store food.

[0098] Some kinds of mushrooms and fishes contain a lot of precursors of vitamin D. Ultraviolet ray is emitted to the precursors, and excites molecules of the precursors to cause the precursors to transform into vitamin D. Thus, refrigerator 1001 can store food while increasing the content of vitamin D in specific food stored in the storage compartment with illuminator 513 emitting ultraviolet ray.

[0099] Illuminator 531 emits light includes red light having a wavelength of about 650 nm and ultraviolet ray to facilitate generating anthocyanin, red plant pigment that is generally contained in, for example, apples, blueber-

ries, strawberries, green beefsteak plants, broccoli, eggplants, and purple sweet potatoes. Since anthocyanin is generally contained in vegetables or fruits, the temperature of storage case 535 is suitable for storing the vegetables. It is confirmed that anthocyanin, a kind of polyphenol, is efficacious for eyes, antiaging by antioxidative activities, and the hardening of the arteries, thus being good for the health.

[0100] The illuminator may include a fairy lamp, a light-emitting diode, a fluorescent lamp, or an ultraviolet lamp, but is not limited. The light-emitting diode generates little heat and has a low running cost, high durability, and high compatibility, thus being preferable.

[0101] The illuminator may be placed in any place in each of the partitioned regions as long as the user can see light emitted from the illuminator when opening the door. In addition, a cover made of resin or glass may be provided on the illuminator to protect the board from humidity, and to diffuse and strengthen light emitted from the illuminator.

[0102] Plural light sources 513A may be placed at one place in the same region, or may be placed at different positions in the same region.

[0103] Controller 537 may turn off illuminator 513 when hinged door 507 is closed, and turn on illuminator 513 only when the hinged door 507 is opened. In this case, detector 517 detects whether door 507 is opened or closed, and controller 537 may turn on and off illuminator 513. This operation prevents the lipid oxidation due to the light emitted to food and an increase in power consumption, while allowing the user to recognize the internal temperature of the storage compartment.

[0104] According to this embodiment, the internal temperature of storage case 535 can be changed to plural temperature ranges in refrigerating compartment 502. The internal temperature of refrigerating compartment 502 may also be changed. In this case, the color of light emitted from illuminator 519 may be changed according to the internal temperature of refrigerating compartment 502.

[0105] Shelf 588C positioned at the lowest position functions as a ceiling surface of storage case 535. Shelf 588C may be made of light-shielding material to prevent light from being scattered from each region to the outside. This structure increases the amount of light emitted to the regions, accordingly allowing the user to reliably recognize the color of light emitted to each region. The light-shielding material may be, for example, opaque resin, colored resin, or metallic material, but is not limited to them. The light-shielding material may have high reflectance, such as metallic material, to further increase the amount of light emitted to storage case 535, and thus to diffuse light entirely to storage case 535.

[0106] In refrigerator 5001, switchable compartment 506 is placed under refrigerating compartment 502 and above vegetable compartment 504 and freezing compartment 503. This layout enables a woman having an average height to open door 508 of switchable compart-

ment 506 and to take out food from switchable compartment 506 without bending her back, thus allowing the user to conveniently use refrigerator 5001. In addition, the woman having an average height can open or close door 510 of vegetable compartment 504, which is frequently used, and put a heavy vegetable into vegetable compartment 504 or take out the vegetable from vegetable compartment 504, without bending her back, thus using refrigerator 5001 conveniently. Further, the layout allows the user to conveniently use refrigerator 5001 while reducing physical load on the user.

[0107] In refrigerator 5001 according to this embodiment, in consideration to the usability, door 507 of refrigerating compartment 502 is a hinged door, and the doors of the other storage compartments are a drawer doors. However, they are not limited to them.

[0108] Refrigerating compartment 502 of refrigerator 5001 according to this embodiment includes illuminator 513 in storage case 535 having the internal temperature changed to plural temperature ranges as well as illuminator 519. Since the colors of light emitted from illuminators 519 and 513 are different from each other, the user can determine whether the regions have the same temperature or different temperatures. In addition, in refrigerator 5001, the user can realize the set temperature based on the color of light emitted from the illuminators, and can determine what kind of item is stored in the storage compartment based on the set temperature, thus providing convenient refrigerator 5001.

[0109] According to this embodiment, controller 537 changes the color of light emitted from illuminator 513 according to the temperature set in storage case 535. Thus, the color of light emitted from the illuminator is determined based on the set temperature. Refrigerator 5001 may include temperature detector 535A, such as a temperature sensor, for detecting the internal temperature of storage case 535. In this case, controller 537 may allow illuminator 513 to emit the light corresponding to the detected temperature.

[0110] According to this embodiment, the illuminator may be provided in storage compartments, such as freezing compartment 503 or vegetable compartment 504, other than storage case 535 having their temperature ranges changed, and emit light having light having specific color corresponding to adjustable temperature ranges. This structure can notify the user of the adjustable temperature ranges, and prevents overcooling and reduce energy consumption, thus helping the user to use the refrigerator.

[0111] Illuminator 513 does not necessarily emit lights of plural colors, but may emit specific color light corresponding to the internal temperature of storage case 535 or the kind of food stored in storage case 535. Alternatively, illuminators 513 emitting light of different colors may be provided in the corresponding storage compartments having different temperature ranges.

[0112] From the viewpoint of economic efficiency, such as standardization or commonality, illuminator 513

may emit light having plural color different from each other. The color of the light may be fixed to be a specific color selected from the colors corresponding to the temperature range set in each storage compartment.

EXEMPLARY EMBODIMENT 5

[0113] Fig. 6 is a cross-sectional view of refrigerator 6001 according to Exemplary Embodiment 5 of the invention. In Fig. 6, components identical to those of refrigerator 5001 shown in Fig. 5 are denoted by the same reference numerals, and their description will be omitted.

[0114] Thermal insulator 518 provided at the boundary between storage case 535 and refrigerating compartment 502 is made of one of urethane foam panel, styrene foam panel, laminate glass fiber, silica aerogel, and vacuum thermal insulator panel, but is not limited to them. Thermal insulator 518 improves the thermal insulating property of storage case 535, and prevents heat from transmitting between the partitioned regions even when the temperature changes from a relatively low temperature, such as a freezing temperature of -18°C to a relatively high temperature range from 40°C to 60°C . As a result, the user can use wide available temperature range, thus conveniently using refrigerator 6001. According to this embodiment, a change of the temperature in storage case 535 is small, and prevents food from being coated with frost at a temperature below a freezing temperature, thereby maintaining the quality of the food. In addition, thermal insulator 518 prevents heat from transmitting between the partitioned regions, and thus prevents unnecessary energy consumption and an increase of energy consumed by refrigerator 6001.

[0115] In the case that thermal insulator 518 is made of light-shielding material, thermal insulator 518 prevents light from being scattered from each partitioned region to the outside. This arrangement increases the amount of light emitted to the partitioned regions, and enables the user to reliably recognize the color of light emitted to each partitioned region,

[0116] Refrigerating compartment 502 of refrigerator 6001 according to this embodiment includes illuminator 513 in storage case 535 having the internal temperature changed to plural temperature ranges as well as illuminator 519. Since the colors of light emitted from illuminators 519 and 513 are different from each other, the user can determine whether the regions have the same temperature or different temperatures. In addition, in refrigerator 6001, the user can realize the set temperature based on the color of light emitted from the illuminators, and can determine what kind of item is stored in the storage compartment based on the set temperature, thus providing convenient refrigerator 6001.

EXEMPLARY EMBODIMENT 6

[0117] Fig. 7 is a cross-sectional view of refrigerator 7001 according to Exemplary Embodiment 6 of the in-

vention. In Fig. 7, components identical to those of refrigerator 5001 shown in Fig. 5 are denoted by the same reference numerals, and their description will be omitted.

[0118] Machinery compartment 512 accommodates therein main components, such as compressor 516 and a condenser, of a refrigeration cycle. Machinery compartment 512 is provided at an upper side of refrigerating compartment 502 and behind refrigerating compartment 502.

[0119] If the machinery compartment is provided behind freezing compartment 503, which is located at the lowest part of body 501, the machinery compartment reduces the volume of freezing compartment 503. In addition, in this structure, a woman having an average height need stretch to reach a rear upper corner of refrigerating compartment 502, thus using inconveniently the refrigerator. Thus, the rear upper side of refrigerating compartment 502 can hardly be used effectively.

[0120] In contrast, machinery compartment 512 is provided at the rear upper part of body 501, that is, at an upper side of refrigerating compartment 502 and behind refrigerating compartment 502, hence increasing the effective volume of freezing compartment 503 without increasing the size of body 501.

[0121] Refrigerating compartment 502 of refrigerator 7001 according to this embodiment includes illuminator 513 in storage case 535 having the internal temperature changed to plural temperature ranges as well as illuminator 519. Since the colors of light emitted from illuminators 519 and 513 are different from each other, the user can determine whether the regions have the same temperature or different temperatures. In addition, in refrigerator 7001, the user can realize the set temperature based on the color of light emitted from the illuminators, and can determine what kind of item is stored in the storage compartment based on the set temperature, thus providing convenient refrigerator 7001.

EXEMPLARY EMBODIMENT 7

[0122] Fig. 8 is a cross-sectional view of refrigerator 8001 according to Exemplary Embodiment 7 of the invention. In Fig. 8, components identical to those of refrigerator 5001 shown in Fig. 5 are denoted by the same reference numerals, and their description will be omitted.

[0123] Thermal insulator 518 made of light-shielding material is provided at the boundary between storage case 535 and refrigerating compartment 502. Machinery compartment 512 accommodating therein main components, such as compressor 516 and a condenser, of a refrigeration cycle is provided at the rear upper part of body 501.

[0124] Fig. 9 is a cross-sectional view of illuminator 513 according to this embodiment. Illuminator 513 includes light-emitting diode (LED) 526 emitting ultraviolet ray having a peak wavelength of 387 nm, LED 527 emitting blue light having a peak wavelength of 468 nm, board 528 having LEDs 526 and 527 mounted thereon, and

cover 529 covering board 528, for preventing a user from directly seeing illuminator 513. In addition, illuminator 513 is fixed to a ceiling surface of storage case 535 with, for example, screws so as to face downward, so that LEDs 526 and 527 emit light to the bottom of the storage case. Cushion 530 provided between cover 529 and storage case 535, and projections 531 provided around cover 529 prevent water drops from entering into illuminator 513.

[0125] Thermal insulator 518 increases the thermal insulating property of storage case 535, and prevents heat from transmitting between the partitioned regions even when the temperature changes from a relatively low temperature, such as a freezing temperature of -18°C to a relatively high temperature range from 40°C to 60°C . As a result, the user can use wide available temperature range, thus conveniently using refrigerator 8001. According to this embodiment, the thermal insulator 518 reduces a change of the temperature in storage case 535, and prevents food from being coated with frost at a temperature below a freezing temperature, thereby maintaining the quality of the food. In addition, thermal insulator 518 prevents heat from transmitting between the partitioned regions, and thus prevents unnecessary energy consumption and an increase of energy consumed by refrigerator 8001.

[0126] According to this embodiment, only when the temperature of storage case 535 is set to a chilled temperature range, a freezing point, or a partial freezing temperature range from 0°C to -5°C through operating panel 514, controller 537 turns on LEDs 526 and 527, but does not turn on LED 526 or 527 for the other temperature ranges.

[0127] Illuminator 513 includes LEDs 526 and 527, and emits purplish blue light to the inside of storage case 535, which is clearly different from the color of light emitted from illuminator 519. Therefore, the user can visibly realize that the internal temperature of storage case 535 is different from the temperatures of other regions of refrigerating compartment 502. The purplish blue color can make the user feel that storage case 535 is clean enough to preserve meat or fishes.

[0128] The chilled temperature range, the freezing temperature, or the partial freezing temperature range from 0°C to -7°C is used for storing items having a short shelf life, such as milk products, meat, or fishes while the items are partially frozen between a frozen state and a non-frozen state. These temperature ranges allow the items to be stored in the switchable compartment for a longer time than in a refrigerating temperature range and to be cooked easier than those in the refrigerating temperature range. For example, the items stored at these temperature ranges can be easy to cut with a knife. However, in these temperature ranges, food seems to be frozen, but the percentage of the food that is actually frozen is considerably lower than that in the freezing temperature range. In the food, an enzyme reaction, a lipid oxidation reaction, and the proliferation of microorganisms

are progressed, and the quality of food deteriorates with time. Therefore, fresh foods stored in these temperature ranges need to be used within one or two weeks. However, since the food seems to be frozen, the user may consider that the food stored in these temperature ranges can be stored as long as frozen food, and stores the food in the switchable compartment for a long time, hence causing the food to be decayed.

[0129] In order to solve these problems, in refrigerator 8001 according to Embodiment 7, when the internal temperature of storage case 535 is set within the freezing temperature range, controller 537 does not turn on illuminator 513. However, only when the internal temperature of storage case 535 is set within the chilled temperature range, the freezing temperature, or the partial freezing temperature range that is higher than the freezing temperature range, controller 537 turns on illuminator 513. When illuminator 513 illuminates storage case 537, the user recognizes that the internal temperature of storage case 537 is set to a low temperature suitable for storing, for example, fresh foods for a short time. That is, the user can visually recognize whether the temperature of the storage compartment is set to the freezing temperature or a low temperature based on light emitted from the illuminator. In the low temperature range in which illuminator 513 is turned on, the food is prevented from being left for a long time, and accordingly eliminates waste of food, hence providing convenient refrigerator 8001.

[0130] The ultraviolet ray emitted from LED 526 influences genes of microorganisms that are floating in storage case 535 or deposited to the wall surface of storage case 535 or the surface of food, and inactivates the proliferation of microorganisms. Thus, the refrigerator can maintain hygienic conditions in the storage compartment, and thus delay the discoloration, foul odor, and slime on the surface of food caused by microorganisms. Therefore, illuminator 513 emitting the ultraviolet ray improves the preservability of food and sanitarily stores food.

[0131] In general, ultraviolet ray emitted to food for a long time facilitates lipid oxidation of the food, and may cause the quality of the food to deteriorate. However, the ultraviolet ray is emitted to meat or fishes for a short time, such as one or two weeks, and hence, does not cause serious problems. In addition, illuminator 513 includes an LED, which emits an amount of light smaller than that emitted from other kinds of lamps, accordingly reducing the effect of light on the lipid oxidation. Since the LED generates little heat, light emitted from the LED affects less on cooling efficiency than other kinds of lamps.

[0132] Controller 537 may control the turning on and off of illuminator 513 in relation to the opening and closing of door 507. In this case, controller 537 may turn off LED 526 of illuminator 513 emitting ultraviolet ray when door 507 is opened. In the case that illuminator 513 is placed at a position that the user cannot see, illuminator 513 may be continued to turn on when the user opens and closes the drawer door. Since light including ultraviolet

rays is invisible to the user, controller 537 turns off LED 526 and turns on LED 527 emitting safe, visible light, when the door is opened. When the door is closed, controller 537 turns off LED 527 and turns on LED 526. Thus, the user can see visible light when opening the door, and easily realize the temperature range of the storage case. When the door is closed, LED 526 emits ultraviolet ray providing antimicrobial effect and reduce power consumption. Thus, refrigerator 8001 can be used easily, and has high preservability of the items, such as food, stored therein.

[0133] The position of illuminator 513 in storage case 535 is not particularly limited. However, illuminator 513 may be placed preferably at a position that cannot be directly seen by the user when hinged door 507 of the refrigerating compartment is opened, Illuminator 513 may be placed preferably at a position which a woman, in a certain country, having an average height standing upright cannot directly see when she opens hinged door 507. If the refrigerator is used in another country, the position of illuminator 513 may be determined preferably based on the average height of women of that country.

[0134] Cover 529 of illuminator 513 can prevent light emitted from the LED from being seen directly from the user. In this case, material of cover 529 is not limited to specific material, but preferably, is resin material having high light-transmittance. The material may have fine irregularities to prevent board 528 inside the cover from not being seen from the user.

[0135] In refrigerating compartment 502 of refrigerator 8001 according to this embodiment, illuminator 513 is provided in storage case 535 whose internal temperature can be changed to a plurality of temperature ranges as well as illuminator 519. Since the colors of light emitted from illuminators 519 and 513 are different from each other, the user can visibly determine whether the partitioned regions have the same temperature or different temperatures. In addition, in refrigerator 8001, the user can realize a set temperature based on the color of light emitted from the illuminator, and can visibly determine what kind of items is stored in the storage case based on the set temperature. In particular, controller 537 turns on illuminator 513 only when the internal temperature of storage case 535 is set to an intermediate temperature, such as the chilled temperature, the freezing temperature, and the partial freezing temperature, between the refrigerating temperature and the freezing temperature. This operation allows the user to recognize the temperature at which food which is partially frozen is stored, thereby providing convenient refrigerator 8001.

[0136] In the case that thermal insulator 518 or shelf 588C is made of light-shielding material, thermal insulator 518 or shelf 588C prevents light from being scattered from each partitioned region to the outside. This arrangement increases the amount of light emitted to the partitioned regions, and enables the user to reliably recognize the color of light emitted to each partitioned region, further, increases the effect of light emitted from illuminator

513 on food.

EXEMPLARY EMBODIMENT 8

[0137] Fig. 10 is a perspective view of refrigerator 9001 according to Exemplary Embodiment 8 of the invention. In refrigerator 9001, body 601 includes thermal insulating case 602 and doors 609, 610, 628, 630, 632, and 634. Partition wall 603 partitions the body into upper region 604 and lower region 605.

[0138] Lower region 605 positioned under partition wall 603 is divided into storage compartments having four drawer doors 628, 630, 632, and 634, respectively. Ice making compartment 628 and vegetable compartment 632 adjacent to each other are provided at the upper part of the lower region 605. Freezing compartments 630 and 634 adjacent to each other are provided at the lower part of the lower region 605.

[0139] Partition wall 606 partitions upper region 604 into left region 607 and right region 608. A front opening of left region 607 is closed with drawer door 609, and a front opening of right region 608 is closed by hinged door 610.

[0140] The width of drawer door 609 is smaller than the width of hinged door 610, and thus the volume of left region 607 is smaller than the volume of right region 608. Hinge 611 is provided on a side of hinged door 610 opposite to drawer door 609. That is, drawer door 609 is provided on the side opposite to the hinge of hinged door 610.

[0141] Space 612 is provided behind a portion where drawer door 609 and hinged door 610 are engaged with each other, and has a predetermined distance from a front opening in from of thermal insulating case 602. Cool air flows through space 612. Partition wall 606 is provided behind space 612 and extends to the back of upper region 604. That is, in upper region 604, left region 607 and right region 608 communicate with each other through space 612 provided in front of partition wall 606. Left region 607 and right region 608 in upper region 604 are refrigerating compartments having temperatures set to refrigerating temperatures.

[0142] Plural trays 613 are provided in left region 607 closed with drawer door 609. When drawer door 609 is opened, trays 613 are pulled out unitarily with drawer door 609.

[0143] Plural shelves 614 arranged to have items placed thereon are provided in right region 608 closed with drawer door 609 and hinged door 610. One side edge of each shelf 614 is supported and fixed to a bracket provided in inner case 615 of insulating case 602. Another side edge of each shelf 614 is supported and fixed to a bracket provided on a side surface of partition wall 606.

[0144] The internal temperature of storage case 535 can be changed to the refrigerating temperature, the chilled temperature, the freezing point, and the partial freezing temperature ranging from about 5°C to -5°C,

and thus, storage case 535 can store fresh foods, such as meat or fishes. A rail mechanism for allowing storage case 535 to slide in forward and backward directions is provided on respective side surfaces of inner case 615 and partition wall 606.

[0145] Respective front ends of shelves 614, storage case 535, and partition wall 606 are flush with each other. That is, the depth of space 612 formed from the front opening of thermal insulating case 602 to the front end of partition wall 606 is substantially equal to the distance from doors 609 and 610 to the front end of shelf 614 and the front end of storage case 535.

[0146] Left region 607 can store bottles, and right region 608 can be used as a refrigerating compartment. Drawer door 609 is provided on left region 607. Plural door trays are provided in space 612 that is closed by hinged door 610 that is provided in right region 608. These door trays are supported and fixed to brackets provided on the rear surface of hinged door 610, and open while door 610 is opened. Since left region 607 and right region 608 are configured to have different purposes, the user can manage the storage of beverages, seasoning, small items, or eggs so as to easily use the regions.

[0147] The depth of space 612 is determined to be large enough to include the depth of door 610. Thus, the depth of each of shelves 614 is reduced by the thickness of door 610. Partition wall 606 having the front end flush with the front ends of shelves 614 is located towards the back. This arrangement provides space 612 with a large depth, and accordingly, makes the user feel that the volume of upper region 604 is large. The front ends of shelves 614 are substantially flush with the front end of partition wall 606, and hence, makes the user feel that the refrigerator has a large storage.

[0148] Fig. 11 is a cross-sectional view of storage case 535 according to this embodiment. Shelf 614 is positioned above storage case 535. Illuminator 513 is provided at the uppermost part of rear surface 535B of storage case 535. Illuminator 513 illuminates the inside of storage case 535 substantially in a downward direction, not in a direction perpendicular to rear surface 535B.

[0149] Illuminator 699 is provided in right region 608 of the refrigerating compartment to illuminate the entire region. When the internal temperature of storage case 535 is set to an intermediate temperature between a refrigerating temperature and a freezing temperature, i.e., to the chilled temperature, the freezing temperature, or the partial freezing temperature ranging from 0°C to -7°C, illuminator 513 emits light having color different from that of light emitted from the above-mentioned illuminator. When the internal temperature of storage case 535 is set to the refrigerating temperature range, illuminator 513 is turned off, or emits light having the same color as that of light emitted from illuminator 699.

[0150] That is, illuminator 513 emitting light having color different from that of light emitted from illuminator 699 is provided in storage case 535 having the internal

temperature changed to plural temperature ranges. Since the colors of light emitted from illuminators 699 and 513 are different from each other, the user can visibly determine whether two partitioned regions of refrigerating compartment 502 have the same temperature or different temperatures. Illuminator 513 is turned on only when the internal temperature of the storage case is set to the chilled temperature, the freezing point, or the partial freezing temperature, which is an intermediate temperature between the refrigerating temperature and the freezing temperature. This structure makes the internal space of the storage case seem to be spacious. Therefore, in particular, when items having a short preservation period, such as fresh foods, are stored in the storage case, the refrigerator prevents the user from forgetting to use the stored items. In addition, when illuminator 513 is turned on, the user can visibly realize that the internal temperature of the storage case is set to a temperature for storing food partially frozen, and is reminded of the kind of the stored items and their preservation periods, thus providing a convenient refrigerator.

[0151] Two different illuminators 699 and 513 are provided in right region 608, and hence, makes the user feel that the right region is bright, and that refrigerator 9001 is spacious and convenient.

[0152] No illuminator is provided in left region 607 for storing liquor bottles or seasoning. Containers for storing liquor or seasoning that is generally stored in the refrigerator for a relatively long time are often made of light-transmittable material, hence facilitating the oxidation of items stored in the containers when light is emitted to the containers for a long time. These containers are preferably stored in a shaded area, and thus, left region 607 to which no light is emitted is has a shape suitable for storing bottles. Thus, the upper region is partitioned into left region 607 to which no light is emitted and right region 608 to which light is emitted, allowing refrigerator 9001 to be used conveniently and maintaining the quality of food stored for a long time.

[0153] As described above, in refrigerator 9001 according to this embodiment, the front opening of the refrigerating compartment positioned at the uppermost among plural storage compartments is partitioned into left and right, left region 607 and right region 608. Drawer door 609 is provided for opening and closing the left region, and hinged door 610 is provided for opening and closing right region 608. Hinged door 610 is positioned in opposite to drawer door 609 and has a size larger than that of drawer door 609. In right region 608 which is a region in a projection plane from the front side of hinged door 610, not only illuminator 699 also illuminator 513 that emits light having color different from that of light emitted from illuminator 699 is provided in storage case 535 having the internal temperature changed to plural temperature ranges. Therefore, different color lights are emitted in the right region.

[0154] Right region 608 which is a region in a projection plane from the front side of hinged door 610 has the larg-

est volume among the storage compartments of the refrigerator. Lights having different colors are emitted to a space including shelves 614 and the internal space of storage case 535, respectively, hence allowing the user to use the regions of the refrigerating compartment according to their purposes. Thus, the user is prevented from confusion when the user stores food in the refrigerating compartment, and thus the user can store food in the region suitable for its purpose. Thus, it is possible to improve the usability of a refrigerator, and maintain the quality of items stored in the refrigerator.

[0155] According to this embodiment, drawer door 609 is provided in left region 607 having a small width, the user can use the refrigerating compartment, which is generally located at the uppermost part, as a storage space corresponding to the drawer door and a storage space corresponding to the hinged door separately according to their purposes. In addition, lights having different colors are emitted to a storage space in storage case 535 and a storage space between shelves 614, which have different temperature ranges, by shelves 614 in a large storage compartment corresponding to the hinged door, the user can conveniently use the storage spaces according to their purposes. As a result, it is possible to prevent confusion when the user stores food in the refrigerating compartment, and thus, the user can store food in the spaces suitable for their purposes. Thus, it is possible to improve the usability of a refrigerator, and maintain the quality of items stored in the refrigerator.

[0156] Shelf 614A located at the lowest position among plural shelves 614 in right region 608 serves as a ceiling of storage case 535. In the case that shelf 614A is made of light-shielding material, the shelf can prevent light emitted from illuminator 513 from being scattered through storage case 535 to the outside. This structure increases the amount of light emitted to storage case 535, and accordingly, allows the user to recognize the color of light emitted to each partitioned region more clearly.

[0157] The ceiling of storage case 535 may be made of thermal insulating material. In this case, when the internal temperature of storage case 535 is set to a temperature out of the refrigerating temperature range, this material prevents heat from transmitting to another region, thus preventing a temperature change and reducing energy consumption.

[0158] The light-shielding material may include material, such as metal, having high reflectance, and further increase the amount of light emitted to storage case 535, and to emit light to entire storage case 535.

[0159] At least a surface of thermal insulator 518 facing storage case 535 may be coated with a reflective material, thereby preventing the scattering of light to the outside due to a light shielding effect, and increasing the amount of light emitted to storage case 535. In addition, the thermal insulator prevents heat from transmitting to another region, hence reducing a temperature change and energy consumption. The reflective material reflects light in the storage case. This structure increases the

amount of light emitted to storage case 535, and emits light to the entire storage case, thus providing a synergy effect including the light-shielding effect, the thermal insulating effect, and the light reflecting effect.

[0160] Illuminator 513 is provided at the uppermost part of rear surface 535B of storage case 535 and is directed slightly downward with respect to rear surface 535B. This arrangement allows light emitted from the illuminator to illuminate the entire space of storage case 535, hence allowing the user to easily recognize the light. In addition, this arrangement reduces the distance between a controller provided at the rear side of body 601 and the illuminator, accordingly arranging wirings easily.

[0161] The invention is not limited to Embodiments 1 to 8.

INDUSTRIAL APPLICABILITY

[0162] A refrigerator according to the present invention allows users to check the internal temperature of each compartment, and is applicable to apparatuses capable of storing food or other items at a constant temperature as well as the refrigerator.

Claims

1. A refrigerator comprising:

a body including a thermal insulating wall, the body having a plurality of regions partitioned with the thermal insulating wall;
a storage compartment provided in one of the plurality of regions;
a first illuminator provided in the storage compartment, the first illuminator emitting light having a plurality of colors; and
a controller operable to
set a temperature of the storage compartment to a plurality of temperature ranges,
select color from the plurality of colors corresponding to the set temperature range, and
allow the first illuminator to emit light having the selected color.

2. The refrigerator of claim 1, wherein the plurality of colors of the light emitted from the first illuminator correspond to the plurality of temperature ranges, respectively, and the controller operable to
set the temperature of the storage compartment to one of the plurality of temperature ranges, and
allow the first illuminator to emit the light of color based on the set temperature.

3. The refrigerator of claim 1, wherein the first illuminator includes a plurality of light sources.

4. The refrigerator of claim 1, wherein the plurality of light sources emit light having the plurality of colors, respectively.

5. The refrigerator of claim 1, further comprising:

a door for opening and closing the storage compartment; and
a detector for detecting whether the door is opened or closed,

wherein the controller allows the first illuminator to emit light when the detector detects that the door is opened.

6. The refrigerator of claim 5, wherein the controller is operable to
allow the first illuminator to emit light having one of the plurality of colors until a predetermined time after the door is opened, and
allow the first illuminator to emit light having color different from the one color when the predetermined time elapses after the door is opened.

7. The refrigerator of claim 1, wherein the body includes a refrigerating compartment provided above the storage compartment,
a vegetable compartment provided under the storage compartment, and
a freezing compartment provided under the storage compartment.

8. The refrigerator of claim 1, further comprising:

a refrigeration cycle for cooling the storage compartment;
a compressor forming the refrigeration cycle; and
a machinery compartment provided at an uppermost part of the body, the machinery compartment accommodating the compressor therein and is.

9. The refrigerator of claim 1, wherein the controller is operable to
set the temperature of the storage compartment selectively to a first temperature range and a second temperature range higher than the first temperature range,
allow the first illuminator emit when the temperature of the storage compartment is set to the second temperature range, and
allow the first illuminator not to emit light when the temperature of the storage compartment is set to the first temperature range.

10. The refrigerator of claim 1, wherein at least a portion of the insulating wall comprises light-shielding ma-

terial.

11. The refrigerator of claim 1, wherein a region located at an uppermost position out of the plurality of regions has a front opening, said refrigerator further comprising;
a first door for opening and closing the front opening;
and
a second door for opening and closing the front opening, the second door and the first door partitioning the front opening into left and right, the second door having a size larger size than a size of the first door.

12. The refrigerator of claim 11, wherein the first door is a drawer door, and the second door is a hinged door.

13. The refrigerator of claim 11, further comprising a partition wall located behind a boundary between the first door and the second door, the partition wall partitioning the region located at the uppermost position into regions.

14. The refrigerator of claim 1, further comprising a second illuminator emitting, to a region other than the one of the plurality of regions, light having color different from the color of light emitted from the first illuminator.

15. A refrigerator comprising:

a body having a thermal insulating wall, the thermal insulating wall partitioning the body into a plurality of regions;
a storage compartment provided in one of the plurality of regions;
a detector for detecting a temperature of the storage compartment;
a first illuminator provided in the storage compartment, the first illuminator emitting light having a plurality of colors; and
a controller operable to
set the temperature of the storage compartment to a plurality of temperature ranges,
select color from the plurality of colors based on the detected temperature, and
allow the first illuminator to emit light having the selected color.

16. The refrigerator of claim 15, wherein the controller is operable to
allow the first illuminator to emit light having one of the plurality of colors when the detected temperature is equal to or lower than a predetermined temperature, and
allow the first illuminator to emit light having color of the plurality of colors other than the one of the plurality of colors when the detected temperature is

higher than the predetermined temperature.

17. The refrigerator of claim 15, wherein the first illuminator includes a plurality of light sources.

18. The refrigerator of claim 15, wherein the plurality of light sources emit light having the plurality of colors, respectively.

19. The refrigerator of claim 15, further comprising a door for opening and closing the storage compartment, wherein the detector detects whether the door is opened and closed, and the controller allows the first illuminator to emit light having the one of the plurality of colors when the detector detects that the door is opened.

20. The refrigerator of claim 19, wherein the controller is operable to
allow the first illuminator to emit light having the one of the plurality of colors until a predetermined time elapses after the door is opened,
allow the first illuminator to emit light having color different from the one of the plurality of colors when the predetermined time elapses after the opening of the door.

21. The refrigerator of claim 15, wherein the body includes
a refrigerating compartment provided above the storage compartment,
a vegetable compartment provided under the storage compartment, and
a freezing compartment provided under the storage compartment.

22. The refrigerator of claim 15, further comprising:

a refrigeration cycle for cooling the storage compartment;
a compressor forming the refrigeration cycle; and
a machinery compartment provided at an uppermost part of the body, the machinery compartment accommodating the compressor therein.

23. The refrigerator of claim 15, wherein the controller is operable to
set the temperature of the storage compartment selectively to a first temperature range and a second temperature range higher than the first temperature range,
allow the first illuminator to emit light when the temperature of the storage compartment is set to the second temperature range, and
allow the first illuminator not to emit light when the temperature of the storage compartment is set to the

first temperature range.

- 24.** The refrigerator of claim 15, wherein at least a portion of the insulating wall comprises light-shielding material. 5
- 25.** The refrigerator of claim 15, wherein a region located at an uppermost position out of the plurality of regions has a front opening, said refrigerator further comprising; 10
a first door for opening and closing the front opening; and
a second door for opening and closing the front opening, the second door and the first door partitioning the front opening into left and right, the second door 15
having a size larger size than a size of the first door.
- 26.** The refrigerator of claim 25, wherein the first door is a drawer door, and the second door is a hinged door. 20
- 27.** The refrigerator of claim 25, further comprising a partition wall located behind a boundary between the first door and the second door, the partition wall partitioning the region located at the uppermost position 25
into regions.
- 28.** The refrigerator of claim 15, further comprising a second illuminator emitting, to a region other than the one of the plurality of regions, light having color different from the color of light emitted from the first illuminator. 30

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Fig. 1

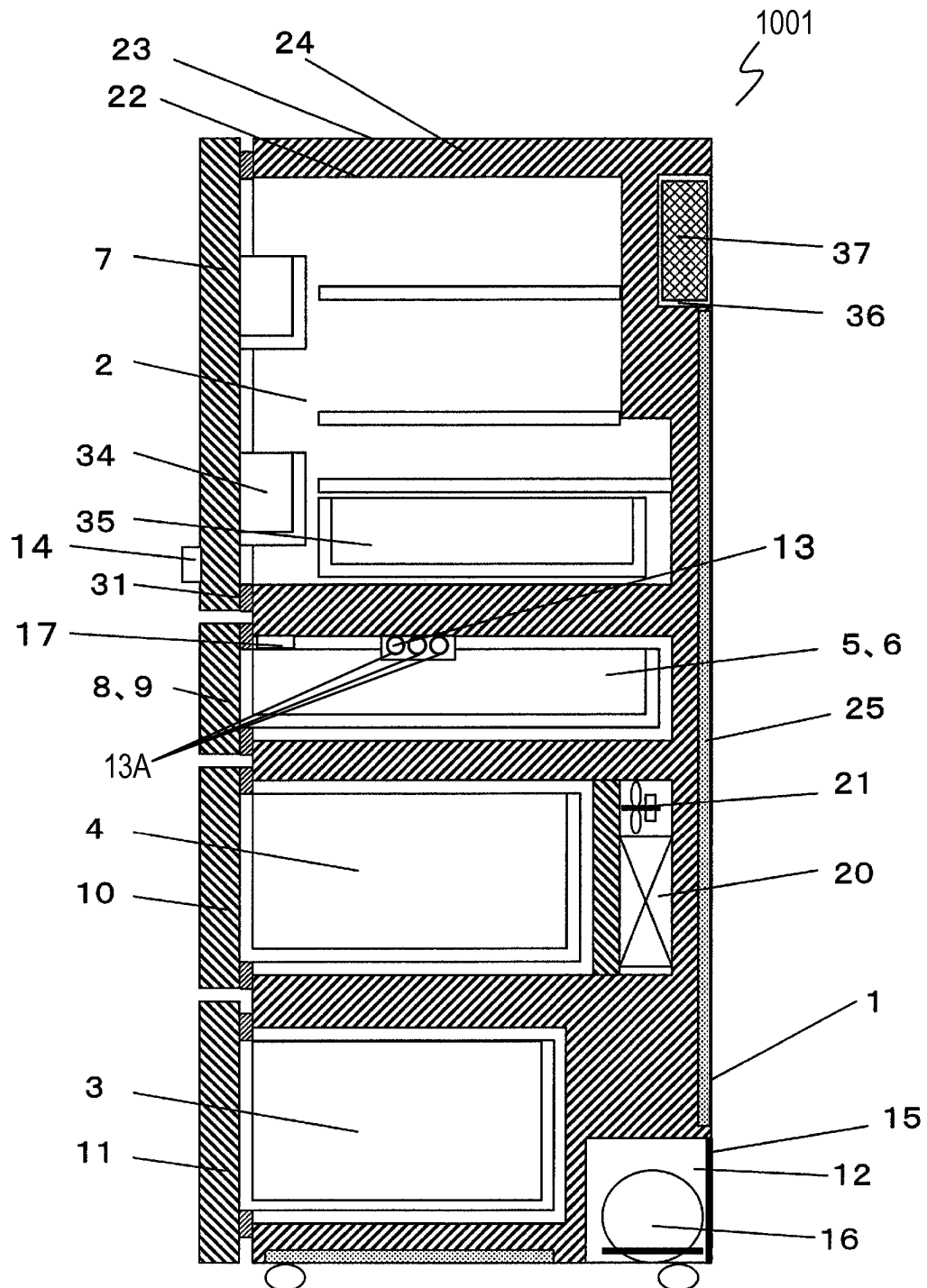


Fig. 2

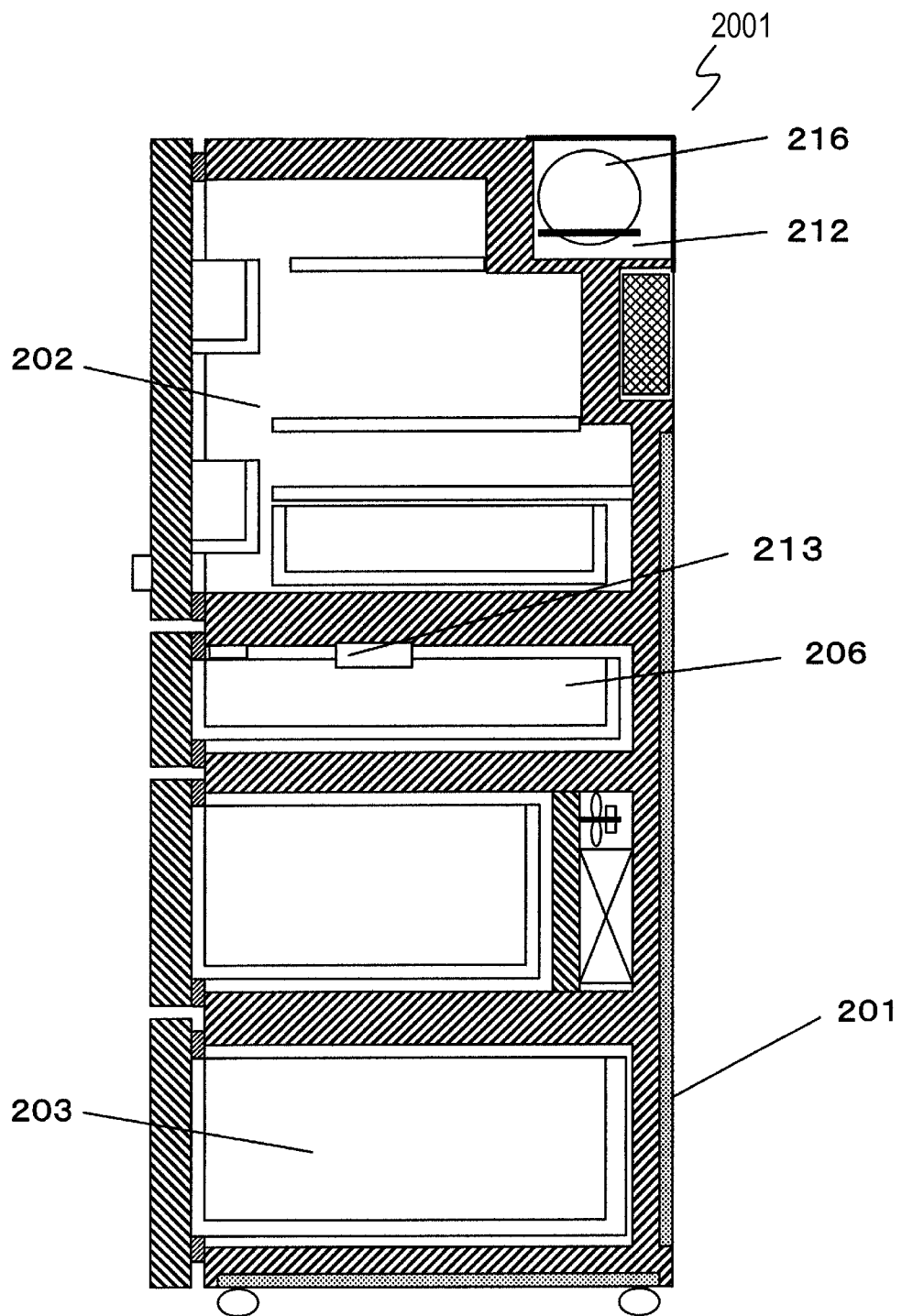


Fig. 3

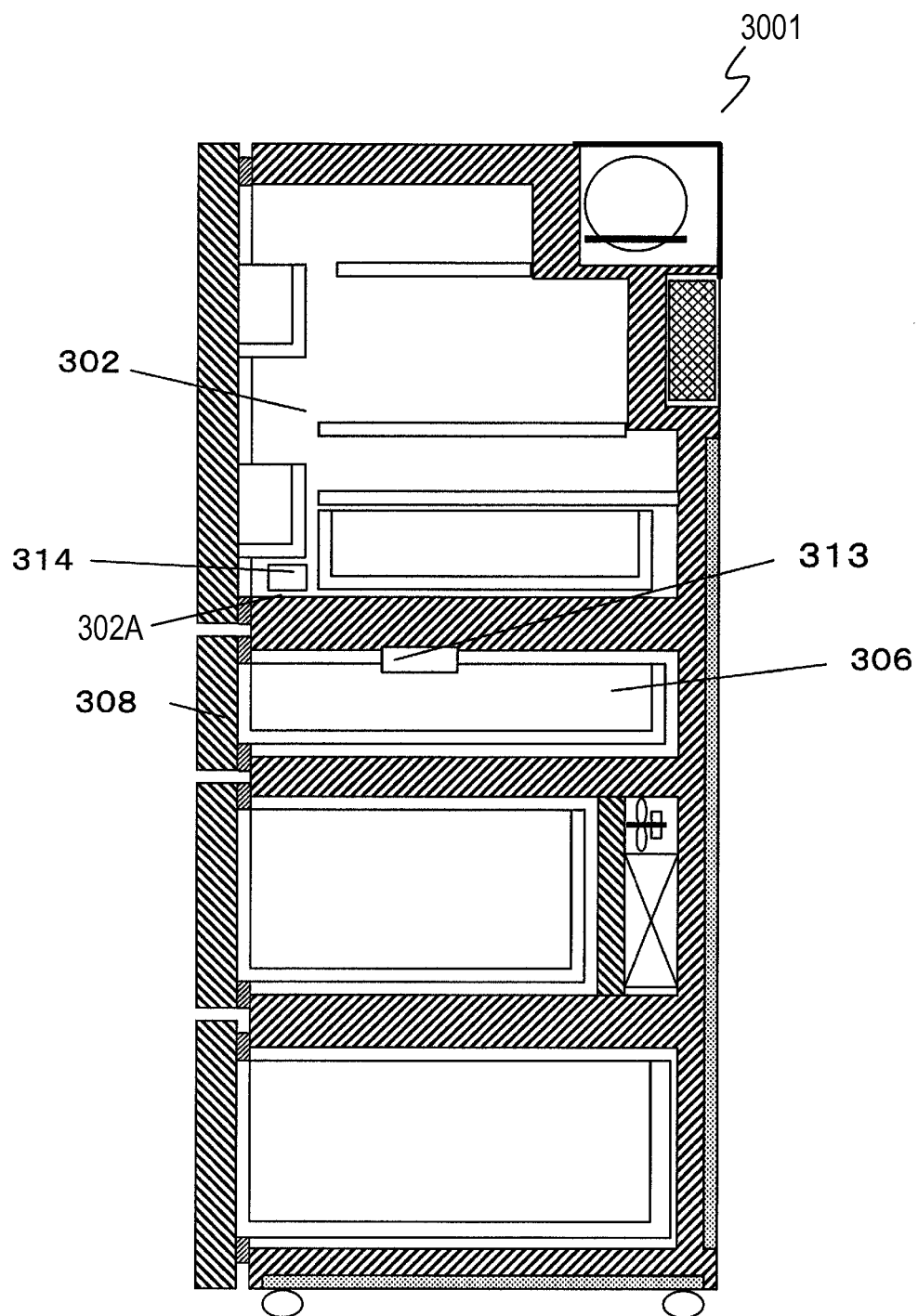


Fig. 4

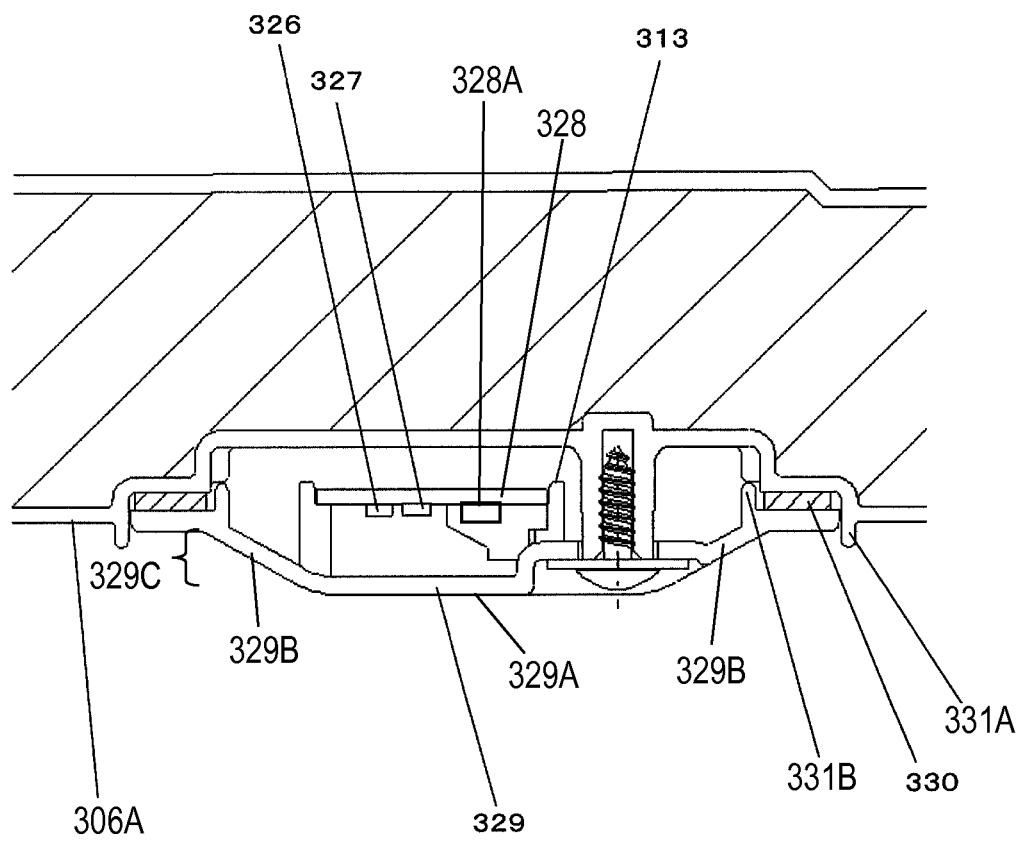


Fig. 5

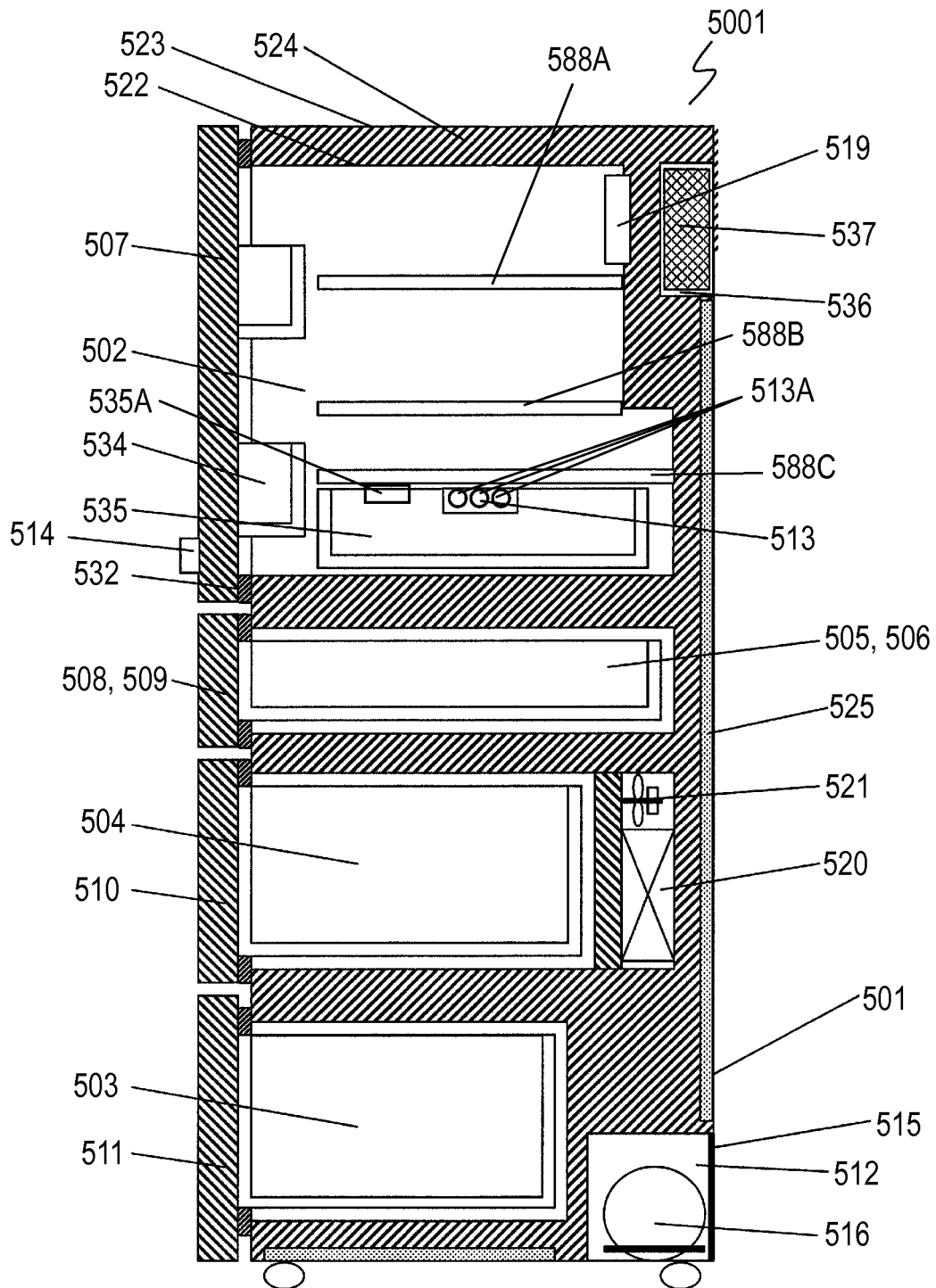


Fig. 6

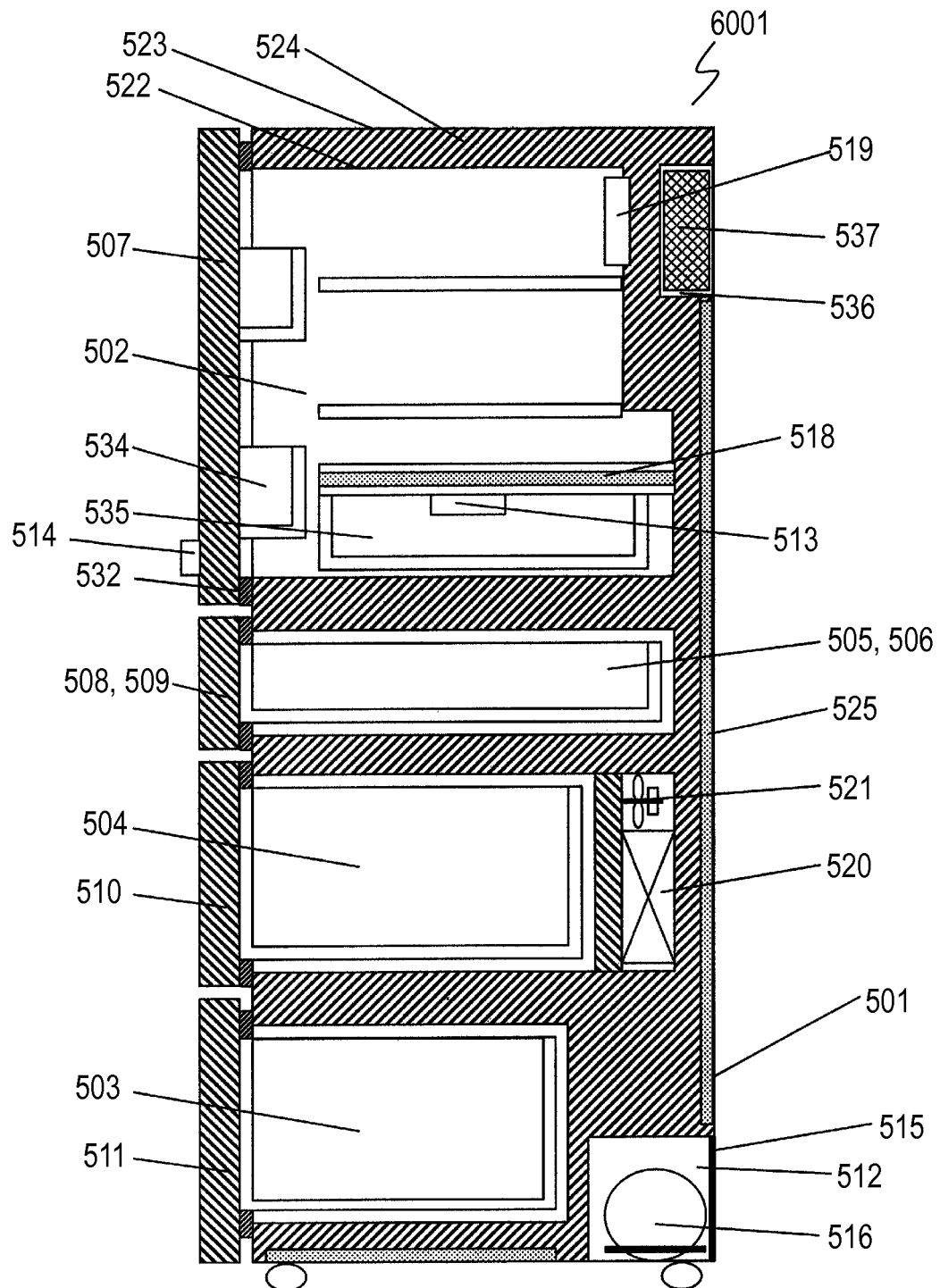


Fig. 7

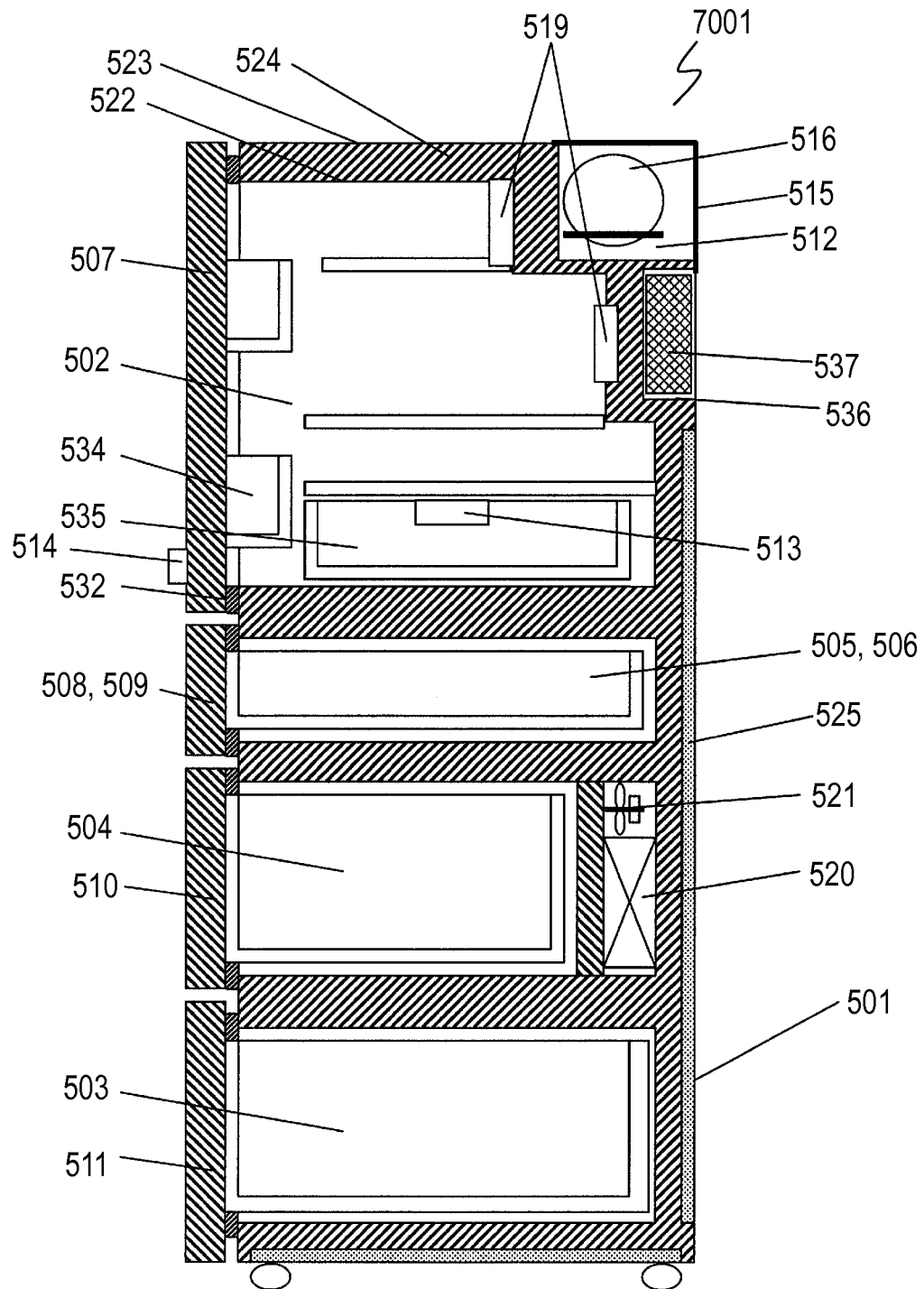


Fig. 8

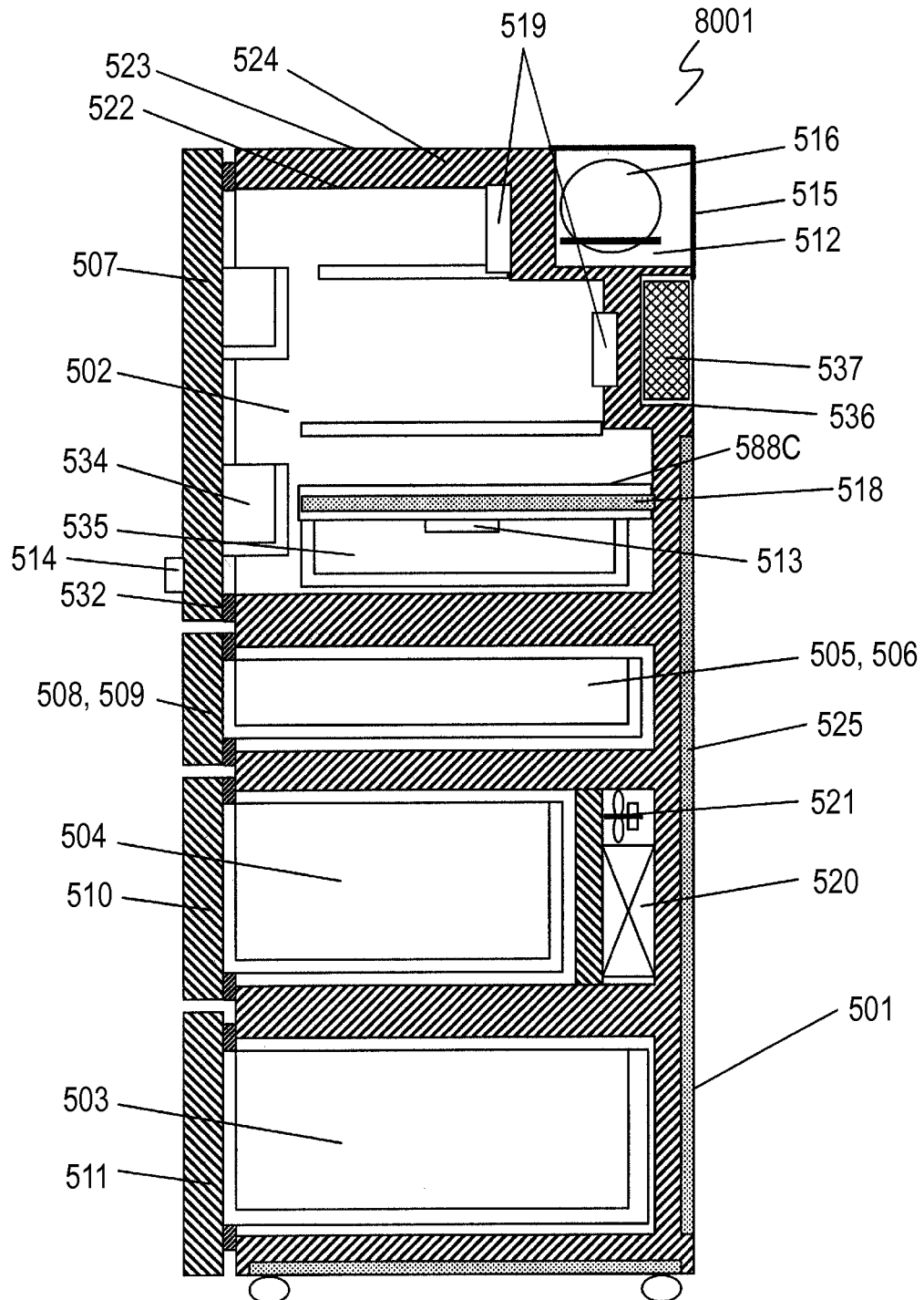


Fig. 9

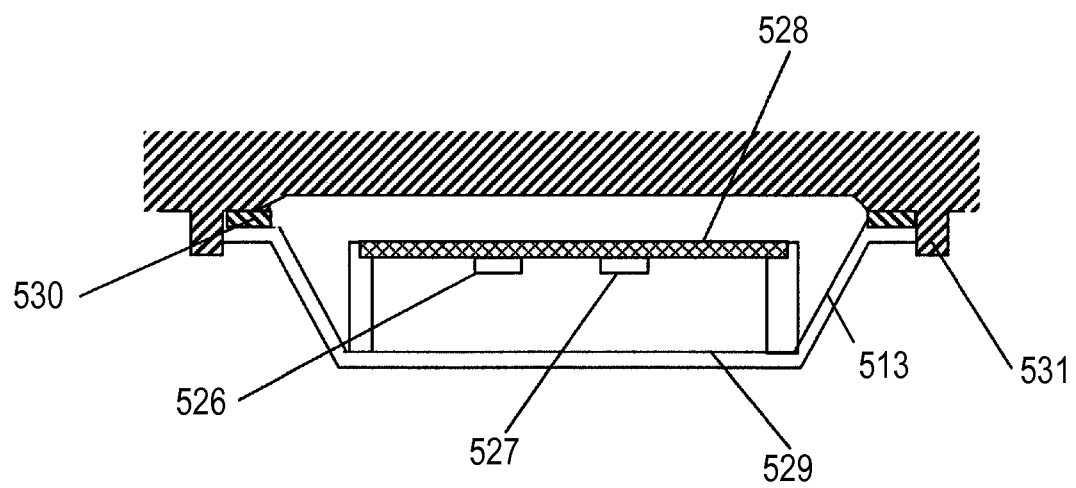


Fig. 10

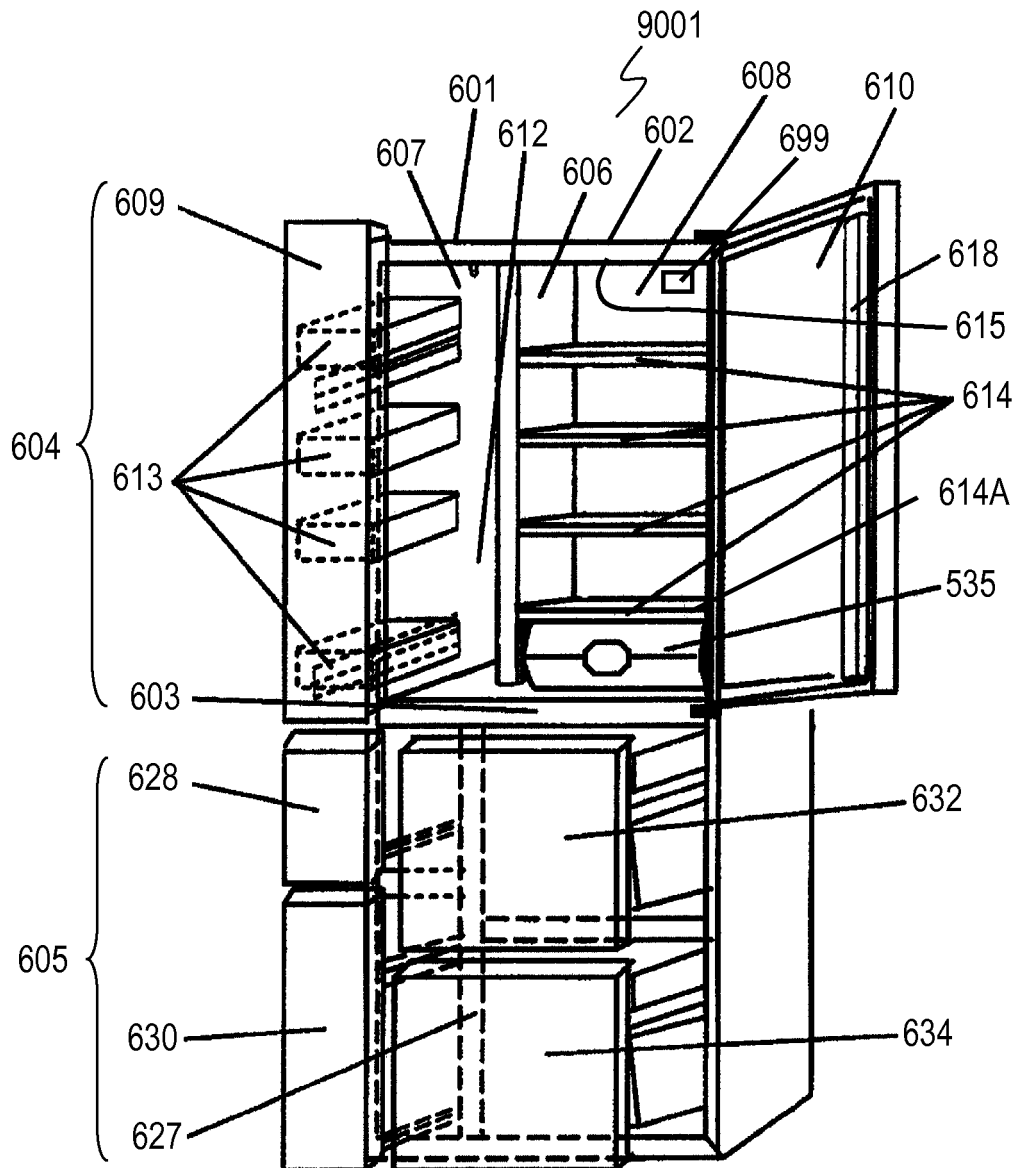


Fig. 11

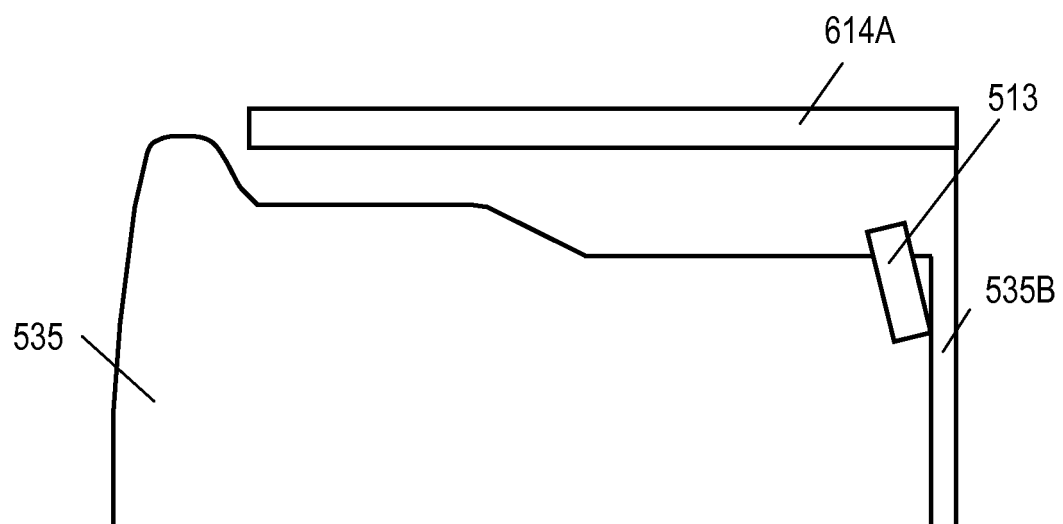


Fig. 12

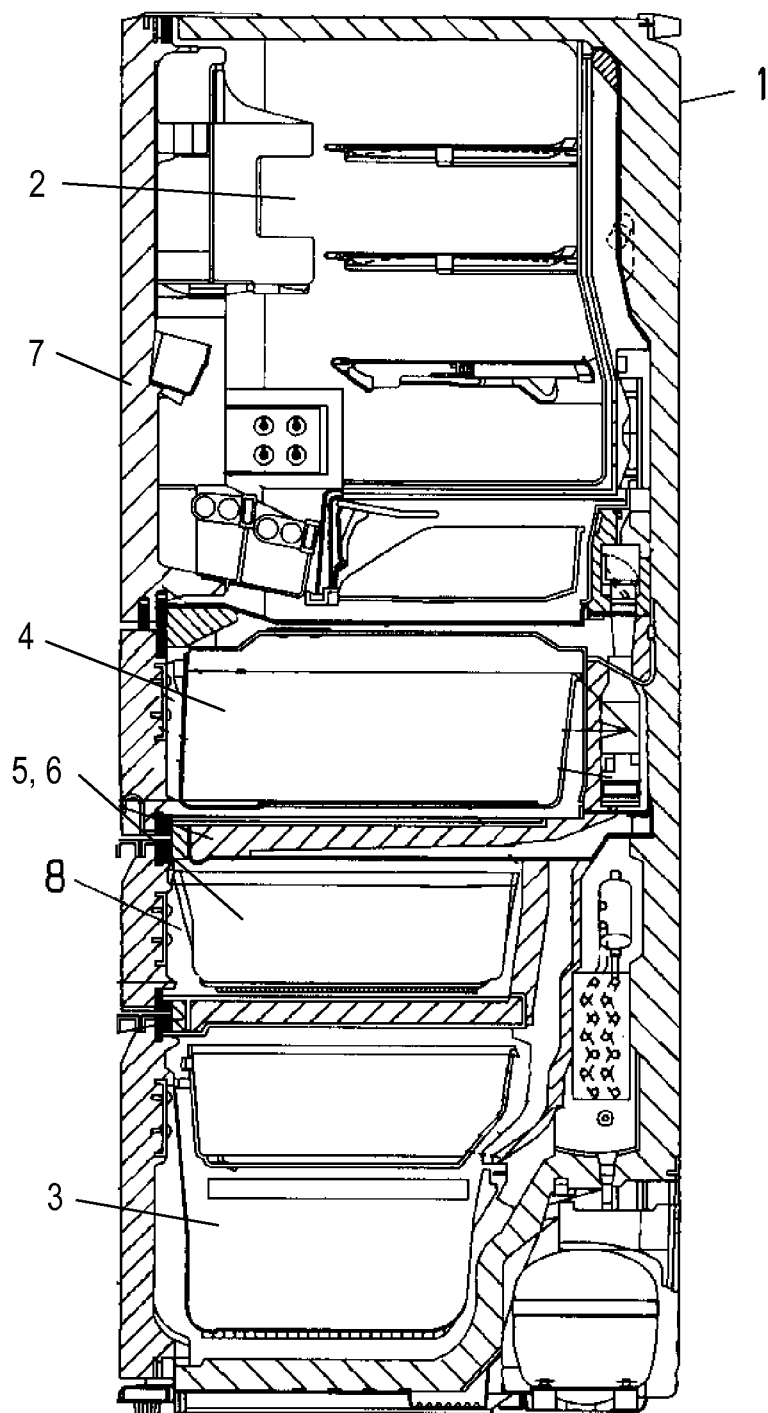
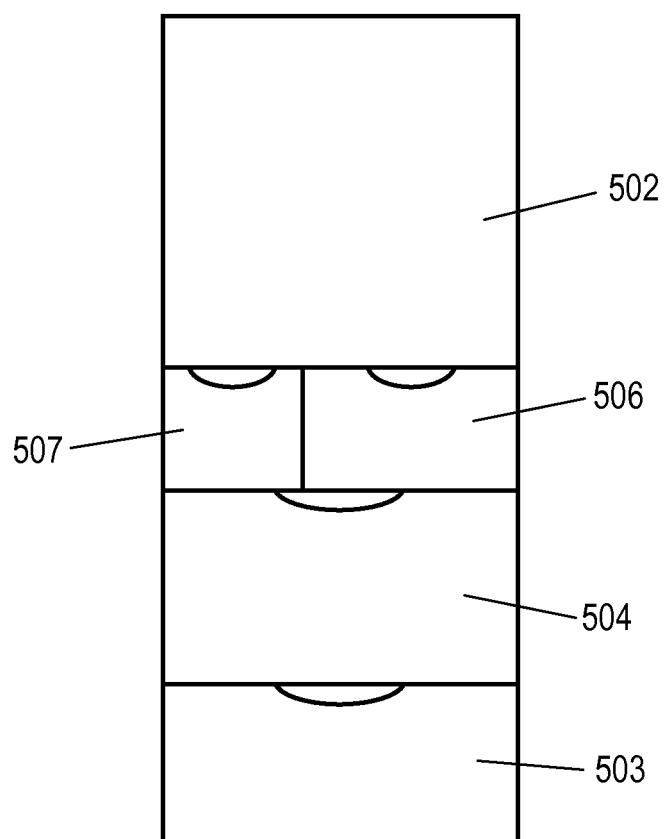


Fig. 13



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/310140

A. CLASSIFICATION OF SUBJECT MATTER

F25D27/00(2006.01), **F25D11/02**(2006.01), **F25D23/00**(2006.01), **F25D29/00**(2006.01), **G09F9/00**(2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F25D27/00(2006.01), **F25D11/02**(2006.01), **F25D23/00**(2006.01), **F25D29/00**(2006.01), **G09F9/00**(2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2006
Kokai Jitsuyo Shinan Koho	1971-2006	Toroku Jitsuyo Shinan Koho	1994-2006

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2004-286333 A (Fujitsu General Ltd.), 14 October, 2004 (14.10.04), Claims; Par. Nos. [0001] to [0027]; Figs. 1 to 9	1-28
A	JP 2000-186883 A (Matsushita Refrigeration Co.), 04 July, 2000 (04.07.00), Full text; all drawings	1-28
A	JP 2002-13864 A (Mitsubishi Electric Corp.), 18 January, 2002 (18.01.02), Full text; all drawings	1-28

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
02 June, 2006 (02.06.06)

Date of mailing of the international search report
13 June, 2006 (13.06.06)

Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2006/310140

JP 2004-286333 A	2004.10.14	(Family: none)	
JP 2000-186883 A	2000.07.04	(Family: none)	
JP 2002-13864 A	2002.01.18	US 6055826 A	2000.05.02
		CN 1217460 A	1999.05.26

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000186883 A [0003]
- JP 2002013864 A [0006]